URBAN GreenUP

D5.4: NBS implementation conclusions and recommendations. Final NBS catalogue

WP 5 , T 5.5

Date of document

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[1] PU = Public

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1 Abstract

This document is a detailed evaluation that aims to present and contextualize monitoring results, evaluate the performance of each NBS, and assess the overall impact of the URBAN GreenUP project in each Frontrunner (FR) cities. By considering KPI and nature-based solutions (NBS) performance reports, it provides an assessment of the impact of NBS within each city, and an overview of the final status of the interventions in each of the FR cities. This assessment considers various factors sourced from two main areas.

Firstly, assessments conducted in the initial project phases within WP1 determine the weights assigned to each variable. This includes prioritizing key performance indicators (KPIs) for each NBS in each city and evaluating the potential impact of the NBS on various challenges. Secondly, the monitoring program in WP5 provides raw values of the impact through KPI reports, which compile data collected during monitoring, and NBS reports, which assess the combined impact of each NBS on the city challenges.

Chapter 3 describes the methodology used in the overall assessment of the NBS through the performance of the KPIs. This assessment is based on the KPI reports and the cities' assessment of the NBS. It explains the formula used to calculate and evaluate the overall performance of the KPIs and NBS interventions.

The final status of the NBS in each front-runner city at the close of this document is shown in Chapter 4, where most of the NBS are reported as finalised.

Chapter 5 -7 contain an analysis of the technical, economic, social and environmental barriers encountered when monitoring KPIs and during the NBS intervention and operation phases in each FR city. They also detail the evaluation of the overall performance of the NBS interventions.

Chapter 8 summarizes the main conclusions, and offers recommendations for NBS implementation based on the experience gained during the URBAN GreenUP project.

Finally, a complete annex has been included with the report catalogue of the measured KPIs and the complete catalogue of assessed NBS.

2 Introduction

This document is the report of the activity carried out in the framework of Task 5.5:

> *Following the **methodology** given in **WP1**, each city will define an **overall performance formula** by establishing **weights** to the **KPIs**. Those weights may depend on social, meteorological or other local aspects and they are defined prior to any NBS implementation. Each city will obtain a global evaluation as a function of the KPIs with their associated weights after its NBS implementation demo is terminated. Moreover, an **overall conclusion** of demo exercises and associated results will be derived and **recommendations** will be provided for future and for both front-runners cities and follower's ones.*

It is therefore a work of collecting, digesting and contextualising the activity carried out during WP5. This document compiles the activity carried out during the monitoring, the evaluation of the impact that the NBS have had in each city and also collects the deviations in the processes, identified barriers and lessons learned.

Apart from the close relationship with the rest of the WP5 tasks, this task also draws on other work packages for its development: NBS monitoring and implementation tasks in WP 2-3-4, as well as information sources and assessments carried out within WP1.

The following diagram shows the workflow of the task, as well as the relationships with other Tasks and Work Packages.

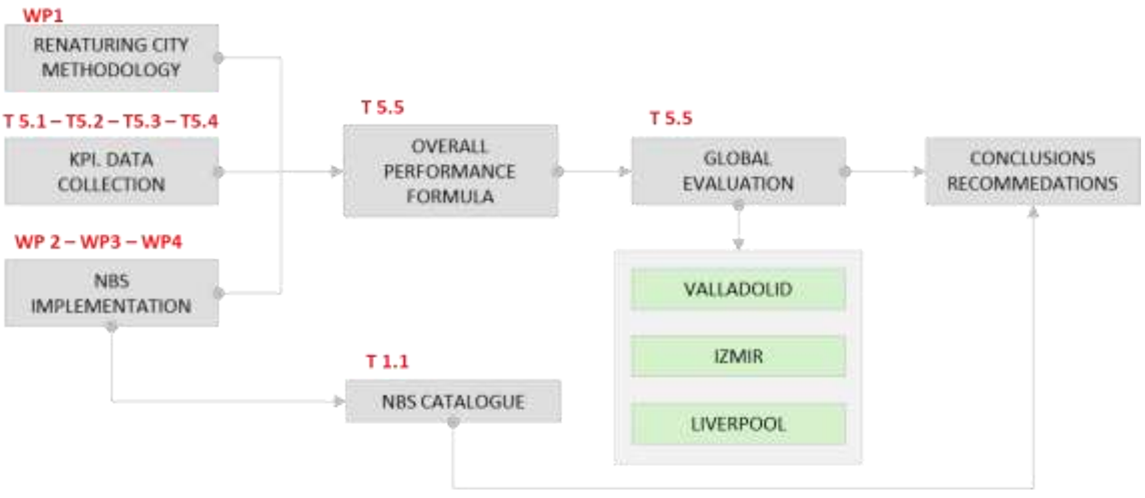


Figure 2.1. Process diagram of Task 5.5 and related tasks.

3 Overall performance formula

The overall assessment of the impact of the NBS within each city responds to different variables.

The factors to be considered come from two main sources:

- Assessments made in the first phases of the project carried out within WP1. The results of this phase will compose the weight assigned to each variable.
    - KPI prioritization: asses the relevance of each KPI for each NBS within each city.
- Results of the monitoring programme carried out in WP5. The values obtained as a result of the monitoring are the raw values of the impact.
    - KPI reports: gathers the data collected during the monitoring of WP5 and assesses the final impact observed for each KPI.
    - NBS reports: contextualises the results obtained from all the KPIs associated with each NBS and assesses the joint impact of that NBS on the City Challenges.

3.1 Establishing weight

In the KPI prioritization process, the challenges defined by the EKLIPSE methodology, re-adapted in URBAN GreenUP T1.2-D1.2 and identified for each city on earlier studies of the project, will be listed. For each challenge listed, the KPIs previously determined in WP5 monitoring studies will appear in the next column. Then, the cities will match those KPIs with NBSs which are being implemented in their demo sites and listed in the top two rows of the matrix. Taking into consideration the results of this output and the pre-determined prioritization questions, a score between 1 and 5 will be assigned to each KPI to determine the priority of this KPI for each NBS. The list of the questions and their explanations are given in the table in section 2.1.4 Questions to prioritize the KPIs (D1.8: KPIs calculation tool and prioritization criteria).

Table 1. The questions scored for each KPI can be seen in the table below

#	List of Questions	Comments / Explanations
Q1	Is the methodology/KPI credible?	Who uses this method? Is it recognized as best practice or widely accepted/used in decision making or compliance monitoring?
Q2	Is it practical, reliable and replicable?	Can one/two people do this quickly and accurately?
Q3	Does other similar data exist for comparison and benchmarking?	Here or in other comparable cities or partner cities. Are there accepted thresholds?
Q4	Does it offer good value for time/money invested?	Can we get results quite quickly? Are consumables and parts affordable? Is it resource efficient?
Q5	Will it further our understanding / add value to the NBS solutions? How much does it tell the story of the NBS solutions?	Is it meaningful? Is it appropriate? Is it understandable? Is it convincing?
Q6	Do we have the expertise/software/time to make the analysis?	Can this be done in-house? Is there a training need?

The average value will be determined as a result of the scoring for 6 questions. Scoring will be made by project teams of each city by internal discussions. Based on these averages, the city's KPI prioritization will be visualized as follows via the spider diagram given in section 3.1. The Likert scale used is from 0 – 5, (0) meaning no use, (1) being poor, (2) limited value, (3) satisfactory/complementary, (4) good while (5) meaning very good or the best we have available.

As a result, each city has obtained a matrix with each of the measured KPIs shown in rows, and the related NBS in columns. The values contained in the matrix show the priority relationship of each KPI with respect to each NBS.

The conceptual development of this matrix can be found in the D1.8: KPIs calculation tool and prioritization criteria. These values will be included as a calculation factor in the overall performance formula.

3.2 Reporting the performance of the KPIs and NBS

The core pillar of the overall evaluation is based on the measurement of the KPIs that the Cities and Technical Partners of the project have carried out throughout the monitoring programme deployed in each Front-runner City within the framework of the WP5.

While Task 5.4 was concerned with managing and storing the data in the relevant databases and hosting the data, Task 5.5 requires a further step in terms of interpreting the data, how the NBS have performed and what the overall perception of the impact of the RUP has been in each of the cities. In addition, possible deviations, unforeseen events and re-conductions provide valuable information that should be captured and reflected as part of the legacy of the URBAN GreenUP project.

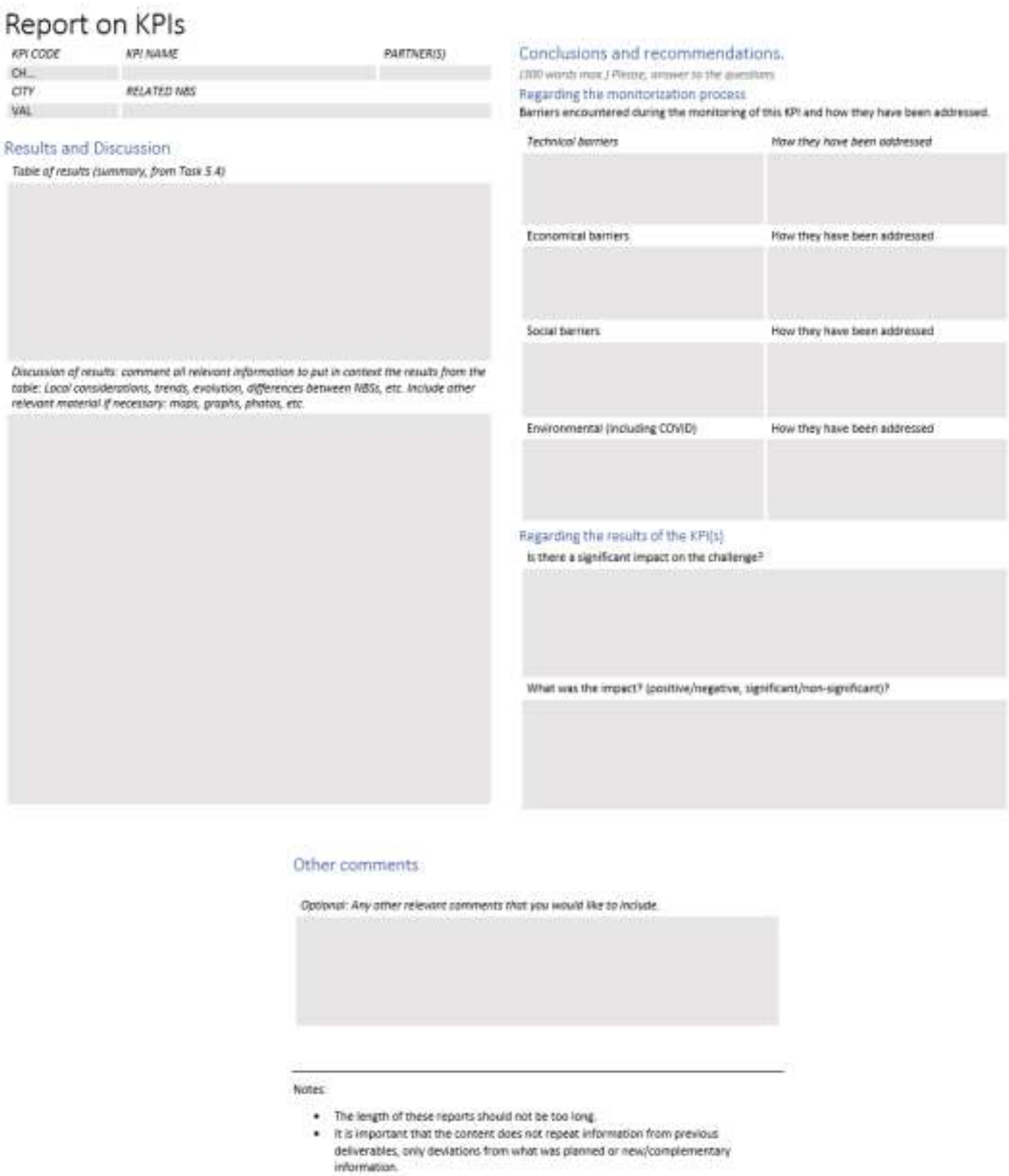
In order to collect this data in an organised and harmonised way, two templates were designed and distributed to the cities (Valladolid, Izmir and Liverpool), which coordinated the work carried out by the technical partners.

The objectives of these templates are:

- **To present and contextualise the results obtained during monitoring for each KPI.** Incidents of the process, discussion of results, supplementary material (graphs, tables, etc.).
- **To evaluate the performance of each NBS.** Joint assessment of NBS-related KPIs, pictures, recommendations and conclusions. This will complement the NBS catalogue.
- **To evaluate the impact of the URBAN GreenUP project in each city.** Overall evaluation, global recommendations and conclusions

3.2.1 KPI template report

The aim of this template is to present and contextualise the results obtained during monitoring for each KPI.



Report on KPIs

KPI CODE	KPI NAME	PARTNER(S)
CH_		
CITY	RELATED NBS	
VAL		

Results and Discussion

Table of results (summary, from Task 5.4)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Conclusions and recommendations.

(300 words max.) Please, answer to the questions

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

What was the impact? (positive/negative, significant/non-significant)?

Other comments

Optional: Any other relevant comments that you would like to include.

Notes:

- The length of these reports should not be too long.
- It is important that the content does not repeat information from previous deliverables, only deviations from what was planned or new/complementary information.

Figure 3.1. View of the empty Report on KPIs template

The first section of the template is dedicated to general data, such as KPI code, name, city and partner in charge of the indicator. It also includes a field to indicate the NBS to which the KPI is related.

The second section includes detailed information on the development of the KPI in terms of results. First, a summary of the numerical results of the indicator is included. This is followed by a section on the discussion and contextualisation of the results. This section will include all the elements necessary for the contextualisation of the data, including graphic material such as charts, images, maps, etc.

The third section is dedicated to the development of the measurement work and the overall conclusion on the analysed impact on the KPI. This section is divided into two parts. The first part refers to the barriers encountered in the development of the measurement work. A bias has been introduced in the template to differentiate the typology of barriers into technical, economic, social and environmental. This last group includes the difficulties due to the restrictions established by the different municipalities during the pandemic. In addition, it was also intended to collect the measures that have been taken or could be taken to address the barriers.

The second part of this section includes the overall assessment of how the impact of this KPI has been perceived in the related challenge, indicating whether it has been positive, negative, significant or non-significant.

Finally, a section for general comments has been included to collect other relevant information that could not be covered in the previous sections.

The KPIs reports are included in Annex.

3.2.2 NBS template report

The NBS template for data collection has a very similar structure to the one above. The objective is to obtain information about the impact and behaviour of the NBS installed in the FR Cities. It also aims to capture the experience of using cities, the problems associated with their operation and the barriers that cities have had to deal with and how they have been solved.

As in the previous case, the first section of the template is identifying. It lists the KPIs associated with each NBS, the name of the NBS, when it was implemented and the partner responsible.

In the second section "Results and discussion", the impact of the NBS on the city is described in detail, based on the associated KPI data and contextualising all of them in the real city environment.

Similar to the KPI template, it was also intended to collect the identified barriers that cities have encountered in terms of technical, economic, social and environmental barriers. In this case, the barriers have been differentiated into two separated stages: during the implementation process and during the operation process. The objective is to reflect the issues both during the construction and installation of the NBS and once they have been installed, including incidents of interaction with the city-citizens as well as problems in the maintenance of the NBS. For each barrier identified, a box has also been included to indicate how it has been managed during the project and/or how it is proposed to be solved with a view to new experiences.

The NBS reports are included in Annex.

Report on NBS

*This template aims to collect significant, relevant and accurate modifications on the NBS implemented during the project.

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH...; CH...; CH...		
CITY	*DATE OF IMPLEMENTATION*	
VAL-IZM-LIV		

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Conclusions and recommendations.

Please, answer to the questions

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Economical barriers	**How they have been addressed**
Social barriers	**How they have been addressed**
Environmental (including COVID)	**How they have been addressed**

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Economical barriers	**How they have been addressed**
Social barriers	**How they have been addressed**
Environmental (including COVID)	**How they have been addressed**

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

Notes:

- The length of these reports should not be too long but trying to include all the relevant information to develop the assessment
- It is important you try to avoid duplicated information from previous deliverables, only deviations from what was planned or new/complementary information.

Figure 3.2. View of the empty Report on NBS template

3.3 Building the overall performance formula

For each KPI, the impact of the NBS that are part of the evaluated practices is assessed. This assessment is carried out qualitatively, but assigns a certain importance to the impact according to different aspects, such as intensity, interactions with other factors, permanence of the impacts, etc. For each NBS it is proposed to assess the associated KPIs in terms of the following aspects:

Table 2. Description of the qualitative factors assessed for the characterisation of impacts.

TI	Type of impact	It reflects the character of the impact on the challenge
	No impact	The impact of the NBS on the indicator is null, so its implementation does not imply an effect on the city's adaptation or resilience to the challenge assessed.
+	**Beneficial impact**	The impact of the NBS on the indicator is positive, so its implementation leads to an improvement in the city's adaptation or resilience to the assessed challenge.
-	**Detrimental impact**	The impact of the NBS on the indicator is negative, so its implementation implies a decrease in the city's adaptation or resilience to the assessed challenge.
IN	Intensity	It refers to the incidence of the NBS over the Challenge.
6	**High impact**	The KPI has detected a significative impact and contributes significantly to the Challenge.
3	**Medium impact**	The KPI has detected a significative impact but cannot contribute significantly to the Challenge.
1	**Low impact**	The KPI has detected a weak impact that cannot contribute significantly to the Challenge.
EX	Extension	It reflects the extent of the specific component of the environment that is affected by the implementation of the NBS.
6	**City**	The effect of the NBS on the KPI is presented globally across the city.
5	**Neighbour**	The effect of the NBS on the KPI occurs in several neighbouring streets or neighbourhoods.
4	**Street**	The effect of the NBS on the KPI is presented at the level of the whole street or relative area.
2	**Building/local**	The effect of the NBS on the KPI occurs in the areas closest to the NBS (nearby surroundings or nearby buildings).
1	**Punctual**	The effect of the NBS on the KPI is very localised and punctual, within the boundary of the NBS itself.
MO	**Moment**	It refers to the term comprised between the moment that the impact is committed, and the first registry of the effect over the environmental factor
6	**Immediate**	The expression of the impact occurs immediately after the installation of the NBS.
4	**Short-term**	The expression of the impact occurs in the short term after the installation of the NBS (< 1 year)
2	**Medium-term**	The expression of the impact occurs in the medium term after the installation of the NBS (1- 2 year)

1	**Long-term**	The expression of the impact occurs in the long term after the installation of the NBS (>5 year)
SY	**Synergy**	The effect produced by the NBS on the KPI is synergistic if it enhances the overall effect of other KPIs on this or other challenges.
6	**Synergic**	their interaction is quite synergistic
3	**Moderate**	produces medium or low synergy
1	**Without synergism or simple**	It does not produce synergistically effects with other KPIs
FR	**Frequency**	It refers to how prompt is the manifestation of a given effect.
6	**Continuous**	when the manifestation is constant
3	**Periodical**	when they manifest in regular cycles
1	**Irregular (sporadic)**	the manifestation is repeated without a regular periodicity

While it is interesting to assess each of the factors analysed separately, a formula for the overall assessment of the impact generated by NbS in cities is proposed below. This simple formula establishes the degree of impact according to the higher or lower score obtained in the different factors, classifying it as weak, low, medium and high. In addition, weights will be established according to the result of the prioritisation of KPIs carried out previously. This value has already been evaluated.

Table 3. Quantification of impacts and classification

I	**Impact**	*I = +/-[IN+SY+FR+MO+EX]*W*
25-30	Very high	The impact is significant, and represent a relevant advance on the Challenge's objectives.
19-24	High	The impact is significant, and represent a certain advance on the Challenge's objectives
13-18	Medium	The impact is significant, but does not represent a major advance on the Challenge's objectives
5-12	Low	The impact on the KPI is irrelevant compared to the aims and objectives of the NBS
w	**Weight**	It reflects relevance of the KPI in the valorisation of the impact (task 1.6.2.)
2.6-5	High	High priority, values from 2.6 to 5. Weight increases 10%
0-2.5	Low	Low priority, values from 0 to 2.5. Weight increases 0%

The task of assessing the NbS has been done through a tool created in Excel, with the NbS of each city in the columns, and the KPIs assessed in the rows.

For each KPI, each expert selects the estimated values for each of the factors. The assessment is based on the experience obtained in the evaluation of the KPIs, whose reports can be consulted in the annex.

4 NBS Implementation

This section shows the final status of the interventions in each of the FR Cities.

4.1 Valladolid

The full aspects of the NBSs developed in Valladolid City have been integrated into Deliverable no. 2.3 which can be checked for more detailed information regarding those NBS.

This epigraph shows a summary list of the current catalogue of NBS actions in the city of Valladolid by subdemos, including a categorical assessment of the state of development of each of them. More specifically, 4 categories have been proposed to evaluate the current state of the NBS plan:

- **Cancelled**: The proposed NBS is cancelled and therefore, it is not going to be executed.
- **On-going**: The proposed NBS is not cancelled but is still in developing process, i.e. PPP, design, tec.
- **Started**: The implementation works has started. In non-technical actions, this state means the action is executing but not finished yet.
- **Finished**: The implementation works has finished and the NBS is working. In non-technical actions means the activity is finished.

If appropriate, a brief description of the possible deviations from what was initially planned is also included.

4.1.1 Subdemo A

The **Sub-Demo A: Green Corridor**, to re-nature the concept of cycle lane in Valladolid, crosses the city from West to East.

This location will host the new green cycle lane and re-naturing existing bike lanes, tree related actions and vertical noise barriers and natural pollinator's modules. The complete list of NBS is shown in next Table.

Table 4. Summary of NBS located in Subdemo A (Valladolid interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
1 - Re-naturing urbanization	Green route	Vac1	**New green cycle lane**	**Finished**
	Arboreal interventions	Vac2	**Planting 1000 trees**	**Finished**
		Vac3	**Tree shady places**	**Finished**
	Resting areas	Vac6	**Green Resting Areas**	**Finished**
2 - Water interventions	SUDS	Vac8	**SUDs for green bike lane**	**Cancelled**
3 - Singular GI	Cycle-pedestrian infrastructures	Vac15	**Cycle-pedestrian green paths**	**Finished**

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
	Smart soils	Vac16	**Smarts soils as substrate**	**Finished**
	Pollinators	Vac19	**Natural pollinator's modules**	**Finished**
	Vertical GI	Vac22	**Green Noise Barriers**	**Cancelled**

As can be seen in the table above, all the actions expect two cancelled planned for Subdemo A in Valladolid are finished. The non-technical actions common to all areas are showed in a separated epigraph.

4.1.2 Subdemo B

The **Sub-Demo B: City Center**, is conceived to re-nature urban areas with low availability of space for green infrastructure.

Vertical and horizontal green interventions, tree related actions and pollinator's modules are going to be developed, as well as other interventions as the electrowetland and the urban garden biofilter. The complete list of NBS is shown in the next Table.

Table 5. Summary of NBS located in Subdemo B (Valladolid interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
1 - Re-naturing urbanization	Arboreal interventions	Vac4	**Shade and cooling trees**	**Finished**
3 - Singular GI	Horizontal GI	Vac26	**Electro wetland roof**	**Finished**
		Vac27	**Green Covering Shelter**	**Finished**
		Vac28	**Green Roof**	**Finished**
		Vac29	**Green Shady Structures**	**Finished**
	Pollinators	Vac20	**Compacted pollinator's modules**	**Finished**
	Pollutants filter	Vac30	**Urban Garden Bio-Filter**	**Finished**
	Smart soils	Vac17	**Smarts soils as substrate**	**Finished**
	Vertical GI	Vac23	**Green Noise Barriers**	**Finished**
		Vac24	**Vertical mobile garden**	**Finished**
		Vac25	**Green Façade**	**Finished**

As can be seen in the table above, all the actions planned for Subdemo B in Valladolid are finished.

4.1.3 Subdemo C

Sub-Demo C: New models of re-naturing urban areas, has four main locations: C1- Football Stadium area (parking), C2- Sustainable Park, C3- Floodable Park and C4- Urban farming activities.

This location will include a re-naturing parking area, the Sustainable Urban Park, the Floodable Park, as well as natural pollinator's modules and urban farming. The complete list of NBS is shown in the next Table.

Table 6. Summary of NBS located in Subdemo C (Valladolid interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
1 - Re-naturing urbanization	Arboreal interventions	Vac5	**Re-naturing parking trees**	**On-going**
	Carbon capture	Vac7	**Urban Carbon Sink**	**Finished**
2 - Water interventions	Flood actions	Vac11	**Floodable Park**	**Cancelled**
	Green pavements	Vac14	**Parking Green Pavement**	**On-going**
	SUDS	Vac10	**Rain gardens**	**On-going**
		Vac9	**SUDs for renaturing parking**	**On-going**
	Water treatment	Vac12	**Green filter area**	**Cancelled**
		Vac13	**Natural wastewater treatment Plant**	**Cancelled**
3 - Singular GI	Pollinators	Vac19	**Natural pollinator's modules**	**Finished**
		Vac20	**Compacted pollinator's modules**	**Finished**
		Vac21	**Natural pollinator's modules**	**Finished**
	Smart soils	Vac18	**Smarts soils as substrate**	**Finished**
	Urban Farming	Vac31	**Urban orchards**	**Finished**
		Vac32	**Community composting**	**Finished**
		Vac33	**Small-scale urban livestock**	**On-going**
4 - Non-technical interventions	Educational activities	Vac34	**Educational path in VAc13**	**Cancelled**
		Vac35	**Educational path in VAc11**	**Cancelled**
		Vac36	**Farming Educational Active**	**Finished**

As can be seen in the table above, most of the actions planned for Subdemo C in Valladolid are finished.

There are 3 actions ONGOING related to water, due to technical barriers to implement this kind of projects in an urban consolidated context, but today resolved. These works are planned to finish in May 2023.

4.1.4 Non-technical actions

Some non-technical interventions for environmental education, engagement, city coaching and support activities, are developed in the three Sub-Demo areas indistinctly. All of them are summarized into the next Table.

Table 7. Summary of Non-technical actions located in Valladolid

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
4 - Non-technical interventions	City coaching	Vac39	**Promotion of ecological reasoning/intelligent**	**Finished**
	Engagement	Vac37	**Engagement Portal for citizens**	**Finished**
		Vac38	**Sponsoring activities**	**Finished**
	Support activities	Vac40	**Single desk for RUP deployment**	**Finished**
		Vac41	**Support to citizen project of NBS**	**Finished**
		Vac42	**City mentoring strategy**	**Finished**

All of the non-technical activities in Valladolid city have already finished, but some on them will continue after the final of the project, because of the interest for citizens and stakeholders, and the role of the Valladolid City Council in the promotion of ecological reasoning, support to citizen, and engagement activities between others.

4.2 Liverpool

This epigraph shows a summary list of the current catalogue of NBS actions in the city of Liverpool by sub-demos, including a categorical assessment of the state of development of each of them. Four categories have been used to evaluate the current state of the NBS planned:

- **Cancelled**: The proposed NBS is cancelled and therefore, it is not going to be executed.
- **On-going**: The proposed NBS is not cancelled but is still in developing process, i.e. PPP, design, tec.
- **Started**: The implementation works has started. In non-technical actions, this state means the action is executing but not finished yet.
- **Finished**: The implementation works has finished and the NBS is working. In non-technical actions means the activity is finished.

Where appropriate, a brief description of the deviations from what was initially planned is also included.

4.2.1 Subdemo A

The **Baltic Corridor** is south of Liverpool City Centre and connected to the Business Improvement District demonstration area by Bold Street. The green route corridor links the area on Bold Street with Wapping Dock and passes through several distinct communities. The key challenges in this corridor were to:

- engage different stakeholders and link up the social spaces between the homes and businesses to promote greater fluidity of use and functionality in the Baltic area,
- find space, especially underground space, for retrofitting Nature Based Solutions into a constrained busy area.

This location hosted actions involving re-naturing urbanization, water interventions and Singular Green Infrastructures, as well as non-technical interventions which are indicated on a separate epigraph. The complete list of NBS is shown in the next Table. and as it can be seen, all the actions are finished.

Table 8. Summary of NBS located in Subdemo A (Liverpool interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
1 - Re-naturing urbanization	Arboreal interventions	LAc-5	**Shade trees**	**Finished**
		LAc-6	**Cooling trees**	**Finished**
	Green route	LAc-1	**New pedestrian and cycleway green route**	**Finished**
	Urban carbon sink	LAc-7	**Urban Carbon Sink**	**Finished**
2 – Water Interventions	SuDS	LAc-8	**Raingarden SuDS**	**Finished**
3 - Singular GI	Floating gardens	LAc-16	**Saltwater ecosystem island**	**Finished**
	Pollinators	LAc-12	**Pollinator verges**	**Finished**
		LAc-13	**Pollinator walls vertical**	**Finished**

Preliminary work also identified permeable or green pavement interventions in sub demo A but these were transferred and delivered as part of a larger scheme in sub demo B.

It was also hoped that a few green resting areas could be incorporated into the Baltic route at NBS locations. However, additional funding was required and it was not possible to source this during the pandemic so the seating plans were put on hold to be completed at a later date.

4.2.2 Subdemo B

The city centre of Liverpool is one of the least well-resourced neighbourhoods of the city for green space. It is constrained by its density and the limited availability for green space development. However, there opportunities for targeted interventions that tackle specific issues, such as flood risk, using NBS.

All the actions are complete except LAc-11 Biochar which was cancelled. The Biochar initiative was cancelled because a preliminary independent report highlighted that the composition of Biochar was unregulated and often variable with samples showing elevated levels of potential toxins. As the Biochar was to be used in tree pits on a high profile and high value scheme a political decision was taken to cancel the trial of Biochar for this project.

The complete list of these is shown in the next Table.

Table 9. Summary of NBS located in Subdemo B (Liverpool interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
1 - Re-naturing urbanization	Arboreal interventions	LAc-5	**Shade trees**	**Finished**
		LAc-6	**Cooling trees**	**Finished**
	Green route	LAc-2	**Green travel route**	**Finished**
	Urban Carbon Sink	LAc -7	**Urban Carbon Sink**	**Finished**
2 - Water interventions	Flood actions	LAc-4	**Urban catchment forestry**	**Finished**
	Hard Drainage pavement	LAc-10	**Green pavement**	**Finished**
3 - Singular GI	Smart Soils	LAc-11	**Enhanced nutrient managing and releasing soil (Biochar)**	**Cancelled**
	Pollinators	LAc-13	**Pollinator walls vertical**	**Finished**
		LAc-14	**Pollinator roofs**	**Finished**
	Pollutants filter	LAc-17	**Green filter area**	**Finished**
	Vertical GI	LAc-15	**Mobile gardens**	**Finished**

4.2.3 Subdemo C

Sub-Demo C is a suburban site, a green area with extensive biodiversity, but with associated drainage issues. Therefore, water interventions are quite relevant to this location, as well as other NBS interventions which are described in the following next Table.

Table 10. Summary of NBS located in Subdemo C (Liverpool interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
1 - Re-naturing urbanization	Arboreal interventions	LAc-5	**Shade trees**	**Finished**
	Carbon capture	LAc-7	**Urban Carbon Sink**	**Finished**
	Green route	LAc-1	**New pedestrian and cycleway green route**	**Finished**
		LAc-3	**Road junction pedestrian improvements**	**Finished**
2 - Water interventions	SUDS	LAc-8	**Water retention ponds**	**Finished**
	Hard drainage (flood prevention)	LAc -9	**Hard drainage (civils work for flood prevention)**	**Finished**

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
3 - Singular GI	Pollinators	LAc-12	**Pollinator verges**	**Finished**
	Floating gardens	LAc-add3	**Freshwater ecosystem island**	**Finished**

All planned works for Demo C have finished.

Initially there were plans for a green fence in sub demo C but this initiative was transferred and delivered in sub demo B instead where it had a greater impact and higher profile. An opportunity was taken to introduce and test an additional small floating freshwater ecosystem in sub demo C as well.

4.2.4 Non-technical actions

Non-technical Interventions were an important element of the planned work which added significant value to the project through engaging communities and working with partners and stakeholders. Opportunities explored include engagement activities such as Forest Schools, Forest Church, wood allotments, a bio app, arts projects and a range of other activities promoting citizen physical and mental health and wellbeing. In addition, a key focus of this work was also work with stakeholders to develop a Re-naturing Urban Plan and a city mentoring strategy. The complete list of these non-technical actions is shown in next Table.

Table 11. Summary of Non-technical actions located in Liverpool

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
4 - Non-technical interventions	City coaching	LAc-27	Promotion of ecological reasoning	**Finished/Ongoing**
	Educational activities	LAc-18	Wood allotments	**Cancelled**
		LAc-19	GI for Education	**Finished**
		LAc-20	Forest School	**Finished**
	Engagement	LAc-21	Engagement Portal for citizens	**Finished**
		LAc-22	Green art/engagement	**Finished**
		LAc-23	Forest church	**Finished**
		LAc-24	Bio APP	**Finished**
		LAc-25	GI for Physical Health	**Finished**
		LAc-26	GI for mental health	**Finished**
	Support activities	LAc-28	Single window/desk for RUP deployment	**Finished**
		LAc-29	Support to citizen project of NBS	**Finished/Ongoing**
		LAc-30	City mentoring strategy	**Finished/Ongoing**

The planned wood allotments were cancelled due to the pandemic lockdown which restricted the ability of people to meet in public. Although other successful wood allotment initiatives had been successfully set up previously, the UK pandemic restrictions prevented the group meeting or working on site and the project became increasingly difficult to deliver in the remaining project time. As a result, a formal project amendment request was made to convert the small sum of funding for the wood allotments into additional engagement activity for other non-technical interventions

Three of the non-technical interventions are finished but by their nature also remain ongoing. These include:

- Promotion of ecological reasoning;
- Support to citizen project of NBS, and the
- City mentoring strategy.

The ongoing sharing of the learning and support to others will continue beyond the end of the project and be a legacy action.

4.3 Izmir

The full aspects of the NBSs developed in Izmir City have been integrated into Deliverable no. 4.3 which can be checked for more detailed information regarding those NBS.

This section shows a summary list of the current catalogue of NBS actions in the city of Izmir by subdemos, including a categorical assessment of the state of development of each of them. More specifically, 4 categories have been proposed to evaluate the current state of the NBS plan:

- **Cancelled**: The proposed NBS is cancelled and therefore, it is not going to be executed.
- **On-going**: The proposed NBS is finalised within the course of URBAN GREENUP but the activities will be carried out by the local government after the URBAN GREENUP project.
- **Started**: The implementation works has started. In non-technical actions, this state means the action is executing but not finished yet.
- **Finished**: The implementation works has finished and the NBS is working. In non-technical actions means the activity is finished.

If appropriate, a brief description of the possible deviations from what was initially planned is also included.

4.3.1 Sub-Demo A

Sub Demo A is located in the central area of Karşıyaka Metropolitan District, which is a highly-urbanized area. It includes different transportation related locations (car parking areas and on-street parklet areas) that will reduce maximum/average temperatures and will reduce air pollutants. Car parking areas will be deployed in different locations with different building density levels in Karşıyaka and Çiğli (in Sasalı Natural Life Park) in order to illustrate peculiarities of urban heat island effect. The complete list of the proposed NBS is shown in table below. All of the actions for Sub Demo C had been finalized by the end of 2020.

Table 12. Summary of NBS located in Subdemo A (Izmir interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
1 - Re-naturing urbanization	Arboreal interventions	IAc-3	Arboreal areas around Ege Park Green Car Park Area	Finished
	Resting areas	IAc-4	Installation of Parklets	Finished
3 - Singular GI	Horizontal GI	IAc-14	Green Car Park Covering Shelter	Finished
		IAc-15	Cool pavement	Finished
		IAc-16	Green Shady structures	Finished
	Smart soils	IAc-10	Smart soil into green shady structures	Finished

4.3.2 Sub-Demo B

In the heart of Sub Demo B there is 'Sasalı Natural Life Park' a thematic park which is interface between urban and natural areas and ideal for developing climate-smart urban farming practices in a special precinct within the Park. Sub Demo B is also supported by non-technical interventions regarding urban farming and bio-diversity supporting activities. The complete list of NBS is shown in next Table.

Table 13. Summary of NBS located in Subdemo B (Izmir interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
2 - Water interventions	SUDS	IAc-6	Grassed swales and water retention ponds around Bio-boulevard	Finished
3 - Singular GI	Pollinators	IAc-11	Natural Pollinator's modules	Finished
	Smart soils	IAc-9	Smart soil production in climate-smart urban farming precinct	Finished
	Urban Farming	IAc-17	Climate-smart greenhouses	Finished
		IAc-18	Improving Overall Efficiency of urban waste water treatment by using by-products	Finished
4 - Non-technical interventions	Educational activities	IAc-20	The Bio-boulevard	On-going
		IAc-21	Education for the Food-smart future of Izmir	On-going
		IAc-22	Urban Farming Educative-participate Activities, Learning for Producers	On-going
	Engagement	IAc-24	Municipality Enabled Urban Farming	On-going
		IAc-25	The support for Women Cooperative community Agriculture	Cancelled
		IAc-26	Bio-Blitz events and open platform education	Finished

4.3.3 Sub-Demo C

Sub Demo C is formed by a 10 km long green corridor from the coastal areas, river beds to highly sensitive nature protection areas. The proposed green corridor includes sustainable transportation options (cycling &walking) and special sections like the Bio-Boulevard that will provide important ecosystem services for urban biodiversity. Sub Demo C also includes non-technical interventions aiming bio-diversity increasing education activities. The complete list of NBS is shown in the table below.

Table 14. Summary of NBS located in Subdemo C (Izmir interventions)

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
1 - Re-naturing urbanization	Arboreal interventions	IAc-2	Planting trees	Finished
	Carbon capture	IAc-5	Urban Carbon Sink	Finished
	Green route	IAc-1	Cycle and pedestrian route in new Green Corridor	Finished
2 - Water interventions	Flood actions	IAc-7	Culvert works for Peynircioğlu River	Finished
	Green pavements	IAc-8	Green pavements for Peynircioğlu River	Finished
3 - Singular GI	Vertical GI	IAc-12	Green fences	Finished
		IAc-13	Establishment of fruit walls	Finished
4 - Non-technical interventions	Educational activities	IAc-19	Industrial Heritage Route Along the Izmir urban Green Corridor (IUGC)	Finished

4.3.4 Non-technical actions

Some non-technical interventions for environmental education, engagement, city coaching and support activities, are developed in the three Sub-Demo areas indistinctly. All of them are summarized into the table below.

Table 15. Summary of Non-technical actions located in Izmir

TYPE OF INTERVENTION	NBS CATEGORY	CODE	NBS NAME	STATE
4 - Non-technical interventions	City coaching	IAc-27	Promotion of Ecological reasoning and intelligent	**Cancelled**
		IAc-28	Izmir bio-diversity Atlas via citizen participation through ICT enabled smart phone tools	Finished
	Engagement	IAc-23	Engagement portal for citizens	On-going
	Support activities	IAc-29	Single window/desk for RUP deployment	**Cancelled**
		IAc-30	Support to citizen project of NBS	On going
		IAc-31	City mentoring Strategy	**Cancelled**

5 VALLADOLID Global Evaluation

5.1 Barriers analysis

5.1.1 KPI barriers

In Valladolid, 41 KPIs were calculated to assess the impacts of the NBS interventions. During the monitoring process, approximately 90% of the KPIs selected encountered ad least one barrier. Valladolid presents an interesting case, because 39 out of the 41 measured KPIs experienced technical problems during the monitoring period.

Figure 5.1. Barriers in Valladolid.

Percentage of KPIs that encountered technical, economic, social or environmental barriers at least once (left). Number of times a KPI encountered any technical, economic, social or environmental barriers during the monitorization process (right)

Some problems were related to insufficient infrastructure, such as street WiFI networks, and could be addressed within the duration of the project. More alarming, however, are the **technical barriers** related to a lack of data for baseline calculation, lack of qualified personnel that could conduct the monitoring or lack of coordination between the local authorities and the partners in charge of monitoring the NBSs. The case of Valladolid offers a unique opportunity to understand how technical barriers could be avoided in the future by improving the planning involved in NBS implementation.

Many of the technical barriers where addressed when possible, but some were also related to the COVID pandemic restrictions, which were particularly harsh in Spain. Similarly, all the **environmental barriers** were the cause of the pandemic, which also affected non-technical activities.

Social barriers in Valladolid present another particular point of interest. Although low citizen participation could have been expected, several of the interventions were confronted with a great amount of negative opinions. This lack of support from the citizens was reflected in the calculation of the KPIs, for example when said citizens knowingly provided wrong and non-sensical answers in surveys designed to gauge citizen perception on NBS. From a lessons learned point of view, it is important that we evaluate where this lack of support originates, if for example it stems from the NBS design itself, or maybe it is due to unsuccessful communication and outreach activities.

5.1.2 NBS barriers

Out of the 36 interventions implemented in Valladolid, only one did not encounter any technical, economic, social or environmental barrier during the implementation phase, and all interventions experienced at least one type of barrier during the operation phase.

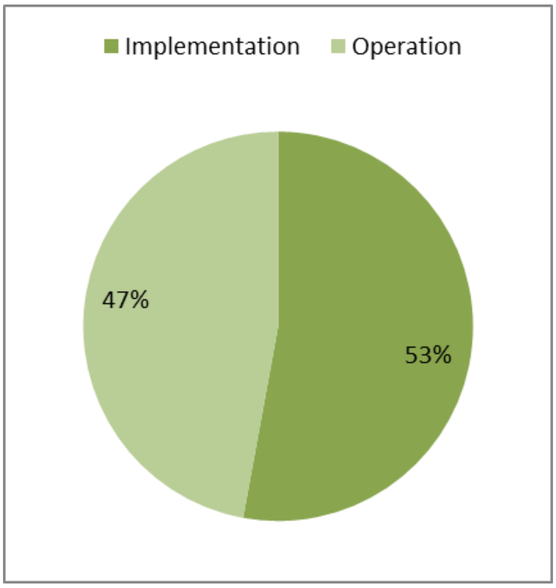


Figure 5.2. Percentage of total barriers encountered by the NbS that fall under the implementation and operation phases in Valladolid

Most of the **technical barriers** encountered by the intervention occurred during the implementation phase, and were related to limitations in the NbS design or existing grey infrastructure that interfered with the implementation. Although technical barriers related to design limitations caused some delays, they were relatively easy to address, and were solved by changing the design of the interventions to integrate existing structures.

Barriers related to existing infrastructure were, however, more difficult to address. In some cases, the blueprints of the intervention sites were not available, or the buildings where the NbS were going to be fixed could not support the extra weight because it was never accounted for during the time of construction. When possible, the NbS design was changed to add extra infrastructure, but this in turn resulted in economic barriers because it was not originally contemplated in the budget. When possible, the city of Valladolid covered the extra expenses.

Other **economic barriers** resulted from budget limitations, and in some cases the NbS was more expensive than other solutions. On paper, this might cause local administrations and citizens to question the necessity of the chosen NbS. Thus, it is important to properly communicate the benefits, but this might not have a positive impact if they are not accompanied with numbers to support the argument.

Social barriers encountered during the implementation phase were mostly related to a lack of awareness about the benefits of the solutions and some NIMBY effects. This lack of awareness, which might stem from flawed communication strategies, led in many cases to the NbS being vandalised, either because the structure was damaged or because the plants used were stolen. Several communication activities we carried out to try to minimize these acts of vandalism and other citizen complaints, with more or less success.

Almost all **environmental barriers** were related to the COVID 19 pandemic restrictions, which caused delays in the implementation processes. In a few cases, however, environmental barriers were ironically the result of climate change, when Autumn in Valladolid (at the time that some of the vegetation of the interventions was supposed to be planted) was unusually dry.

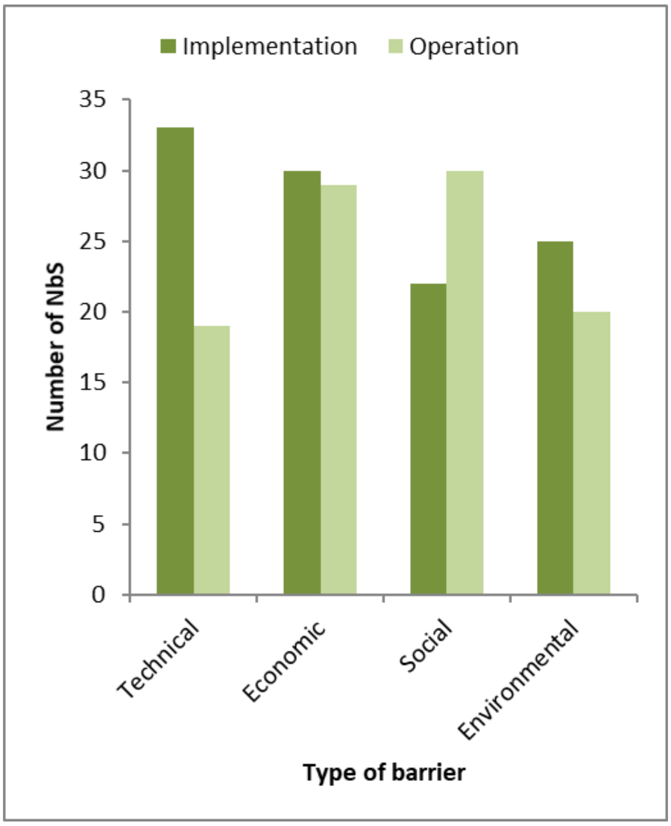


Figure 5.3. Number of NbS that encountered technical, economic, social and environmental barriers during the implementation/operation processes in Valladolid, according to barrier type

During the **operation phase**, most of the technical, economic and, surprisingly, social barriers, were related to maintenance activities. These activities, which are often not contemplated in the budget, turned to be in many cases more expensive than expected thought Valladolid City Council covered the expenses. This, however resulted in the misplaced perception by the citizens that the new interventions were not being properly maintained, and exacerbated the negative opinion that some of the citizens had about the NbS interventions.

Environmental barriers encountered during the operation phase were mostly related to extreme weather events, such as the long period of droughts, which caused high mortality rates among the vegetation planted in the interventions, or heavy rains events, which flooded the biofilters. In future interventions, the increase in extreme weather events would have to be considered and accounted for during the NbS design phase.

5.2 NBS performance evaluation

Note: For details on the factors, please check section 3.

In Valladolid, a total of 155 impacts have been identified, all of them positive out of a total of 32 NbS assessed. The following graph shows the impacts obtained grouped by challenge. As can be seen, the Challenge with the highest number of impacts detected is **Challenge 04 Green Space Management** (44 impacts), followed by **Challenge 2 Water management** (37). On the other hand, **Challenge 10 Potential of economic opportunities and green jobs** is the challenge with less impacts detected (2).

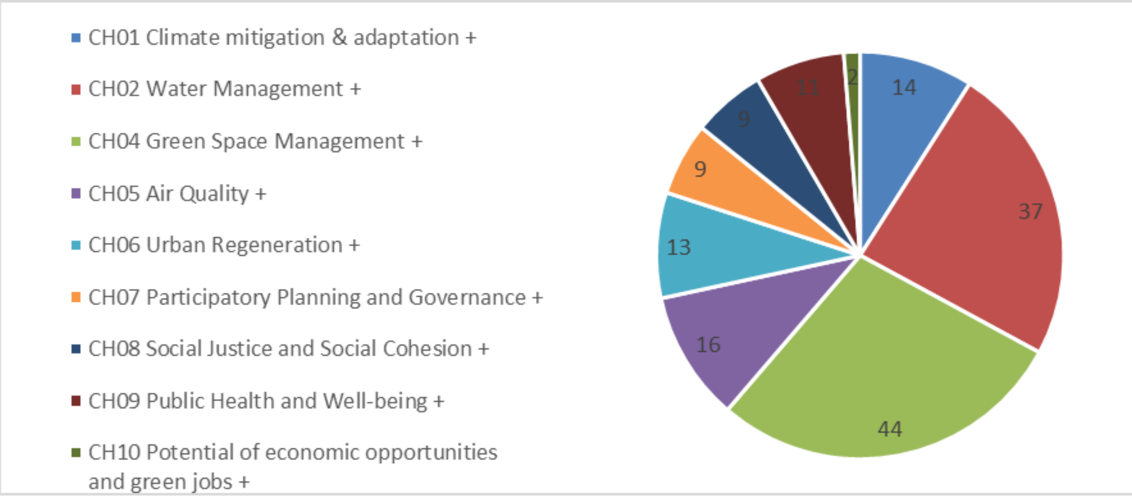


Figure 5.4. Number of positive impacts detected in Valladolid

The following graph shows the NBS grouped by blocks, with each block having a surface area proportional to the number of impacts detected. **Green façade** is the NBS with the highest number of impacts detected, followed by trees-related NbS (**Tree shady places**, **shade and cooling trees**, etc.) and the innovative NbS (**Electrowetland** and **Urban Garden Biofilter**).

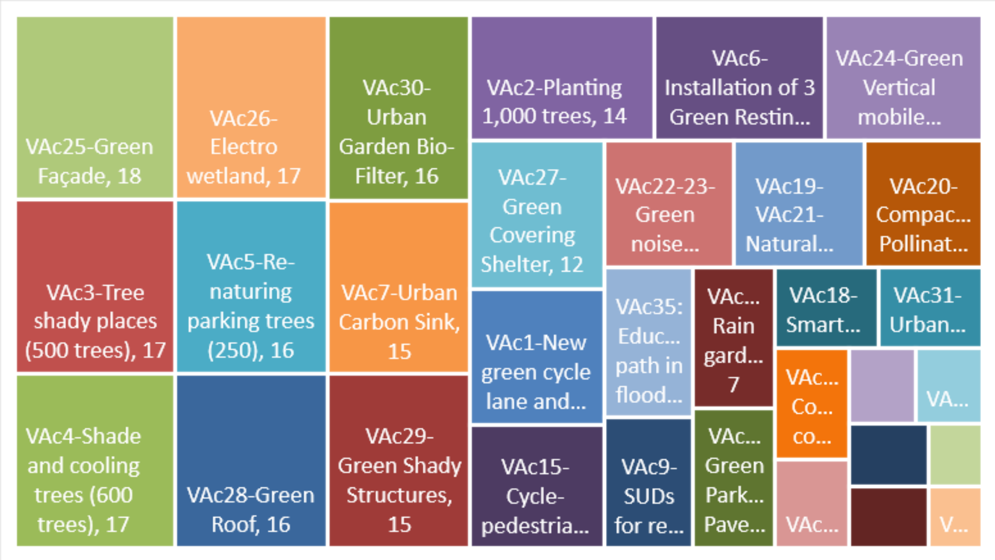


Figure 5.5. Impacts detected by NBS in Valladolid

In terms of assessed impact **intensity**, in general, the challenges with the highest impact are **Challenge 2 Water management**, followed by **Challenge 06 Urban regeneration**. **Challenge 2 Water management** has also received the highest number of high intensity impacts.

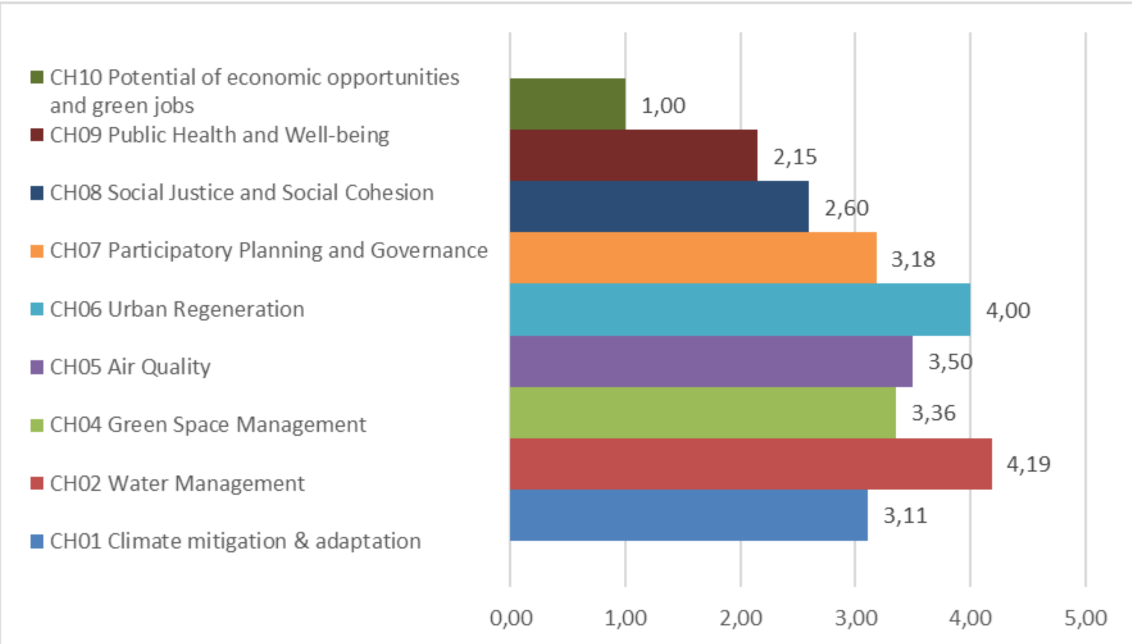


Figure 5.6. Average impact intensity by Challenges in Valladolid

By NbS, it is observed that they all have a similar average Impact Intensity. 3 **non-technical actions** are the interventions with the highest average (Promotion of ecological intelligent reasoning, Engagement Portal for citizen and Single desk for RUP deployment), followed by **NBS related to tree planting** (Re-naturing parking trees and Planting 1000 trees, etc.).

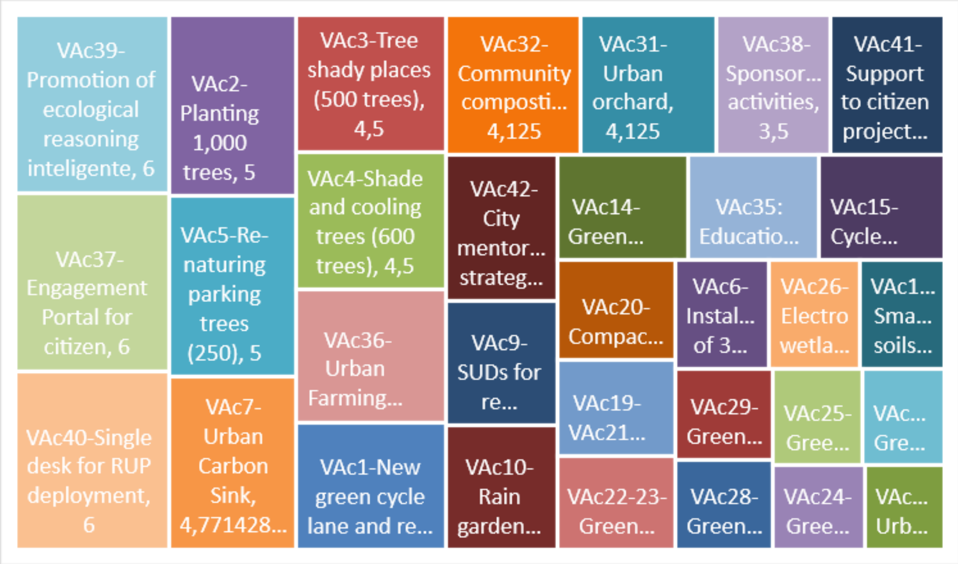


Figure 5.7. Average impact intensity by NbS in Valladolid

However, the following table shows another point of view. These are the NBS with high impact intensities. **Tree-related NbS** (Tree shady places, shade and cooling trees, re-naturing parking trees and Planting 1000 trees and Urban Carbon Sink) have obtained a high impact intensity in 3 indicators.

Table 16. NBS with KPIs rated with high intensity. Valladolid.

NBS	IN = 6
VAc3-Tree shady places (500 trees)	13
VAc4-Shade and cooling trees (600 trees)	13
VAc5-Re-naturing parking trees (250)	13
VAc2-Planting 1,000 trees	11
VAc7-Urban Carbon Sink	11
Rest of NbS	<= 5

In terms of assessed impact **extension**, in general, impacts on Challenges such as **CH09 Public Health and Wellbeing, CH01 Climate mitigation and adaptation** and **CH06 Urban regeneration** occur at the **city level**, while challenges such as **CH08 Social Justice and Social Cohesion** have a **more localised impact**.

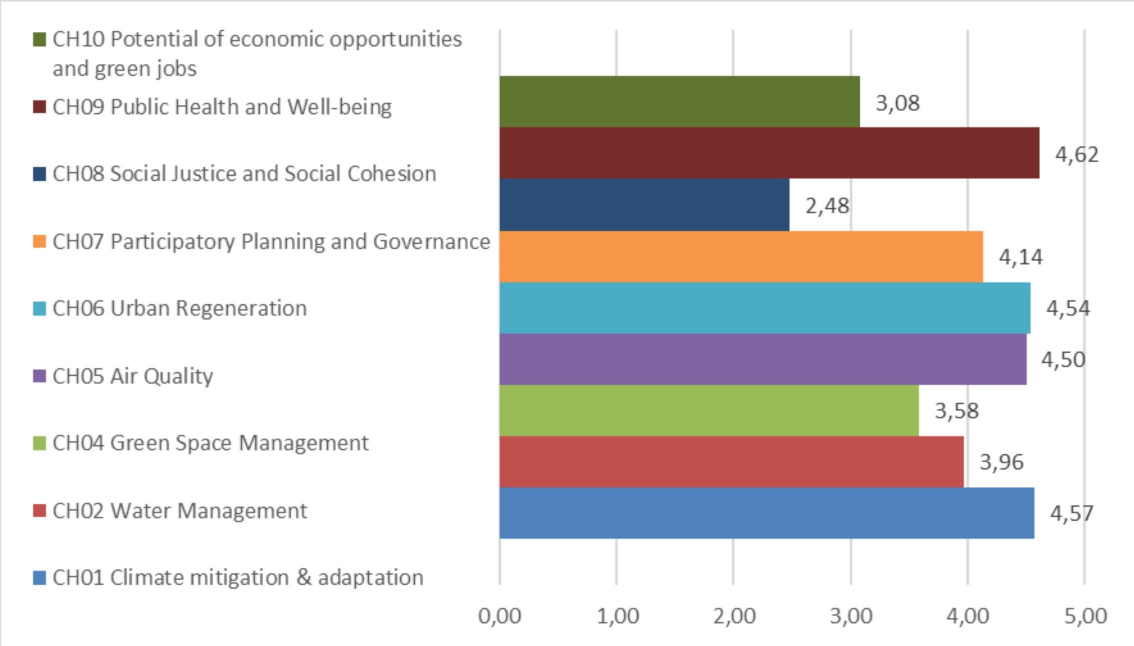


Figure 5.8. Average impact extension by Challenges in Valladolid

As can be seen in the graph below, non-technical stocks have a larger average impact (on the left side of the graph) than technical actions (on the right side).

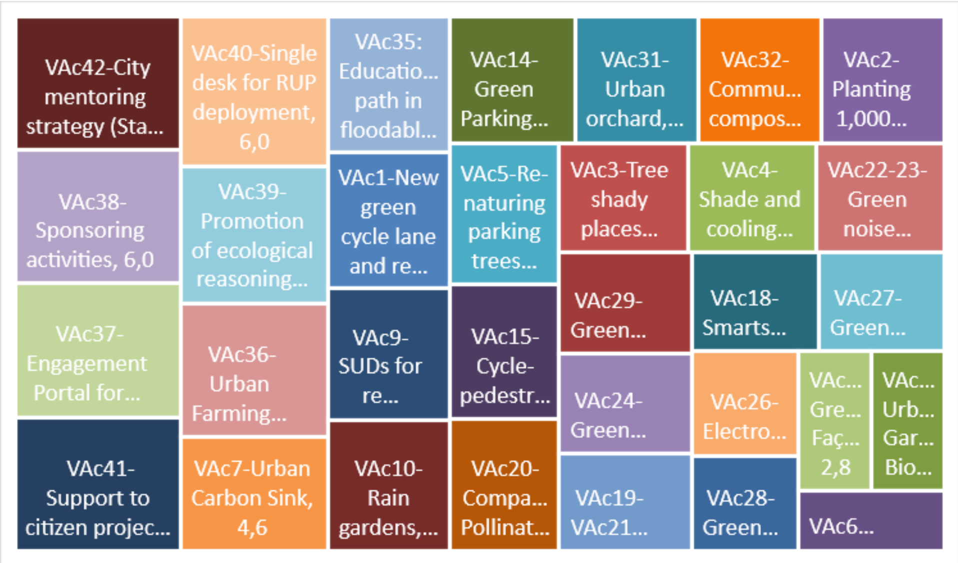


Figure 5.9. Average impact extension by NbS in Valladolid

In terms of **moment** of impact, it is notable that impacts on **CH02 Water management** and **CH04 Green space management** are more immediate than others such as **CH01 Climate mitigation and adaptation** and **CH08 social Justice and cohesion**.

Figure 5.10. Average impact moment by Challenges in Valladolid

In relation to the above, the NBS with the most immediate impacts are those most related to water (SUDS, raingardens, etc).

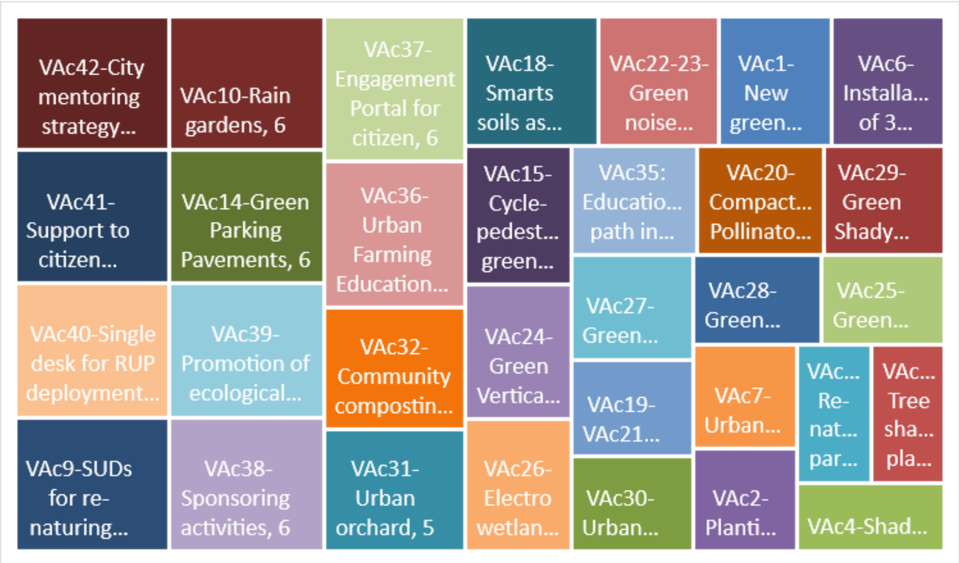


Figure 5.11. Average impact moment by NbS in Valladolid

In terms of **synergy**, the non-technical actions show more synergies in their indicators, as well as Technical actions such as Urban carbon sink and tree-related actions.

Table 17. NBS with KPIs rated with high synergy. Valladolid

NBS	SY = 6
VAc7-Urban Carbon Sink	8
VAc1-New green cycle lane and re-naturing existing bike lanes	3
VAc36-Urban Farming Educational activities	3
VAc39-Promotion of ecological reasoning inteligente	3
Other NBs	<= 2

Figure 5.12. Average impact synergy by NbS in Valladolid

In terms of **frequency**, the NBS installed generates a continuous impact on most of them. Also in relation to the challenges, the averages are high and greater than 3 for most of them, indicating that there is a prevalence of continuous impacts. In this sense, the Challenges with more infrequent impacts are those of a social and economic topics (**CH10 Potential of economic opportunities and green jobs** or **CH08 Social Justice and social cohesion**), while the environmental challenges show more frequent impacts (such as **CH05 Air quality** or **CH04 Green Space Management**).

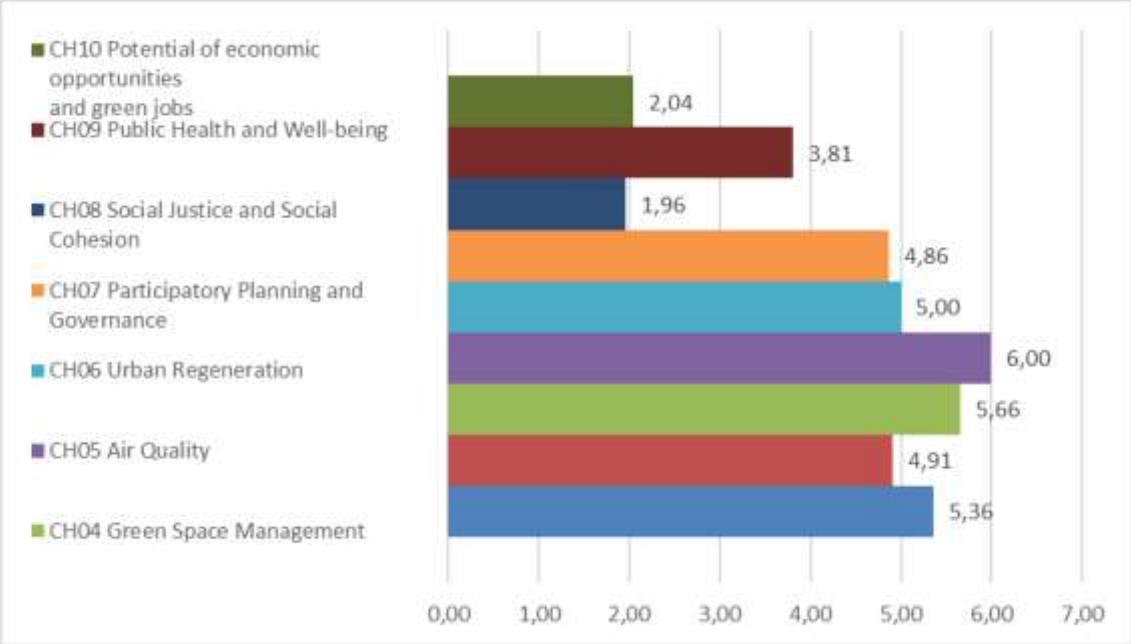


Figure 5.13. Average impact frequency by Challenges in Valladolid

Figure 5.14. Average impact frequency by NbS in Valladolid

5.3 Overall conclusion

Most interventions faced technical barriers during implementation, but they were relatively easy to address by modifying designs and integrating existing structures. Additional infrastructure requirements and budget limitations posed challenges, and the cost of some NbS solutions raised questions about their necessity. Lack of awareness and NIMBY effects led to vandalism and citizen complaints, emphasizing the need for effective communication strategies supported by data. COVID-19 restrictions caused delays, while climate change effects such as droughts and heavy rains impacted intervention viability. Insufficient budgeting and perceived inadequate maintenance by citizens affected interventions, along with extreme weather events.

In summary, addressing technical, economic, social, and environmental barriers requires modifying designs, improving communication, considering climate change impacts, and allocating sufficient resources for maintenance.

The following table shows a map of the rating obtained after applying the overall performance formula, corrected with the prioritisation of KPIs. There is a concentration of high-very high impacts in the upper-left part of the table. This means that actions related to tree planting and the creation of a new cycle path have generated high impacts in almost all of the Challenges, especially those most related to environmental issues. On the other hand, non-technical actions have clearly generated very high impacts, especially in Challenge 8 Social Justice and Social Cohesion.

Figure 5.15. Overall summary table of results of the total impact assessment in Valladolid

NBS	CH01	CH02	CH04	CH05	CH06	CH07	CH08	CH09	CH10
VAc1-New green cycle lane and re-naturing existing bike lanes									
VAc3-Tree shady places (500 trees)									
VAc4-Shade and cooling trees (600 trees)									
VAc2-Planting 1,000 trees									
VAc5-Re-naturing parking trees (250)									
VAc7-Urban Carbon Sink									
VAc9-SUDs for re-naturing parking									
VAc10-Rain gardens									
VAc14-Green Parking Pavements									
VAc15-Cycle-pedestrian green paths									
VAc18-Smarts soils as substrate									
VAc20-Compacted Pollinator's modules									
VAc19-VAc21-Natural pollinator's modules									
VAc22-23-Green noise barriers									
VAc25-Green Façade									
VAc24-Green Vertical mobile garden									
VAc27-Green Covering Shelter									
VAc26-Electro wetland									
VAc28-Green Roof									
VAc29-Green Shady Structures									
VAc30-Urban Garden Bio-Filter									
VAc6-Installation of 3 Green Resting areas									
VAc31-Urban orchard									
VAc32-Community composting									
VAc35: Educational path in floodable park area									

NBS	CH01	CH02	CH04	CH05	CH06	CH07	CH08	CH09	CH10
VAc36-Urban Farming Educational activities									
VAc37-Engagement Portal for citizen									
VAc38-Sponsoring activities									
VAc39-Promotion of ecological reasoning inteligente									
VAc40-Single desk for RUP deployment									
VAc41-Support to citizen project of NBS									
VAc42-City mentoring strategy (Staff Exchange activities)									

Note: Impact scoring: Very high (25-30), High (19-24), Medium (13-18), Low (12-5), Negative (<0)

Based on the table above, the impacts for each category and for each NBS have been accounted for in the following table. Therefore, each number shows the count of Challenges whose average is classified under each impact category. As can be seen, the NBSs with the highest number of average impacts classified as "very high" are **Urban Carbon Sink** (5) and other tree-related NbS (Shade and cooling trees (600 trees), Planting 1,000 trees, Re-naturing parking trees). On the other hand, non-technical interventions such as **Engagement Portal for citizen, sponsoring activities, Single desk for RUP deployment, Support to citizen project of NBS** or **City mentoring strategy (Staff Exchange activities**), and technical action such as **Compacted Pollinator's modules** or **Smarts soils as substrate** have obtained less (or no) high or very high impacts.

Table 18. Count of each impact category per NBS in Valladolid

NBS	Very high	High	Medium	Low
VAc1-New green cycle lane and re-naturing existing bike lanes	2	2	0	1
VAc3-Tree shady places (500 trees)	3	3	0	2
VAc4-Shade and cooling trees (600 trees)	4	2	0	2
VAc2-Planting 1,000 trees	4	2	0	1
VAc5-Re-naturing parking trees (250)	4	2	0	1
VAc7-Urban Carbon Sink	5	1	0	1
VAc9-SUDs for re-naturing parking	2	1	0	0
VAc10-Rain gardens	2	1	0	0
VAc14-Green Parking Pavements	2	1	0	0
VAc15-Cycle-pedestrian green paths	1	3	0	1
VAc18-Smarts soils as substrate	0	0	1	0
VAc20-Compacted Pollinator's modules	0	1	3	0
VAc19-VAc21-Natural pollinator's modules	1	1	2	1
VAc22-23-Green noise barriers	2	2	2	1
VAc25-Green Façade	0	3	2	2
VAc24-Green Vertical mobile garden	1	2	3	1
VAc27-Green Covering Shelter	1	3	1	2
VAc26-Electro wetland	2	1	3	1

NBS	Very high	High	Medium	Low
VAc28-Green Roof	0	3	2	2
VAc29-Green Shady Structures	1	3	3	1
VAc30-Urban Garden Bio-Filter	1	1	4	1
VAc6-Installation of 3 Green Resting areas	1	2	2	1
VAc31-Urban orchard	1	1	0	0
VAc32-Community composting	2	0	0	0
VAc35: Educational path in floodable park area	2	1	2	1
VAc36-Urban Farming Educational activities	2	0	1	0
VAc37-Engagement Portal for citizen	1	0	0	0
VAc38-Sponsoring activities	1	0	1	0
VAc39-Promotion of ecological reasoning inteligente	2	0	0	0
VAc40-Single desk for RUP deployment	1	0	0	0
VAc41-Support to citizen project of NBS	1	0	1	0
VAc42-City mentoring strategy (Staff Exchange activities)	1	0	1	0

The following table is similar to the previous one, but shows the count of impacts categorised by Challenge. These results show that **CH06 Urban Regeneration** benefit the most from the NBS installed in Valladolid, with 16 NBS rated as "very high" impact. In contrast, **CH05 Air Quality** and **CH10 Potential of economic opportunities and green jobs** have had 0 Very High impacts.

Table 19. Count of each impact category per Challenges in Liverpool

CHALLENGES	CH01	CH02	CH04	CH05	CH06	CH07	CH08	CH09	CH10	**TOTAL**
Very high	4	6	11	0	16	6	8	2	0	**53**
High	3	3	12	4	8	9	0	3	0	**42**
Medium	6	3	3	4	0	7	0	8	3	**34**
Low	1	0	0	0	0	0	17	0	5	**23**
TOTAL	**14**	**12**	**26**	**8**	**24**	**22**	**25**	**13**	**8**	

6 LIVERPOOL Global Evaluation

6.1 Barriers analysis

6.1.1 KPI barriers

In Liverpool, 42 KPIs were used to monitor and evaluate the impact of the implemented NBS. Approximately 90% of the KPIs experience some kind of barrier, while only around 10% could be measured without any technical, economic, social or environmental difficulties.

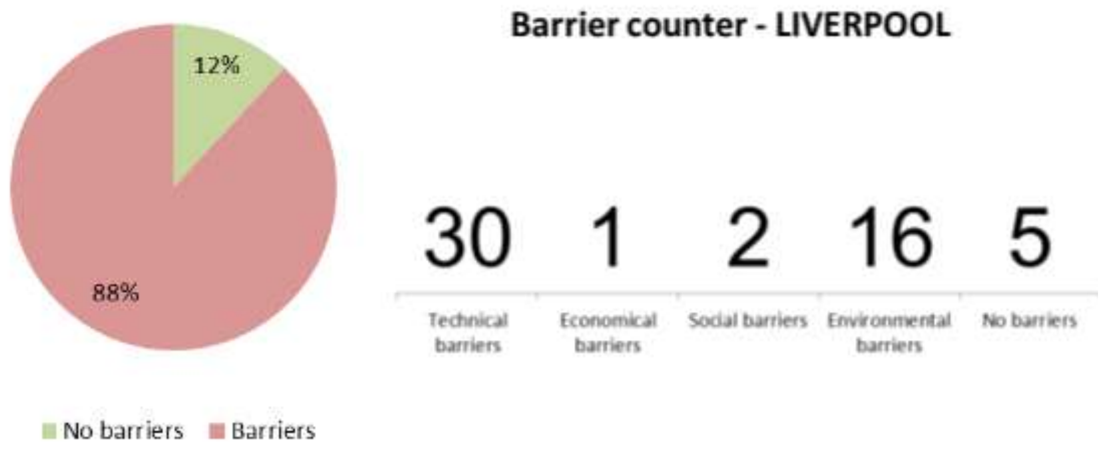


Figure 6.1. Barriers in Liverpool.

Percentage of KPIs that encountered technical, economic, social or environmental barriers at least once (left). Number of times a KPI encountered any technical, economic, social or environmental barriers during the monitorization process (right)

In the case of Liverpool, **technical barriers** represent the highest number and were mostly related to software and model limitations.

On the other hand, the KPIs monitored in Liverpool experienced almost no **social or economic barriers**. However, many KPIs were measure using modelling or digital tools, which could have affected the type of barriers encountered.

Regarding **environmental barriers**, many were related to the restrictions of the pandemic, as is the case in Valladolid and Izmir. In some cases, however, the monitoring results were heavily impacted by atmospheric variables such as wind direction and speed, or other environmental variables that could not be accounted for in the methodology.

6.1.2 NBS barriers

In Liverpool, all NbS interventions except one encountered at least one type of barrier during the implementation phase. Similarly, all the interventions but one encountered at least one type of barrier during the operation phase. Of all barriers encountered, 45% occurred during the intervention phase, and 55% occurred during the operation phase.

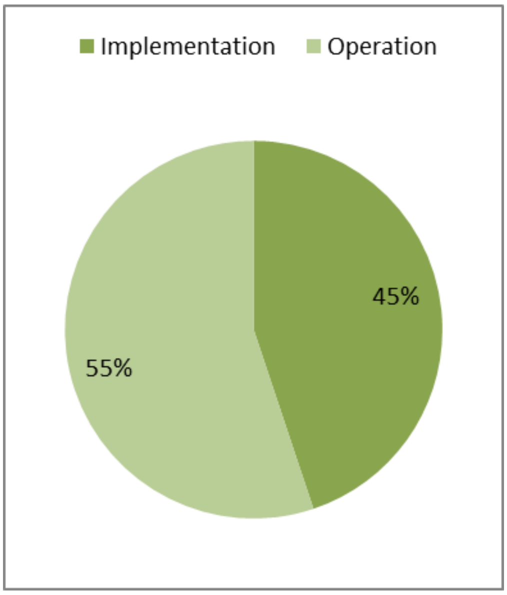


Figure 6.4: Percentage of total barriers encountered by the NbS that fall under the implementation and operation phases in Liverpool.

In all cases, NbS interventions experienced more barriers during the operation phase than the implementation phase.

Among the **technical barriers** that the interventions encountered during implementation, bureaucratic barriers played a major role. In many cases the stablished procedures delayed or interfered with the implementation works. These barriers were often addressed by opening communication channels between the city authorities, contractors and technical partners. Other technical barriers were related to existing infrastructure. For example, if tree roots had to be contained so avoid damage in underground utilities networks.

Economic barriers were often related to budget limitations when the interventions exceeded the original budget. In many cases, accommodations had to me made by all participants to solve design and budget-related barriers, but in most cases a solution was reached.

Social barriers, as is often the case, were the result of the citizen´s lack of acceptance. In the Liverpool case, however, this lack of acceptance might have stemmed from the pandemic restrictions, since a lot of the consultation and communications planned could not take place. Further, English was not the native language of some of the citizens, so the communication strategy had to be adapted to reach and engage the maximum number of people. The pandemic restrictions also delayed the implementation works due to problems sourcing materials and insufficient work force.

The barriers encountered during **the implementation phase** were carried over somewhat to the operation phase. Most of the technical barriers were barriers that can be relatively expected.

For example, in the case of some interventions the ground composition was quite stony and hard to work with, or had demolition waste, etc. In these cases, the barriers were addressed by working around them, for example, by choosing softer areas to plant the trees, using more appropriate tools, or containing the tree roots if they were planted next to roads or underground utilities. Economic and environmental barriers during this phase were quite similar to those of the implementation phase, and were related to budget limitations, pandemic restrictions and delays in maintenance work.

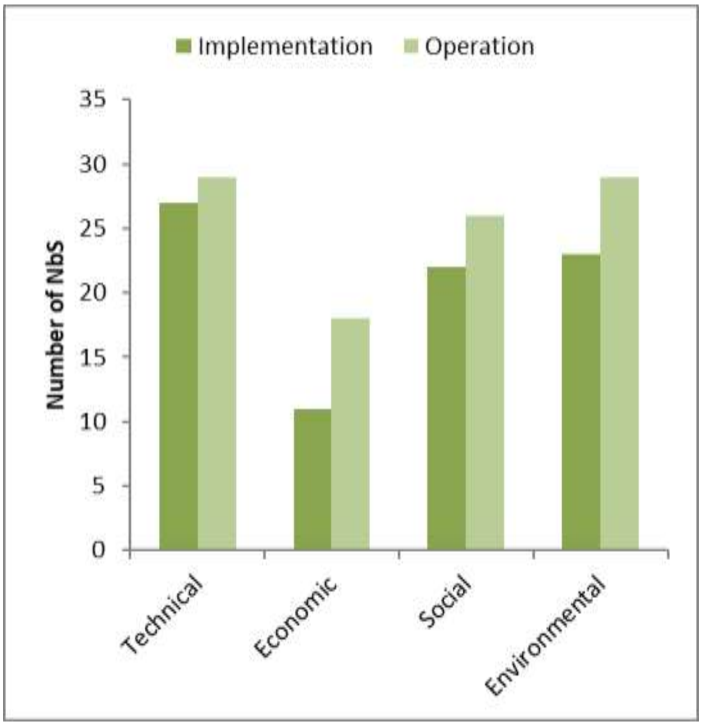


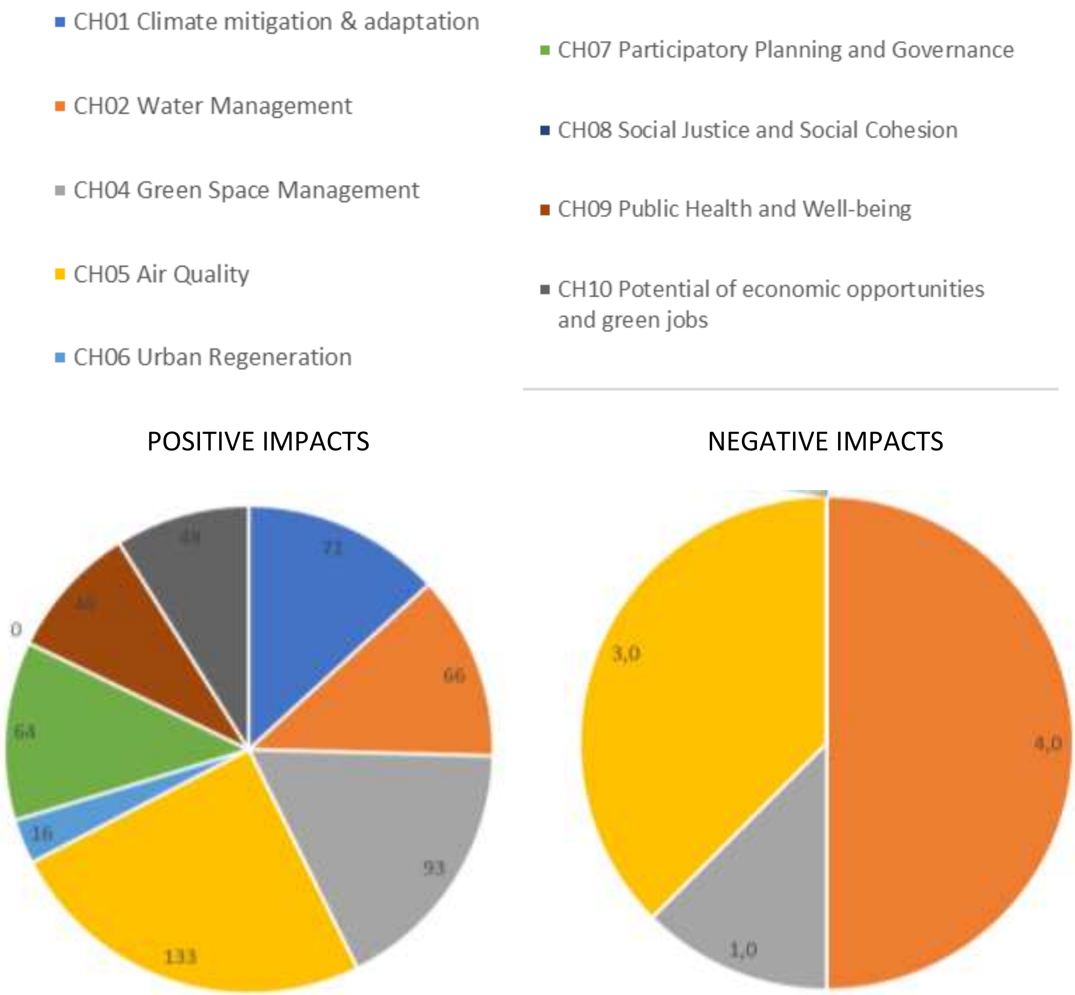
Figure 6.2. Number of NbS that encountered technical, economic, social and environmental barriers during the implementation/operation processes in Liverpool, according to barrier type

6.2 NBS performance evaluation

Note: For details on the factors, please check section 3.

In Liverpool, a total of 547 impacts have been identified, 539 of them positive out of a total of 17 NbS assessed. The following graph shows the impacts obtained grouped by challenge. As can be seen, the Challenge with the highest number of positive impacts detected is **Challenge 5, Air Quality** (133 impacts), followed by **Challenge 04 Green Space Management** (93). On the other hand, negative impacts have been identified in **Challenge 02 Water Management** (4), **Challenge 5 Air Quality** (3 impacts) and **Challenge 04 Green Space Management** (1).

Figure 6.3. Number of impacts detected in Liverpool



The number of positive impacts detected by NBS has been counted. As a result, the NBS with the highest number of impacts show a total of between 40-38 positive impacts. This includes the following:

- Cooling trees
- Floating gardens
- Grassed swales and water retention ponds
- Rain gardens
- Shade trees
- Urban catchment forestry
- Urban carbon sink
- Green filter area
- Pollinator verges and spaces
- Pollinator walls/vertical
- Pollinators roofs
- Vertical mobile garden

The following graph shows the NBS grouped by blocks, with each block having a surface area proportional to the number of positive impacts detected.

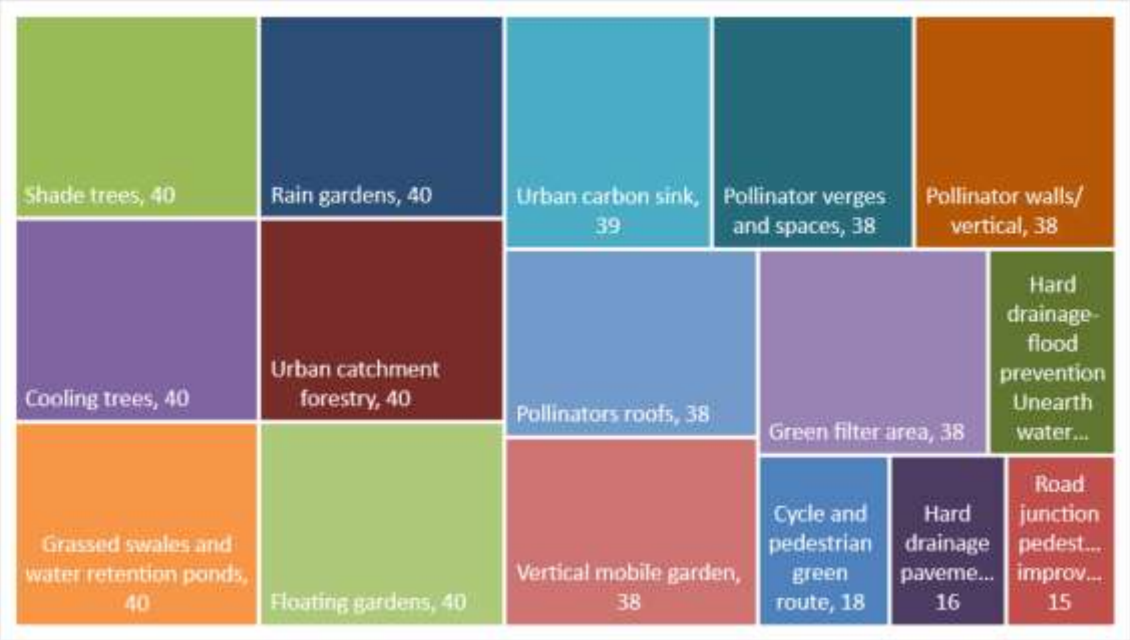


Figure 6.4. Impacts detected by NBS in Liverpool

As for the NBS with negative impacts detected, they are **Hard drainage pavements (5)** and **Road junction pedestrian improvement (3).**

In terms of assessed impact **intensity**, in general, the challenges with the highest average impact are **Challenge 06 Urban regeneration** (54), **Challenge 07 Participatory Planning** and **Governance** (44.5) and **Challenge 04 Green Space Management.**

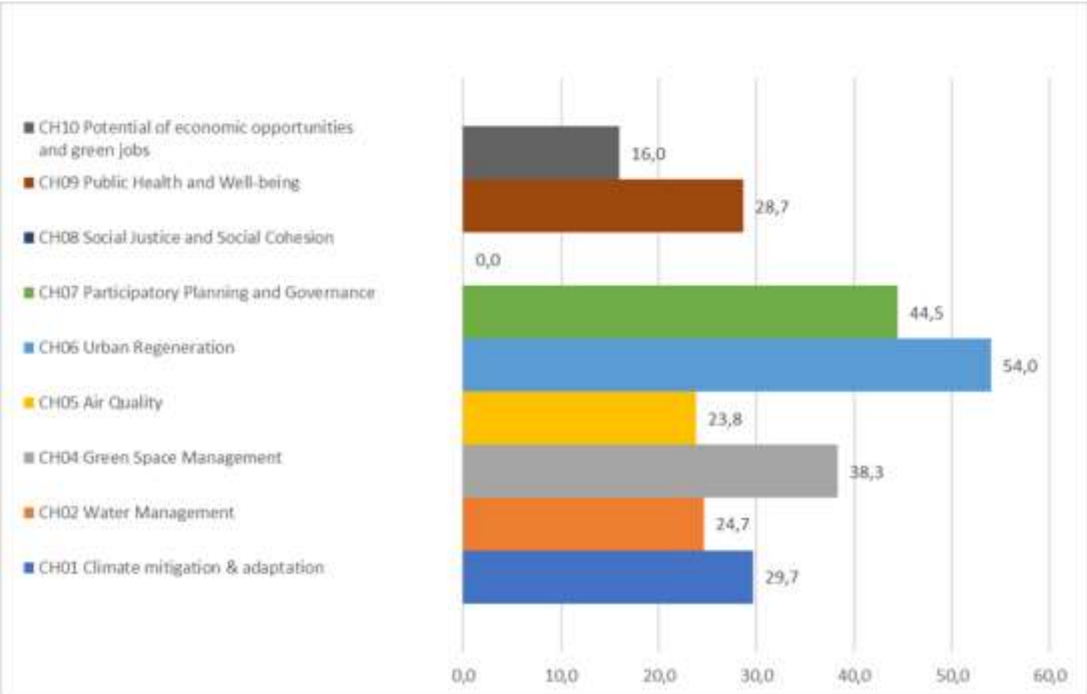


Figure 6.5. Average impact intensity by Challenges in Liverpool

By NBS, the ones with the highest average impact are the **Shade trees (3)** and **Cooling trees (3)**, followed by the **Cycle and pedestrian green route** (2.5), **Road junction pedestrian improvement** (2.5), **and Rain gardens** (2.5). This can be seen in the next figure.

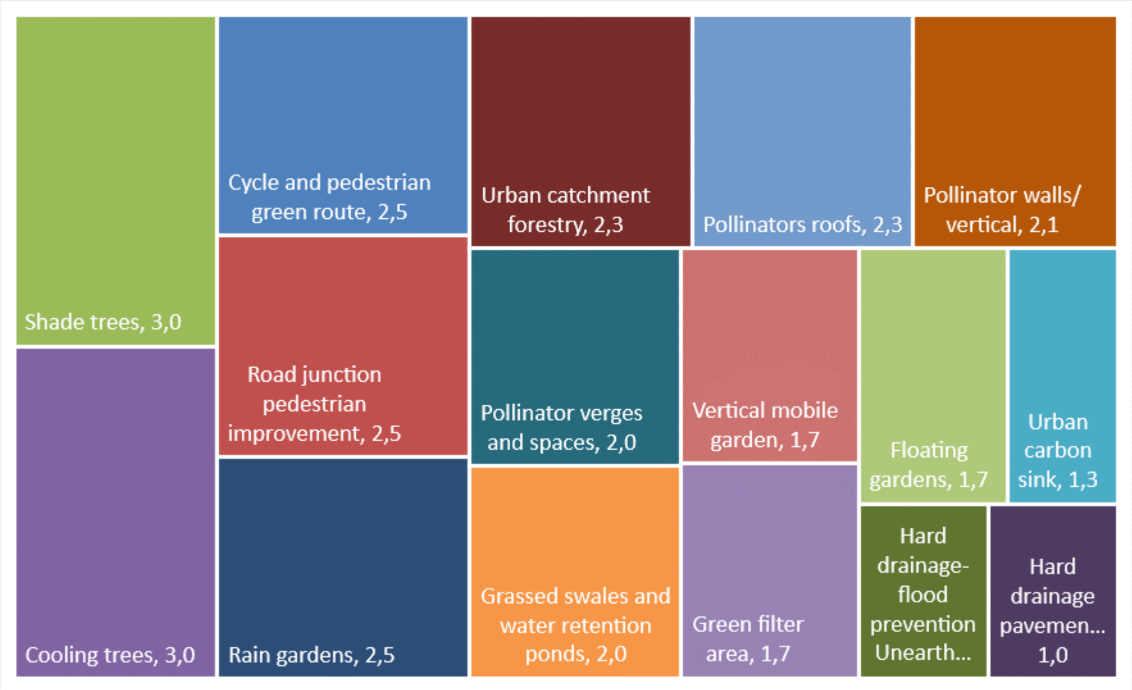


Figure 6.6. Average impact intensity by NbS in Liverpool

In contrast, the following table shows another point of view. These are the NBS with high impact intensities. **Shade trees** and **Cooling trees** have obtained a high impact intensity in 10 indicators.

Table 20. NBS with KPIs rated with high intensity. Liverpool.

NBS	IN = 6
Shade trees	10
Cooling trees	10
Pollinators roofs	8
Cycle and pedestrian green route	7
Road junction pedestrian improvement	7
Rain gardens	6
Pollinator verges and spaces	4
Pollinator walls/vertical	4
Urban carbon sink	2

In terms of assessed impact **extension**, impacts on **Challenge 10 Potential of economic opportunities and green jobs,** are felt at the **city-neighbourhood level**. On the other hand, Challenges such as **CH04 Green Space Management** or **CH02 Water management** has more localised impacts, at street-building level.

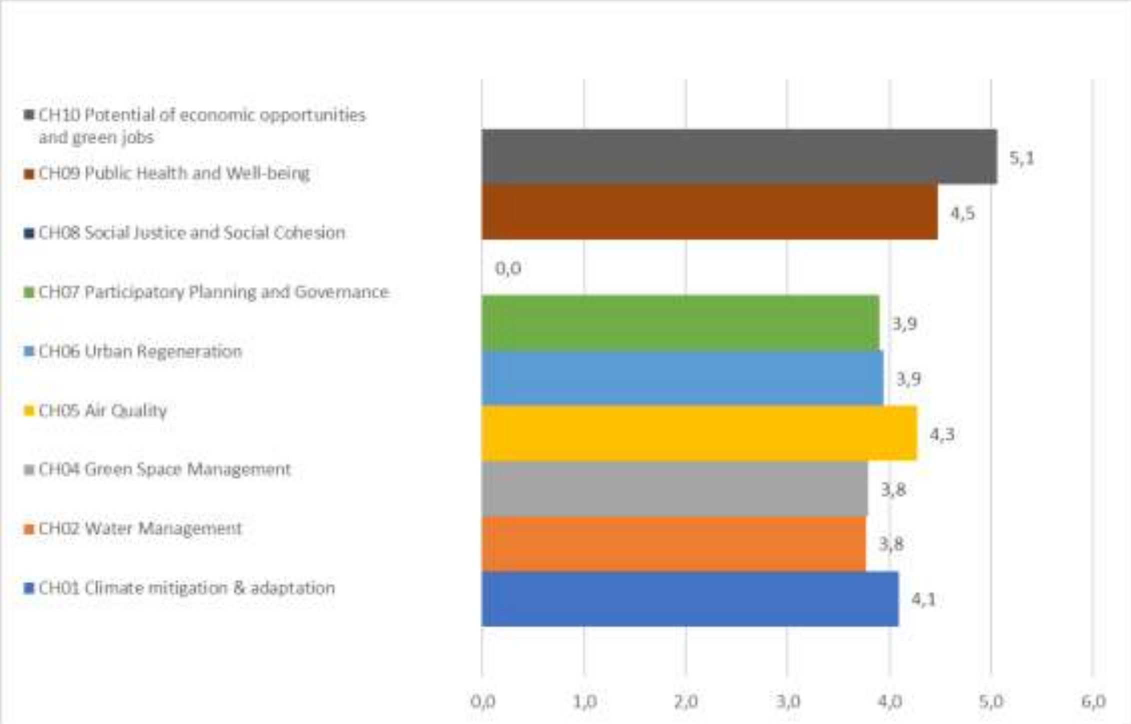


Figure 6.7. Average impact extension by Challenges in Liverpool

By NBS, **Cooling trees and Cycle and pedestrian green route** and **Road junction pedestrian improvement** have a more extensive average impact, compared to other more specific actions such as **Vertical mobile gardens**.

Figure 6.8. Average impact extension by NbS in Liverpool

In terms of timing of impact, the challenges for which the most immediate impact has been identified are **CH09 Public Health and Well-being**, **CH06 Urban Regeneration** and **CH02 Water**

management. In these challenges, the average impact is immediate (6). In contrast, impacts on **CH10 Potential of economic opportunities and green jobs** occur over the longer term.

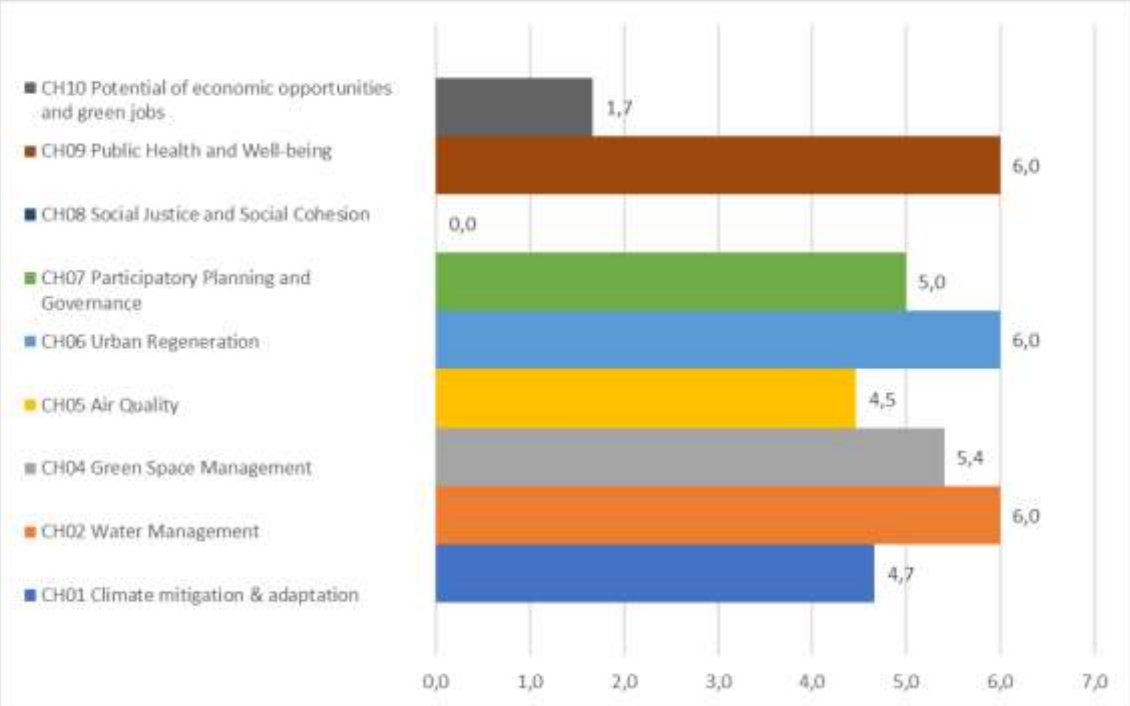


Figure 6.9. Average impact moment by Challenges in Liverpool

As for the average moment of impact per NBS, as can be seen in the graph below the values are practically similar for all NBS, ranging from 4.9-4.7.

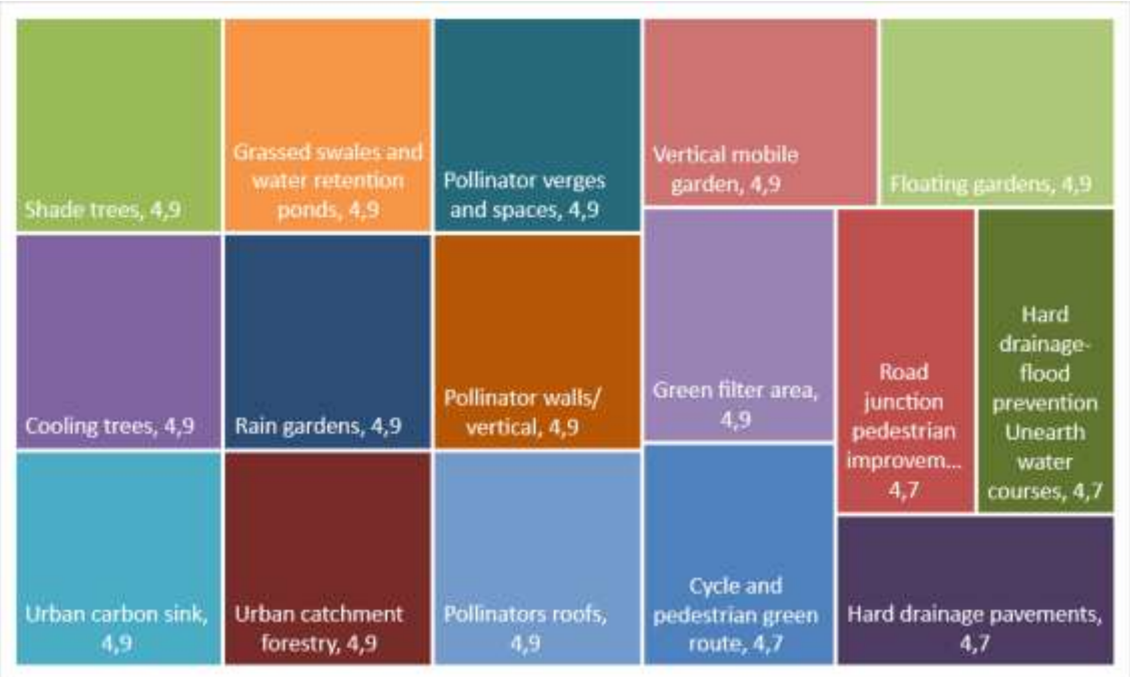


Figure 6.10. Average impact moment by NbS in Liverpool

All NBS are **synergistic**, with values around 5. This means that their effects on the different KPIs assessed are interrelated and their effects are not independent of each other.

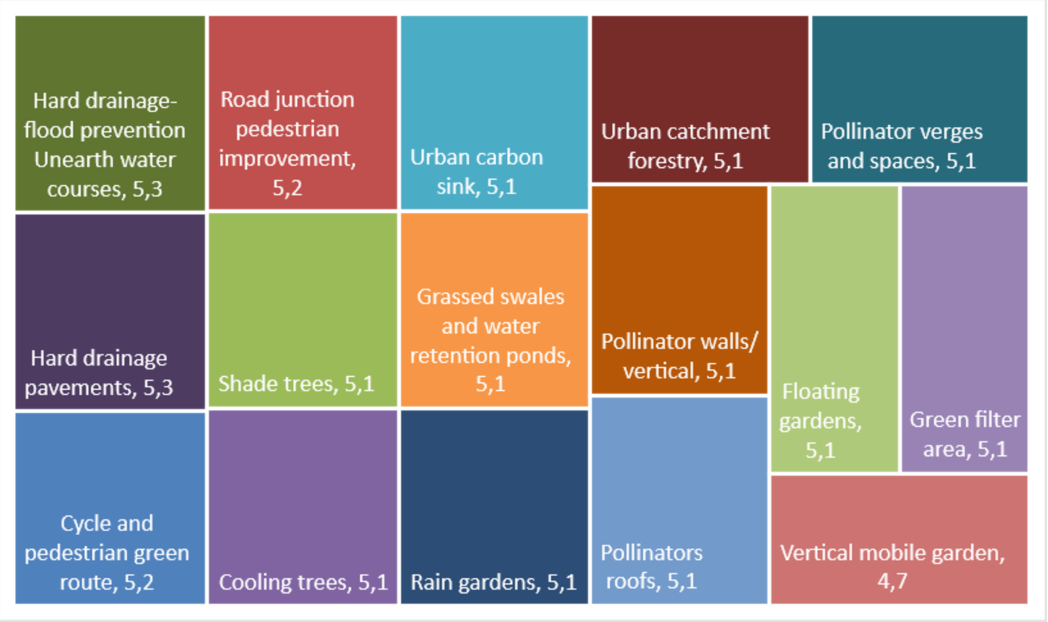


Figure 6.11. Average impact synergy by NbS in Liverpool

The challenges with the highest number of synergies detected are **CH04 Green space management (94)**, followed by **CH07 Participatory planning and governance (64)** and **CH05 Air quality (62)**. On the other hand, the least synergetic Challenges were **CH01 Climate mitigation & Adaptation** (12 indicators marked as Non-synergic), followed **by CH09 Public Health and Well-being (2).**

Table 21. Challenges with KPIs rated with high synergy (SY=6) and non-synergic (SY=1). Liverpool.

CHALLENGE	SY = 6	SY = 1
CH01 Climate mitigation & adaptation	24	12
CH02 Water Management	56	0
CH04 Green Space Management	94	0
CH05 Air Quality	62	0
CH06 Urban Regeneration	16	0
CH07 Participatory Planning and Governance	64	0
CH08 Social Justice and Social Cohesion	0	0
CH09 Public Health and Well-being	46	2
CH10 Potential of economic opportunities and green jobs	16	0

In terms of **frequency**, the NBS installed generates a continuous impact on most of them, with the exception of the **Vertical Mobile Garden**. In relation to the challenges, CH10 Potential of economic opportunities and green jobs, CH05 Air Quality, CH02 Water management and CH09 Public Health and Well-being have an average of this factor above 5, which refers to a high number of KPIs with continuous effects.

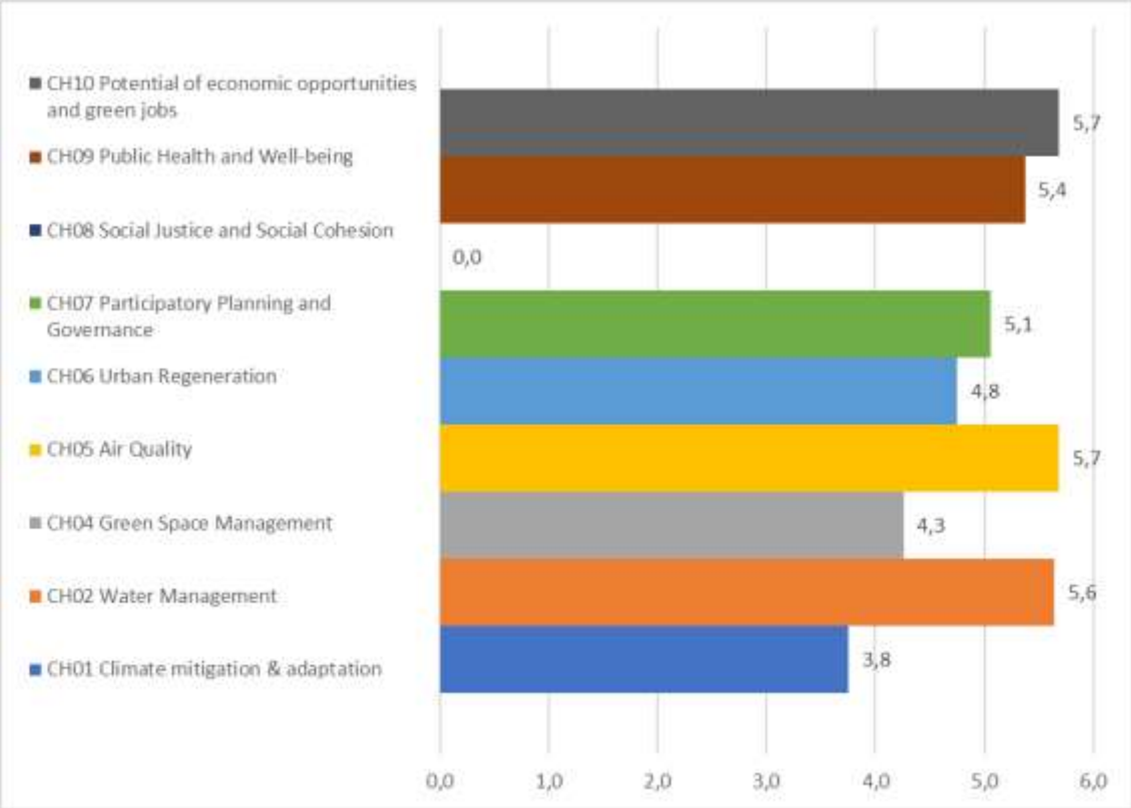


Figure 6.12. Average impact frequency by Challenges in Liverpool

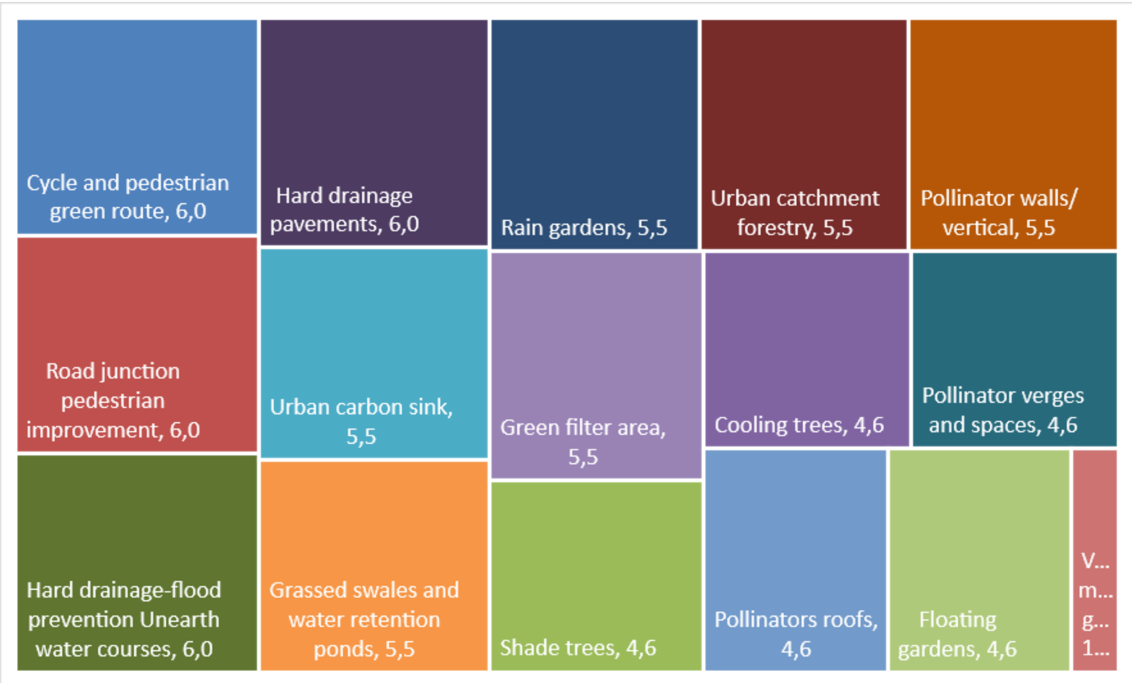


Figure 6.13. Average impact frequency by NbS in Liverpool

6.3 Overall conclusion

NbS interventions faced more barriers during the operation phase compared to the implementation phase. Bureaucratic and infrastructure-related technical barriers were addressed through improved communication channels. Economic barriers arose from budget limitations, requiring accommodations from all parties involved. Social barriers, influenced by the pandemic and language barriers, affected citizen acceptance. The implementation phase barriers carried over to the operation phase, with expected technical challenges addressed through adaptive approaches. Economic and environmental barriers persisted, tied to budget limitations, pandemic restrictions, and maintenance delays.

For each KPI, the formula for calculating the impact has been applied. Subsequently, the average impact of all KPIs assessed in each challenge has been calculated for each NBS. The result of this analysis is shown in the table below.

Table 22. Overall summary table of results of the total impact assessment in Liverpool.

NBS	CH01	CH02	CH04	CH05	CH06	CH07	CH09	CH10
Cycle and pedestrian green route								
Road junction pedestrian improvement								
Shade trees								
Cooling trees								
Urban carbon sink								
Grassed swales and water retention ponds								
Rain gardens								
Urban catchment forestry								
Hard drainage-flood prevention Unearth water courses								
Hard drainage pavements								
Pollinator verges and spaces								
Pollinator walls/vertical								
Pollinators roofs								
Vertical mobile garden								
Floating gardens								
Green filter area								

Note: Impact scoring: Very high (25-30), High (19-24), Medium (13-18), Low (12-5), Negative (<0)

Based on the table above, the impacts for each category and for each NBS have been accounted for in the following table. Therefore, each number shows the count of Challenges whose average is classified under each impact category.

Table 23. Count of each impact category per NBS in Liverpool

CHALLENGES	Very high	High	Medium	Low	Negative
Cycle and pedestrian green route	4	1	1		
Road junction pedestrian improvement	4		1		1
Shade trees	3	4	1		
Cooling trees	3	4	1		
Urban carbon sink		7	1		
Grassed swales and water retention ponds	3	4	1		
Rain gardens	4	3	1		
Urban catchment forestry	4	3	1		
Hard drainage-flood prevention Unearth water courses	1	5	1		
Hard drainage pavements	1	3	1	1	1
Pollinator verges and spaces	4	3	1		
Pollinator walls/vertical	5	2	1		
Pollinators roofs	4	3	1		
Vertical mobile garden		2	5	1	
Floating gardens	2	5	1		
Green filter area	2	5	1		

As can be seen, the NBS with the highest number of average impacts classified as "very high" are **Pollinators walls/vertical** (5), followed by interventions such as Cycle and pedestrian green route, Road junction pedestrian improvement, Rain gardens, Urban catchment forestry, Pollinator verges and spaces and Pollinators roofs (all of them with 4). On the other hand, interventions such as **Urban carbon sink** or **Vertical mobile garden** have not obtained an average impact rating of very high in any Challenge. It should also be noted that two NBS have had negative impacts in a challenge: **Road junction pedestrian improvement** and **Hard drainage pavements**.

The following table is similar to the previous one, but shows the count of impacts categorised by Challenge. These results show that **CH06 Urban Regeneration** and **CH09 Public Health and Well-being** benefit the most from the NBS installed in Liverpool, with 13 and 12 NBS rated as "very high" impact. **CH01 Climate mitigation & adaptation** and **CH02 Water Management**, while not showing NBSs with Very High impact, have the highest number of NBSs with "High" impact.

In contrast, for **CH10 Potential of economic opportunities and green jobs** the impacts have been of a medium-low typology, and this can be considered as the Challenge that has benefited the least from the NBS installed in Liverpool. In addition, it should be noted that medium negative impacts have been detected in two Challenges: **CH02 Water Management** and **CH05 Air Quality**.

Table 24. Count of each impact category per Challenges in Liverpool

CHALLENGES	CH01	CH02	CH04	CH05	CH06	CH07	CH09	CH10	**TOTAL**
Very high		7	6		13	6	12		**44**
High	11	5	8	14	3	10	3		**54**
Medium	1	1	1	1			1	15	**20**
Low			1					1	**2**
Negative		1		1					**2**
TOTAL	**12**	**14**	**16**	**16**	**16**	**16**	**16**	**16**	

7 IZMIR Global Evaluation

7.1 Barriers analysis

7.1.1 KPI barriers

In the city of Izmir, 27 KPIs were used to assess the impact of the NBSs implemented. Around 80% of the KPIs calculated encountered at least one type of barrier.

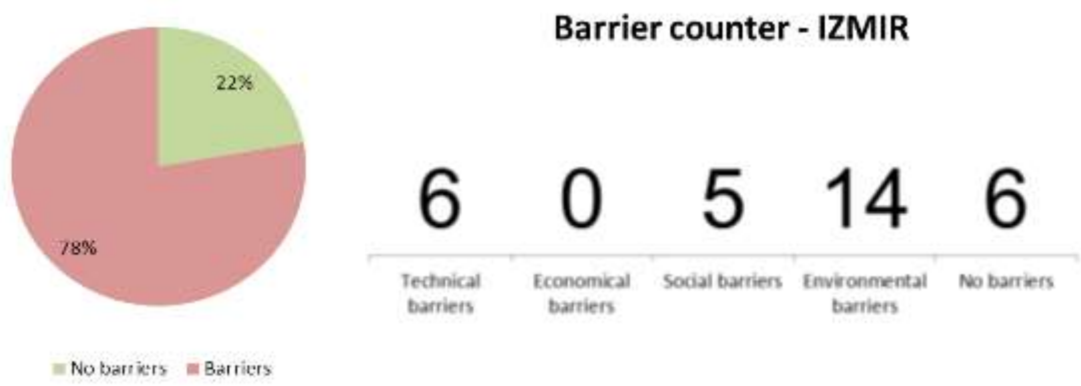


Figure 7.1. Barriers in Izmir.

Percentage of KPIs that encountered technical, economic, social or environmental barriers at least once (left). Number of times a KPI encountered any technical, economic, social or environmental barriers during the monitorization process (right)

Among these, most barriers where related to technical or environmental factors, or a mix of both. In many cases, the restrictions associated to the Covid pandemic prevented the implementation or proper maintenance of the NBS. As a result, the plants used in the NBS could not be watered, causing some of them to die or to grow more slowly, so the plants could not grow enough to cover the shading structures.

The pandemic also caused delays in data collection, since the purchase and installation of monitoring devices had to be postponed. Furthermore, the lack of qualified technical local hindered the maintenance of certain interventions, because trained technicians had to be called from different locations.

On the other hand, most social barriers were related to the perception of the interventions by the citizens. A negative perception of the interventions, coupled with insufficient communication and dissemination activities, may result in a lack of citizen support, especially in high density neighbourhoods where these types of interventions might be considered impractical.

In some cases, bigger, older trees were removed and smaller trees were planted to replace them. This has resulted in a negative impact of the NBS according to some KPIs, especially those related to carbon sequestration measurements. Even though a positive impact is expected to increase as the tree grows, it is important to assess each location before the interventions, and decide on an individual case basis what is the best approach.

7.1.2 NBS barriers

Izmir is the city where less barriers during NBS implementation and operation were encountered. Out of the total number, 60% of the barriers were experienced during the operation phase, and 40% of the barriers during the implementation phase.

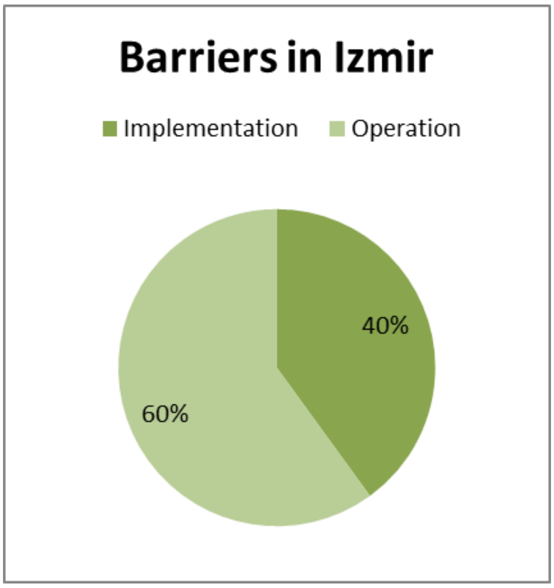


Figure 7.2. Percentage of total barriers encountered by the NbS that fall under the implementation and operation phases in Izmir.

Many of the **technical barriers** were similar to those already discussed for Valladolid and Liverpool, and were related to delays in bureaucratic processes such as the obtention of the necessary permits, or to problems regarding the utilities of the city, like for example securing a source of electricity for the automatic irrigation of some of the interventions. However, in the case of Izmir, some technical barriers were also the result of a lack of expertise. The contractors of the city did not have much experience in NBS implementation, and as such, technical partners had to contribute with their knowledge to complete the implementation phase on time. This offers a unique opportunity for the city of Izmir to offer activities that can train their workforce, and provides new possibilities of economic development.

The NBS interventions in Izmir did not experience any **economic barriers** during the implementation or operation phases.

Social barriers involved specific complaints from small businesses that were affected by a reduction in parking spaces. These businesses claimed that the number of clients would also decrease, if no space for cars was available. This illustrates again the need to properly communicate the benefits of the interventions, but also the need to carried out consultation and co-design activities that might improve public opinion.

The interventions in Izmir experienced some barriers associated to the COVID 19 pandemic, but also barriers that were the result of the design of the interventions. In some cases, materials that were resistant to harsh weather conditions (such as steel or plastic) were chosen for the interventions instead of more environmentally friendly materials.

Technical operation barriers were mostly the result of maintenance issues. For example, in some cases the maintenance was not properly done because political priorities changed considerable during the three-year period. In other cases, the characteristics of the intervention area make the maintenance challenging. In all cases, however, the Parks and Garden Department of the Municipality took responsibility and increased their efforts.

The lack of experts mentioned before also affected somewhat the operation of the interventions, as was the case for the parabolic systems, which require cleaning and maintenance from expert technicians. Most social and enviromental barriers were also similar to those encountered in Valladolid and Liverpool, such as the COVID delays already discussed.

As with the other two cities, the pandemic heavily impacted all non-technical interventions and all the communication and disseminationa activities, which in turn affected social perception and public opinion.

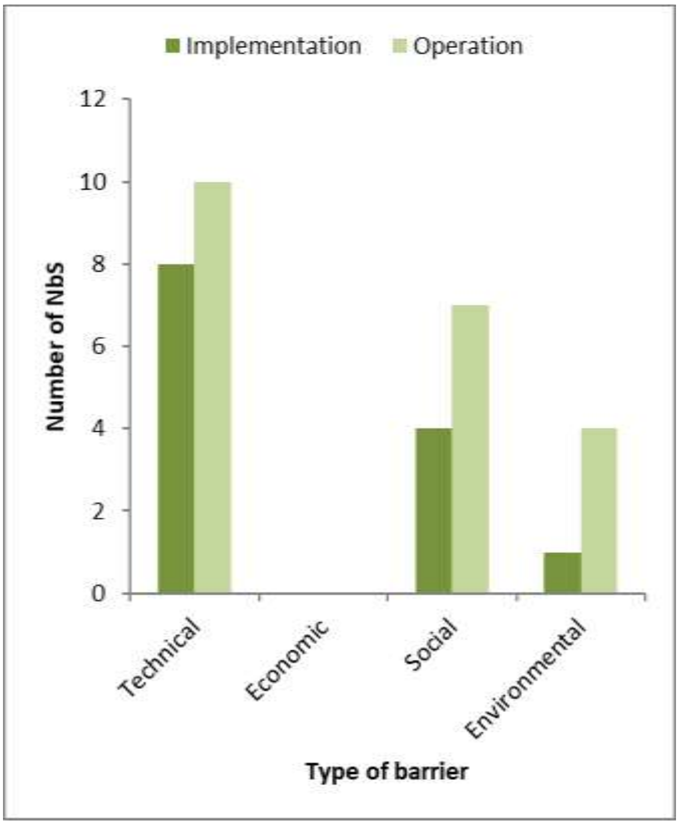


Figure 7.3. Number of NbS that encountered technical, economic, social and environmental barriers during the implementation/operation processes in Izmir

7.2 NBS performance evaluation

Note: For details on the factors, please check section 3.

In Izmir, a total of 69 impacts have been identified, all of them positive out of a total of 16 NbS assessed. The following graph shows the impacts obtained grouped by challenge. As can be seen, the Challenge with the highest number of impacts detected is **Challenge 1, Climate mitigation and adaptation** (27 impacts), followed by **Challenge 5 Air Quality** (17) and **Challenge 04 Green Space Management** (10).

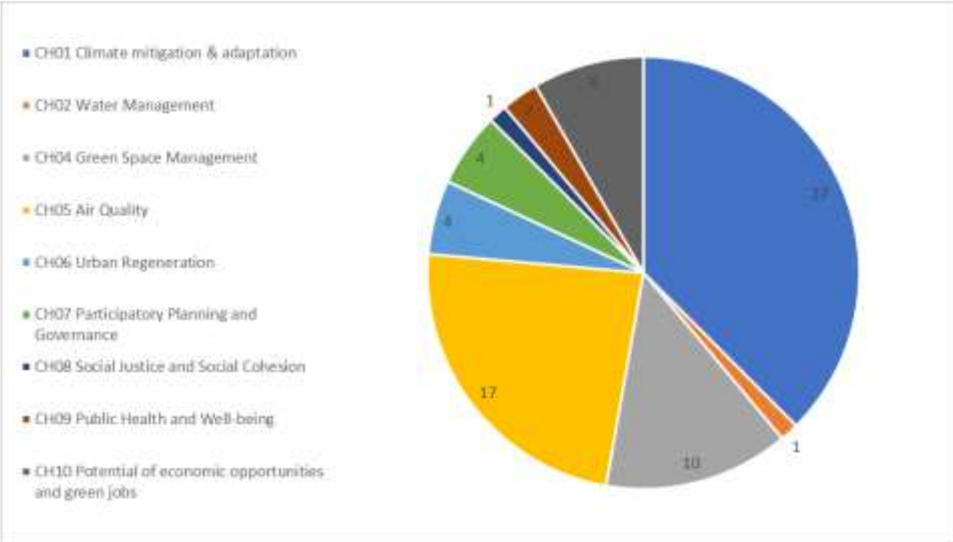


Figure 7.4. Number of positive impacts detected in Izmir

The following graph shows the NBS grouped by blocks, with each block having a surface area proportional to the number of impacts detected. **Arboreal areas around urban areas** and **Green Shady structures** are the NBS with the highest number of impacts detected, followed by **Cycle and pedestrian green route**.

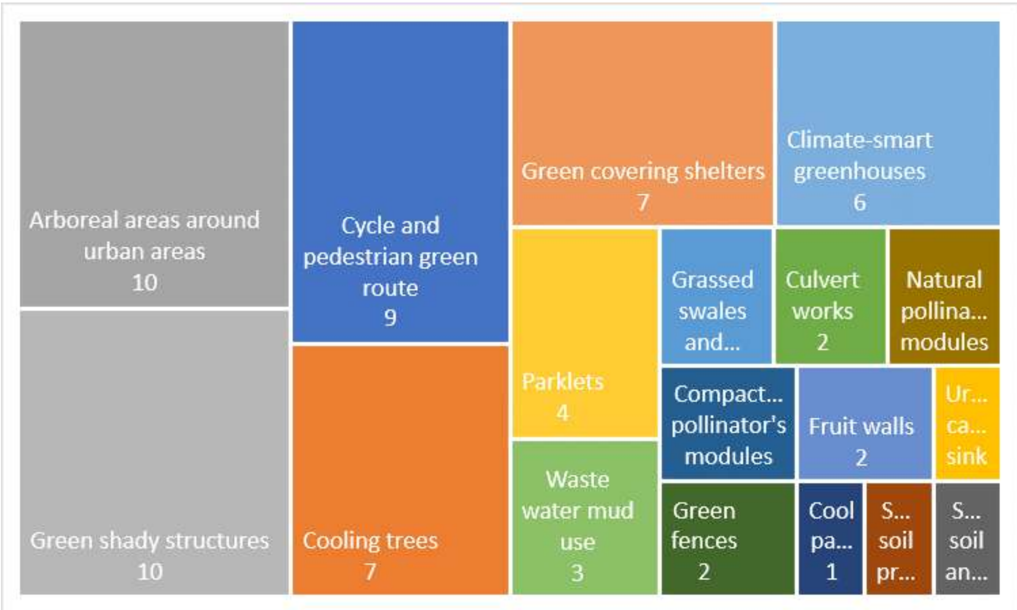


Figure 7.5. Impacts detected by NBS in Izmir

In terms of assessed impact **intensity**, in general, the challenges with the highest impact are **Challenge 08 Social Justice and Social Cohesion**, followed by **Challenge 07 Participatory Planning and Governance** and **Challenge 06 Urban regeneration**. However, it is Challenge 04 that has received the highest number of high intensity impacts.

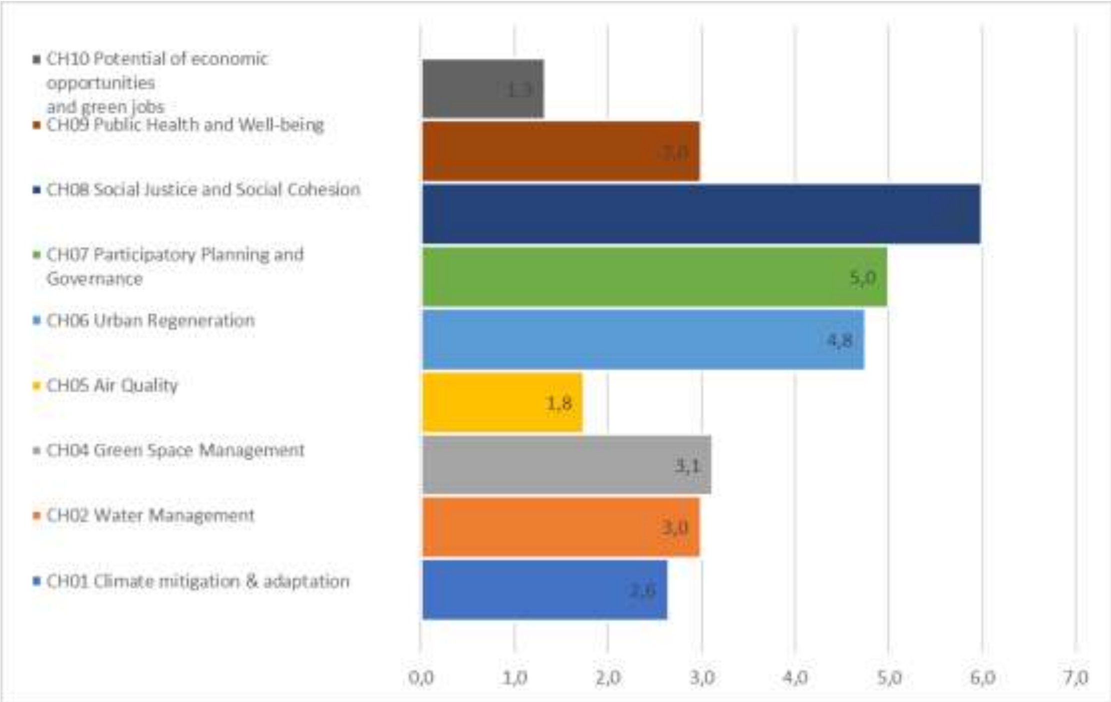


Figure 7.6. Average impact intensity by Challenges in Izmir

By NBS, the ones with the highest average impact are the **Urban Carbon Sink**, followed by the **pollinator modules** and **Cooling trees.** This can be seen in the next figure.

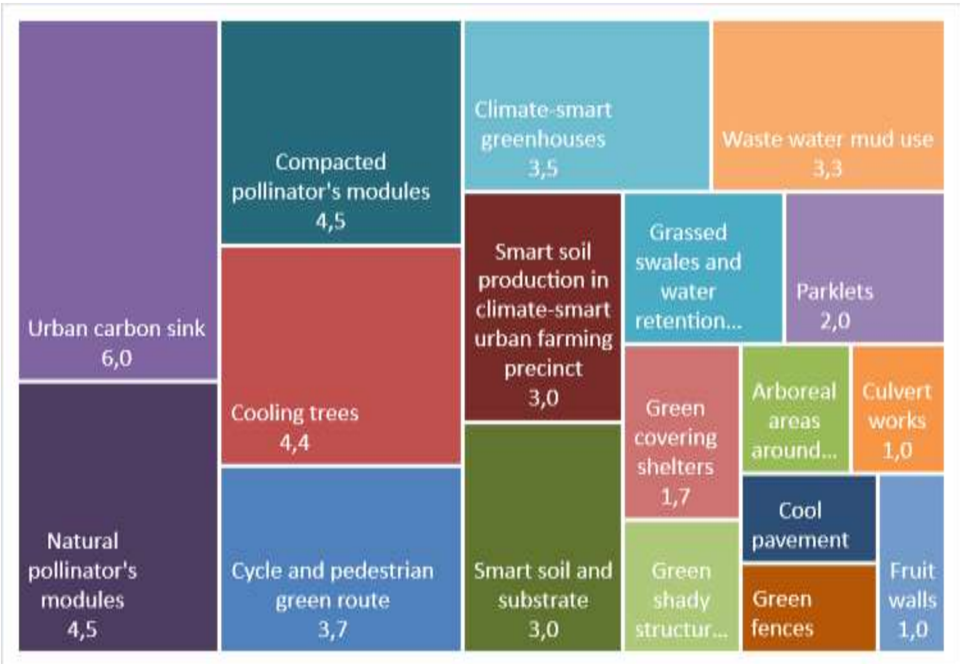


Figure 7.7. Average impact intensity by NbS in Izmir

However, the following table shows another point of view. These are the NBS with high impact intensities. **Cycle and pedestrian green route** and **Cooling trees** have obtained a high impact intensity in 3 indicators.

Table 25. NBS with KPIs rated with high intensity. Izmir

NBS	IN = 6
Cycle and pedestrian green route	3
Cooling trees	3
Climate-smart greenhouses	2
Urban carbon sink	1
Natural pollinator's modules	1
Compacted pollinator's modules	1
Waste water mud use	1

In terms of assessed impact **extension**, in general, impacts on **social and governance challenges** are felt at the **city level**, while **environmental** challenges, such as those related to water or air quality, have a **more localised impact**.

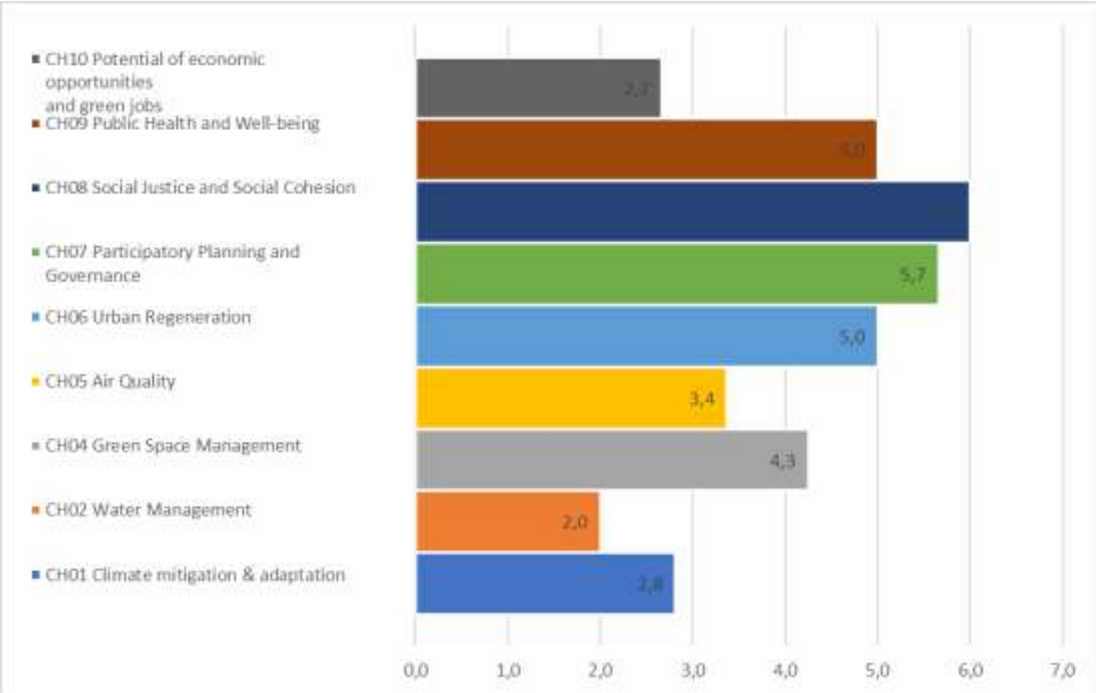


Figure 7.8. Average impact extension by Challenges in Izmir

By NBS, Cooling trees and urban carbon sink have a more extensive average impact, compared to other more specific actions such as smart soils.

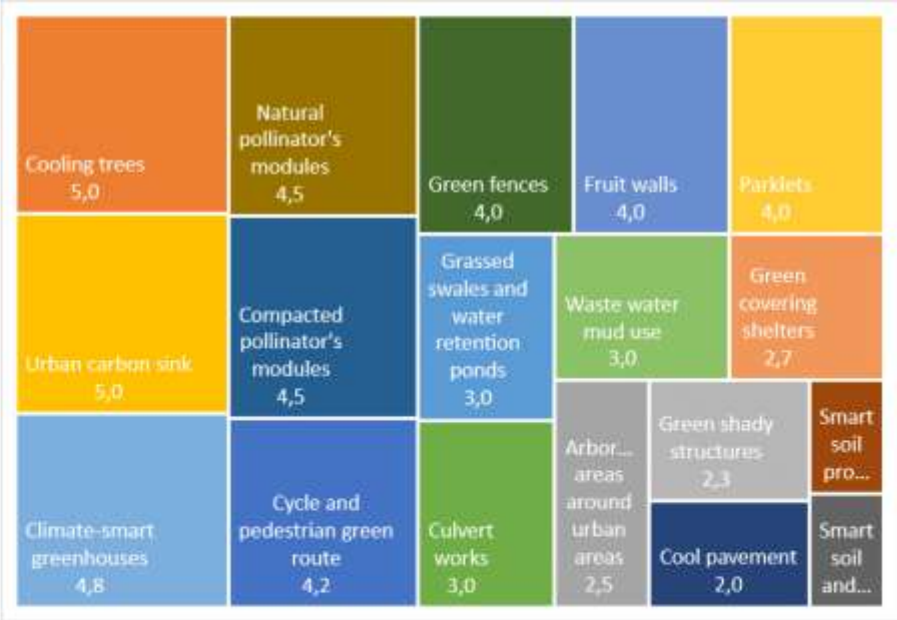


Figure 7.9. Average impact extension by NbS in Izmir

In terms of **moment** of impact, it is notable that impacts on health and well-being are more immediate than others such as social justice or air quality.

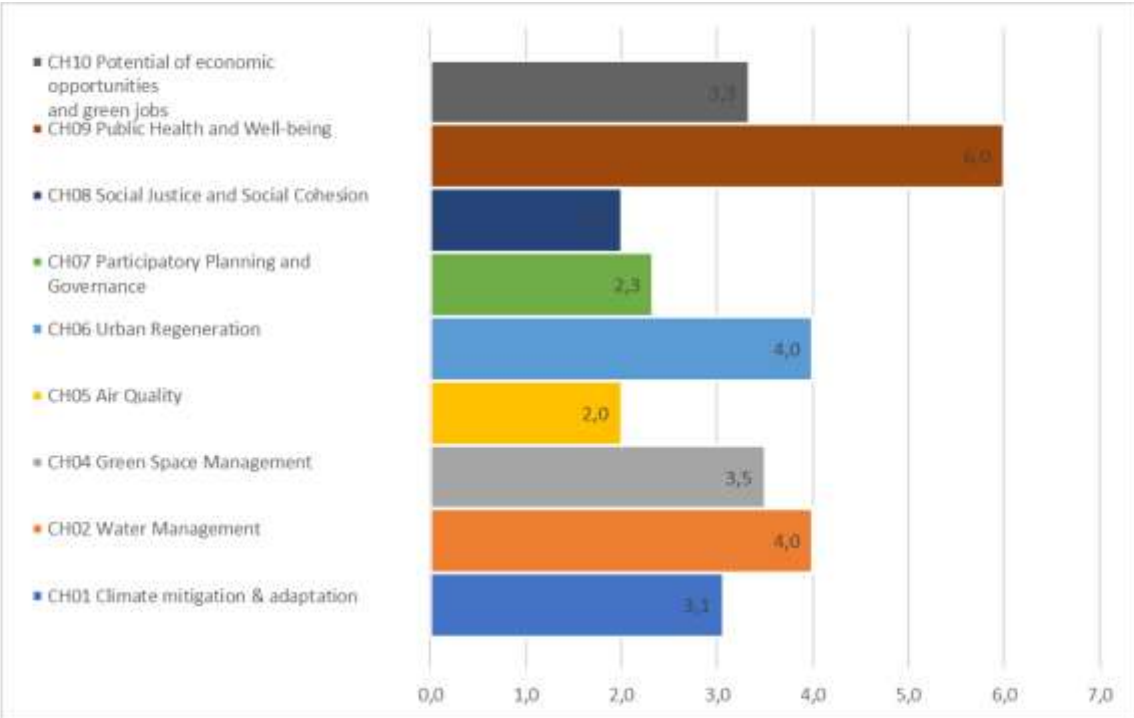


Figure 7.10. Average impact moment by Challenges in Izmir

In relation to the above, the NBS with the most immediate impacts are those most related to health and well-being, i.e. Cycle and pedestrian green route.

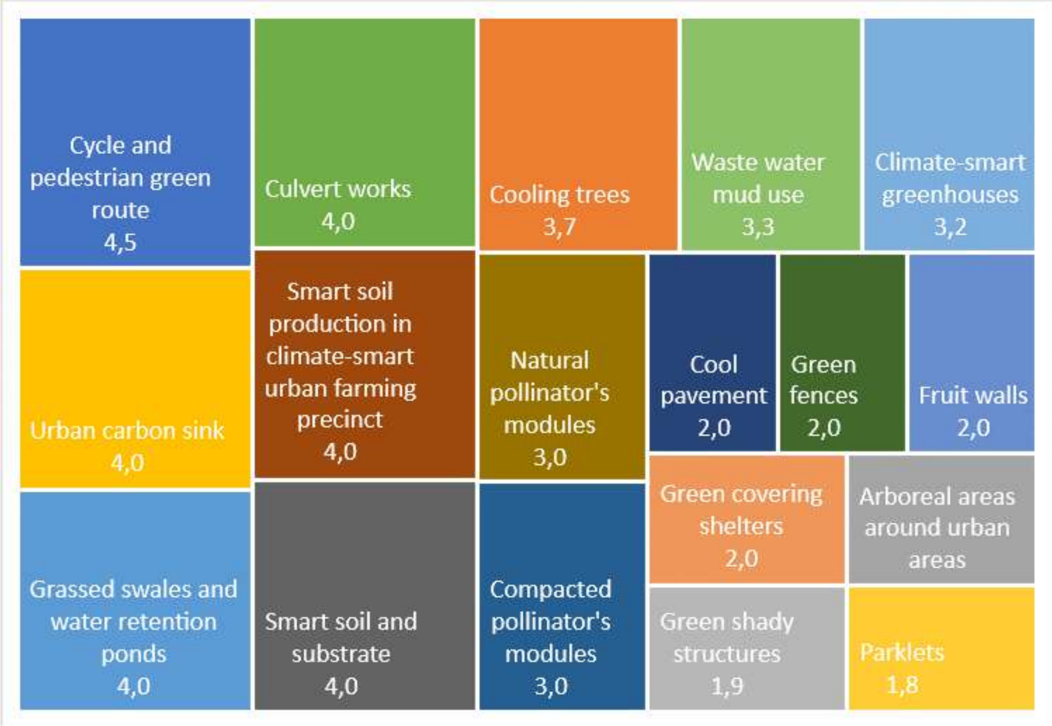


Figure 7.11. Average impact moment by NbS in Izmir

In terms of **synergy**, Urban Carbon Sink and Cooling trees are the two NBS that shows more synergies in their indicators, as well as cycle and pedestrian Green Route. This NBS shows the higher number of synergic rating.

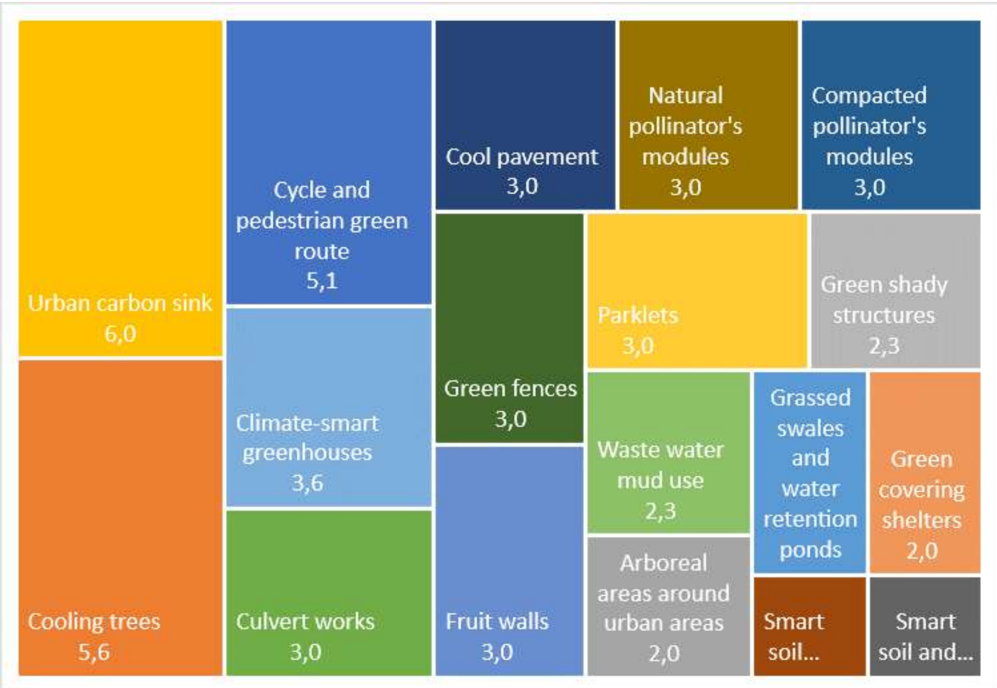


Figure 7.12. Average impact synergy by NbS in Izmir

Table 26. NBS with KPIs rated with high synergy. Izmir

NBS	SY = 6
Cycle and pedestrian green route	7
Cooling trees	6
Climate-smart greenhouses	3
Urban carbon sink	1

In terms of **frequency**, the NBS installed generates a continuous impact on most of them. Also in relation to the challenges, the averages are high and greater than 3 for most of them, indicating that there is a prevalence of continuous impacts.

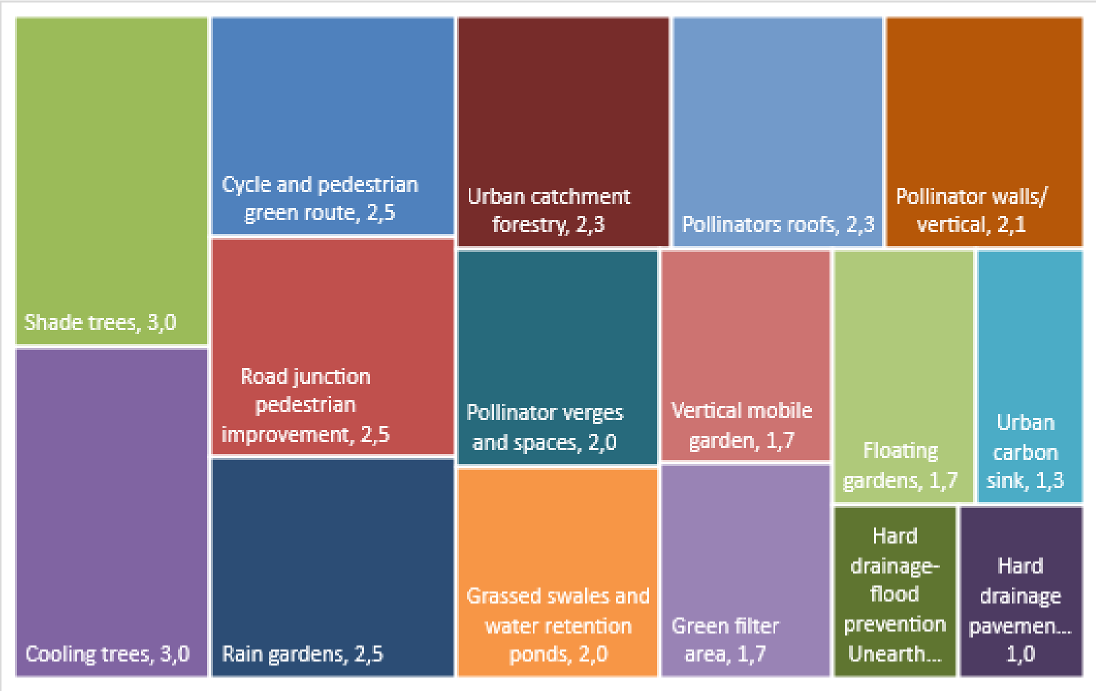


Figure 7.13. Average impact frequency by Challenges in Izmir

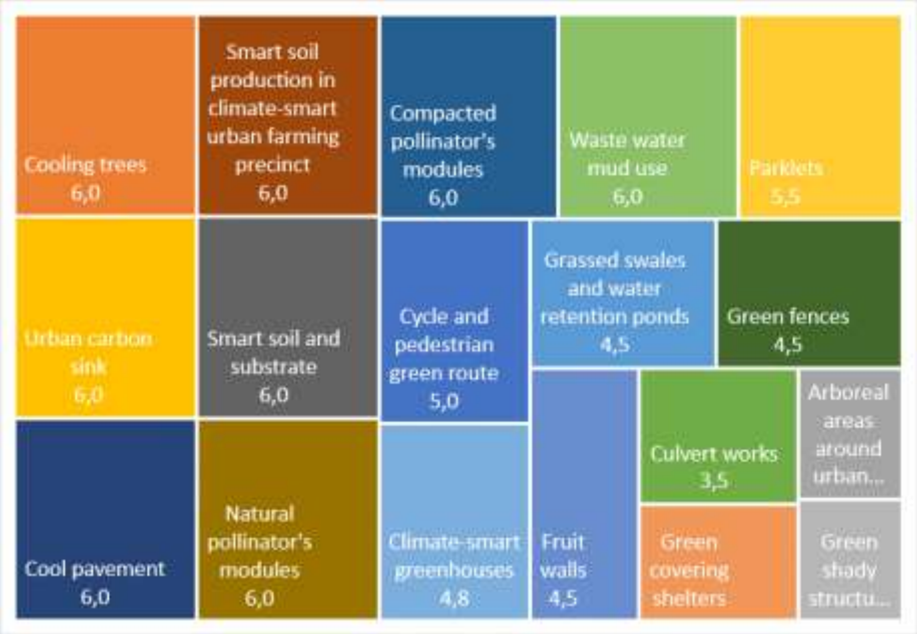


Figure 7.14. Average impact frequency by NbS in Izmir

7.3 Overall conclusion

The city of Izmir encountered fewer barriers during the implementation and operation of NbS interventions compared to Valladolid and Liverpool. However, a majority of barriers occurred during the operation phase. Technical barriers included bureaucratic delays, utility-related issues, and a lack of expertise in NBS implementation.

Izmir has the opportunity to provide training activities and foster economic development based on this experience. There were no significant economic barriers, but social barriers emerged from concerns of small businesses affected by reduced parking spaces, highlighting the importance of effective communication and consultation. Some barriers were related to the pandemic and intervention design choices.

Environmental and social barriers resembled those faced by other cities, influenced by the pandemic's impact on communication and public perception.

The following table shows a map of the rating obtained after applying the overall performance formula, corrected with the prioritisation of KPIs. As can be seen, there are two NBS with the highest number of impacts with a very high rating, namely Cycle and pedestrian green route and Cooling trees, both with 4 challenges that have reached this average rating.

Figure 7.15. Overall summary table of results of the total impact assessment in Izmir

NBS	CH01	CH02	CH04	CH05	CH06	CH07	CH08	CH09	CH10
Cycle and pedestrian green route									
Cooling trees									
Arboreal areas around urban areas									
Urban carbon sink									

NBS	CH01	CH02	CH04	CH05	CH06	CH07	CH08	CH09	CH10
Grassed swales and water retention ponds									
Culvert works									
Cool pavement									
Smart soil production in climate-smart urban farming precinct									
Smart soil and substrate									
Natural pollinator's modules									
Compacted pollinator's modules									
Green fences									
Fruit walls									
Green covering shelters									
Green shady structures									
Parklets									
Climate-smart greenhouses									
Waste water mud use									

Note: Impact scoring: Very high (25-30), High (19-24), Medium (13-18), Low (12-5), Negative (<0)

Based on the table above, the impacts for each category and for each NBS have been accounted for in the following table. Therefore, each number shows the count of Challenges whose average is classified under each impact category.

Table 27. Count of each impact category per NBS in Izmir

NBS	Very high	High	Medium	Low
Cycle and pedestrian green route	4			1
Cooling trees	4			
Arboreal areas around urban areas			1	1
Urban carbon sink	1			
Grassed swales and water retention ponds			2	
Culvert works		1		1
Cool pavement			1	
Smart soil production in climate-smart urban farming precinct			1	
Smart soil and substrate			1	
Natural pollinator's modules	1	1		
Compacted pollinator's modules	1	1		
Green fences			2	
Fruit walls			2	
Green covering shelters			1	1
Green shady structures			1	2
Parklets		1	1	
Climate-smart greenhouses	2	1	1	
Waste water mud use	1		2	

As can be seen, the NBSs with the highest number of average impacts classified as "very high" are **Cycle and pedestrian green route** and **Cooling Trees** (4). On the other hand, interventions such as **Cool pavement, Smart soil production in climate-smart urban farming precinct** and **Smart soil and substrate** have reach medium impact in one challenge.

The following table is similar to the previous one, but shows the count of impacts categorised by Challenge. These results show that **CH04 Green Space Management** benefit the most from the NBS installed in Izmir, with 4 NBS rated as "very high" impact. **CH06 Urban Regeneration**, shows a total of impacts classified as high or very high.

In contrast, **CH08 Social Justice and Social Cohesion** and **CH09 Public Health and Well-being** have had fewer impacts (1 each), but these have been very high. However, it can be said that **CH02 Water Management** also had 1 impact, but this was a medium impact.

Table 28. Count of each impact category per Challenges in Liverpool

CHALLENGES	CH01	CH02	CH04	CH05	CH06	CH07	CH08	CH09	CH10	**TOTAL**
Very high	2		4	1	3	1	1	1	1	**14**
High	1			2	1	1				**5**
Medium	7	1	4	2					2	**16**
Low				3					3	**6**
TOTAL	**10**	**1**	**8**	**8**	**4**	**2**	**1**	**1**	**6**	

8 Conclusions and recommendations

During the execution of this task, a total of 106 KPIs (42 from Valladolid, 40 from Liverpool and 24 from Izmir) and 67 NBS (21 from Valladolid, 22 from Liverpool and 24 from Izmir) have been reported. The assessment of these KPIs and NBS has been carried out firstly on an individual basis, including the performance report, the difficulties encountered and the solutions provided in each of them. All this information has been compiled in a detailed annex that serves as a catalogue of the NBS implemented and their associated KPIs.

On the basis of the experience gained, a systematic semi-qualitative assessment has been carried out on the basis of various aspects relating to the way in which the NBS impacts are manifested in the different challenges and through the KPIs evaluated. As a result of this massive multi-criteria analysis, a total of 771 impacts have been identified (155 from Valladolid, 547 from Liverpool and 69 from Izmir).

Regarding the overall performance of the NBS, a higher number of KPIs with positive impacts have been observed in actions associated with massive tree planting actions, such as cooling trees, shade trees, urban carbon sink, etc. On the other hand, less massive actions such as the electrowetland, biofilter, pollinator modules, etc., have registered fewer associated impacts. However, it should be considered that these actions are more intensive and address very specific challenges, so it is advisable to assess them in terms of their specific challenges and not in terms of the city as a whole. Finally, non-technical actions have an extensive impact, their potential extends to the neighbourhood or city, while more concrete (technical) NBS have a more localised impact.

The challenge that has benefited the most from the implementations has been CH06 Urban Regeneration, while among the least benefited is CH10 Potential of economic opportunities and green jobs. However, this impact accounting is closely related to the number of KPIs assessed for each Challenge, so a case-by-case study is recommended.

A total of 150 barriers were identified during the monitorization program of the KPIs in the cities (76 in Valladolid, 49 in Liverpool and 25 in Izmir). Most of these barriers (in total 70 in the 3 cities) were of a technical nature. The number of environmental barriers is also noteworthy, although it should be noted that this group includes those related to the incidence of COVID and the effects of the lock-down restrictions on the variables measured.

Based on the experience gained during the project, some recommendations on monitoring are presented below.

- When selecting indicators, it is important to have the necessary and adequate infrastructure to monitor them.
- The high dependence on specialised staff poses a risk for the monitoring of indicators and the evaluation of results. Therefore, when selecting methodologies, it is advisable to choose those that, while meeting the proposed objectives, require less specialisation.

- The limitations of indicators based on specific models and software, which are a simplification of reality that does not always consider specific or extraordinary factors, must be considered.
- Simplify communication channels during monitoring as much as possible: from the collection of raw data to the final assessment. The presence of a long chain of actors can hinder data transmission and lead to distortion.
- The assessment of citizen perception is problematic in certain respects, so that it is difficult to establish whether the negative responses are due to dissatisfaction with the implementation of the NBS per se, or to the lack of an adequate communication and dissemination strategy.

On the other hand, a total of 427 barriers were identified during the implementation of the NBS in the cities and their maintenance/operational works (208 in Valladolid, 185 in Liverpool and 34 in Izmir). Slightly more than half of these barriers occurred during the implementation phase (with the exception of the case of the city of Valladolid, where more barriers were found during the operational phase). In both the operation and implementation phases, most of the barriers encountered were technical, although those related to social aspects in the operation phase (in the case of Valladolid) or environmental barriers in the operation phase (in the case of Liverpool) are also notable.

Based on the experience accumulated by the three cities, the following are some useful recommendations for NBS implementation and conservation.

- It is recommended to carry out a detailed study of the areas of action, identifying existing **infrastructures** and **physical barriers** that may interfere with implementation.
- The design and implementation of a coordinated **communication** and awareness-raising **strategy** is essential for the success of RUPs and their integration into the daily life of citizens. Local communities, different sociological profiles and dynamics must be taken into account, so that it is able to reach as many citizens as possible.
- In relation to the above, **vandalism** is an important risk factor to consider, which can be addressed through awareness raising campaigns, but which should also be taken into account in the design phase of the NBS.
- In some cases, the renewal of old or at-risk trees and their replacement by younger plants can have a negative impact on some factors, such as carbon sequestration. However, it is necessary to assess the impact that interventions based on living elements have in the **long term** and not only in the immediate moment.
- The correct **timing** of the construction of interventions is essential, especially if they involve living elements. In addition, it is necessary to foresee agile response measures to preserve plants and trees, such as the need for irrigation and amendments due to extreme weather events.
- **Materials** supply can be a problem due to unforeseen circumstances and situations. It is therefore advisable to use common materials that are produced locally. The durability of materials and their environmental sustainability must also be considered.

- The **budget** is an important aspect to consider, as in many cases technical barriers increase costs. It is convenient to foresee these situations, especially when the actions are very innovative and/or have to be adapted to the presence of existing infrastructures or constructions.
- Excessive **bureaucracy** or lack of coordination between departments and different authorities can be a major barrier to the implementation of NBS, especially if they are particularly innovative. Effective channels of communication need to be opened between departments, different authorities, contractors and technical staff.
- The **lack of technical knowledge** on the part of contractors and maintenance companies can be an obstacle to the successful implementation and long-term maintenance of the most innovative NBS. It is therefore advisable to foresee these situations and to have specialised technical support, and on the other hand, to promote specific technical training actions in the maintenance of these innovative green and blue infrastructures.

In conclusion, the project has contributed to the change of the 3 Front-runner cities towards an urbanism that is more oriented for the ecosystem services provided by nature-based solutions. The transformation has not only been external transformation in the landscape of the cities, but also a process that has tested the capacity of the cities to implement such interventions, and from which valuable experience has undoubtedly been gained.

URBAN GreenUP

D5.4: NBS implementation conclusions and recommendations. Final NBS catalogue

Annex

WP 5 , T 5.5

Date of document

31st May 2022 (M60)

Authors: CAR, ACC, GMV, VAL, LIV, IZM, LEI

URBAN GreenUP

SCC-02-2016-2017

Innovation Action – GRANT AGREEMENT No. 730426

Table of Content

1 Final KIPs Catalogue

1.1 Valladolid

1.1.1 CH0101 Ton CO2 Carbon removed per year

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0101	Ton Co2 Carbon removed per year	CAR
CITY	*RELATED NBS*	
VAL	VAC07 and Tree-planting actions: VAC2, VAC3, VAC4, VAC5	

Results and Discussion

Table of results (summary, from Task 5.4)

Total CO2 absorption (ton) 20 years	VALUE	UNITS
Ex-ante	10,02	Ton CO2/ha
Ex-post	31,20	Ton CO2/ha
CH0101	**211%**	**%**

Data provided for the KPI calculation is only referred to the Urban Carbon Sink action (VaC07). The data given in the table correspond to the cumulative uptake of the trees planted in the UCS after 20 years of planting.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

VaC07

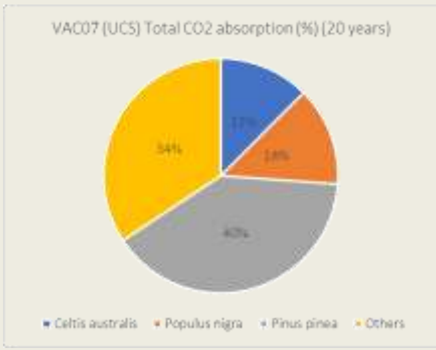
The baseline (ex-ante) corresponds to the agricultural harvest: Alfalfa crop (Medicago sativa) 4-5 years rotation. The CO2 absorption for the baseline has been calculated for the value of 20 years, by using data from Source 1[1].

[1] Ref. Mortenson, Matthew & Schuman, Gerald & Ingram, Lachlan. (2004). Carbon Sequestration in Rangelands Interseeded with Yellow-Flowering Alfalfa (Medicago sativa ssp. falcata). Environmental Management. 33. S475-S481. 10.1007/s00267-003-9155-9.

- The ex-post has been calculated using data from Valladolid City Council (tree planting list) and the absorption rates from Source 2[2].

The graph shown below (left), shows the global trend in CO2 absorption up to 40 years after planting. As can be seen, CO2 absorption will be particularly significant after 35 years (mature trees).

The graph on the right shows which species contribute most to carbon sequestration in the UCS, either by their sequestration power or by the number of trees planted. *Pinus pinea* contributes with the 40% of the CO2 fixation potential of the UCS. It is follows by *Populus nigra* and *Celtis australis*.



Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
It has not been possible to calculate the value for tree planting actions. There is no data on the situation before the tree planting actions carried out within the framework of the URBAN GreenUP project.	This KPI has been only calculated for VaC07 action (Urban Carbon Sink).
Economical barriers	How they have been addressed
No economical barriers detected.	
Social barriers	How they have been addressed

[2] CALCULADORA DE ABSORCIONES EX ANTE DE DIÓXIDO DE CARBONO DE LAS ESPECIES FORESTALES ARBÓREAS ESPAÑOLAS. Ministerio para la transición ecológica y el reto demográfico

https://www.miteco.gob.es/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/calculadoras.aspx

No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The CO2 fixation has been increased in a 211% within the area of the Urban Carbon Sink (VAC07). The action implemented has led to a change in land use. Although the existing agricultural cover was already fixing atmospheric carbon prior to the URBAN GreenUP action, has increased significantly. Moreover, this impact increases over time.

What was the impact? (positive/negative, significant/non-significant)?

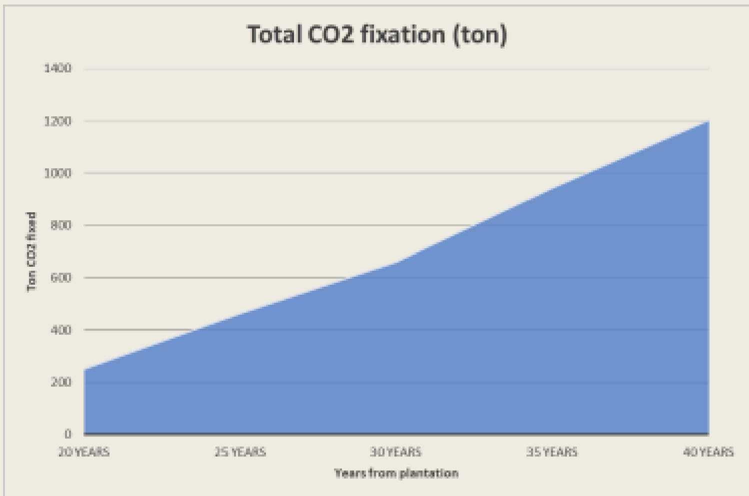
There is a significant impact on C sequestration in the area of the Urban Carbon Sink. The contribution to the "Challenge 1: Climate mitigation & adaptation" is a positive impact in the values.

Regarding the Tree planting actions, although no value can be set for this KPI, the planting of 2391 trees in the city will contribute positively to carbon sequestration (see "other comments").

Other comments

Optional: Any other relevant comments that you would like to include.

Regarding the tree planting actions, the cumulative absorption for the trees planted under the URBAN GreenUP project framework are shown in the next table and graphs.



1.1.2 CH0102 Ton Co2 Carbon removed per year

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0102	Ton Co2 Carbon removed per year	CAR
CITY	*RELATED NBS*	
VAL	VAC07 and Tree-planting actions: VAC2, VAC3, VAC4, VAC5	

Results and Discussion

Table of results (summary, from Task 5.4)

Total CO2 absorption (ton) 20 years	VALUE	UNITS
Ex-ante	2,83	Ton CO2/year
Ex-post	8,8215	Ton CO2/year
CH0101	**211%**	**%**

Data provided for the KPI calculation is only referred to the Urban Carbon Sink action (VaC07). The data given in the table correspond to the cumulative uptake of the trees planted in the UCS after 20 years of planting.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

VaC07

The baseline (ex-ante) corresponds to the agricultural harvest: Alfalfa crop (Medicago sativa) 4-5 years rotation.

- The CO2 absorption for the baseline has been calculated for the value of 20 years, by using data from Source 1[3].
- The ex-post has been calculated using data from Valladolid City Council (tree planting list) and the absorption rates from Source 2[4].

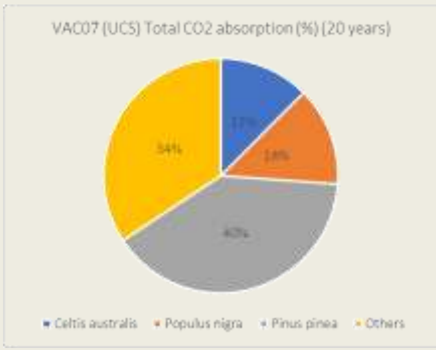
The graph shown below (left), shows the global trend in CO2 absorption up to 40 years after planting. As can be seen, CO2 absorption will be particularly significant after 35 years (mature trees).

[3] Ref. Mortenson, Matthew & Schuman, Gerald & Ingram, Lachlan. (2004). Carbon Sequestration in Rangelands Interseeded with Yellow-Flowering Alfalfa (Medicago sativa ssp. falcata). Environmental Management. 33. S475-S481. 10.1007/s00267-003-9155-9.

[4] CALCULADORA DE ABSORCIONES EX ANTE DE DIÓXIDO DE CARBONO DE LAS ESPECIES FORESTALES ARBÓREAS ESPAÑOLAS. Ministerio para la transición ecológica y el reto demográfico

https://www.miteco.gob.es/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/calculadoras.aspx

The graph on the right shows which species contribute most to carbon sequestration in the UCS, either by their sequestration power or by the number of trees planted. *Pinus pinea* contributes with the 40% of the CO2 fixation potential of the UCS. It is follows by *Populus nigra* and *Celtis australis*.



Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
It has not been possible to calculate the value for tree planting actions. There is no data on the situation before the tree planting actions carried out within the framework of the URBAN GreenUP project.	This KPI has been only calculated for VaC07 action (Urban Carbon Sink).
Economical barriers	How they have been addressed
No economical barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The CO2 fixation has been increased in a 211% within the area of the Urban Carbon Sink (VAC07). The action implemented has led to a change in land use. Although the existing agricultural cover was already fixing atmospheric carbon prior to the URBAN GreenUP action, has increased significantly. Moreover, this impact increases over time.

What was the impact? (positive/negative, significant/non-significant)?

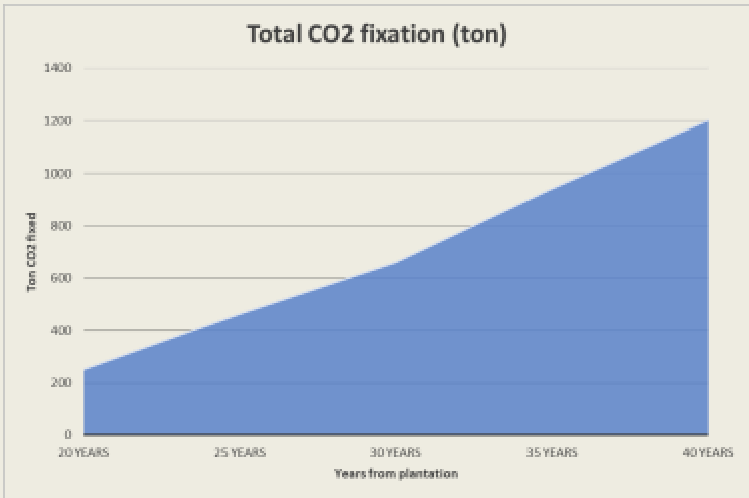
There is a significant impact on C sequestration in the area of the Urban Carbon Sink. The contribution to the "Challenge 1: Climate mitigation & adaptation" is a positive impact in the values.

Regarding the Tree planting actions, although no value can be set for this KPI, the planting of 2391 trees in the city will contribute positively to carbon sequestration (see "other comments".

Other comments

Optional: Any other relevant comments that you would like to include.

Regarding the tree planting actions, the cumulative absorption for the trees planted under the URBAN GreenUP project framework are shown in the next table and graphs.



1.1.3 CH0105 Decrease in mean or peak daytime local temperatures (ºC)

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105	Decrease in mean or peak daytime local temperatures (ºC)	CAR

CITY *RELATED NBS*

VAL	VAc24, VAc25, VAc27 & Vac29,	

Results and Discussion

Table of results of this KPIs for the relevant NBS interventions in the city of Valladolid. In this case, as introduction for each NBS is indicated the reference site selected to calculate the CH0105 KPI. The selection of the reference site has been done according the NBS implementations site characteristics among the available reference data.

The calculation of this KPI has been done individually for each NBS because, as these NBS have building or street scale, the evaluation of all of them at district or city scale joining all the date, has no interest itself. However, the individual evaluation of each NBS will support the selection of the proper NBS when a temperature reduction is aiming in the hot season.

VAc25 Green Façade (Ending implementation date 30/06/2020)

NBS intervention site (El Corte Inglés Building in Constitución St.). Reference site (Rinconada Sq. in Valladolid).

Temperture reduction (ºC)	VALUE	UNITS	Year
Ex-ante (2019)	-1,45	ºC	
Ex-post (2020)	-1,44	ºC	
Ex-post (2021)	-1,29	ºC	
CH0105	**11**	**%**	**2021**

VAc 27 Green Covering Shelter (Ending implementation date 24/02/2020)

NBS intervention site in España Sq. Reference site in Montero Calvo St. in Valladolid. The reference site is not a square such as the España Sq. but Montero Calvo St. is very close to it and on the other side España Sq is not a conventional open square. Anyway, the use of Rinconada Sq. data to calculate this KPI produces similar results in terms of impact.

Temperture reduction (ºC)	VALUE	UNITS	Year
Ex-ante (2019)	0,66	ºC	
Ex-post (2020)	2,46	ºC	
Ex-post (2021)	0,57	ºC	
CH0101	**14%**	**%**	**2021**

VAc29 Green shady structures (Ending implementation date 26/02/2021)

NBS intervention site in Santa María St. Reference site in Montero Calvo St. in Valladolid. Both streets are parallel and very close and have a similar configuration.

Temperture reduction (ºC)	VALUE	UNITS	Year
Ex-ante (2019)	0,16	ºC	
Ex-ante (2020)	1,33	ºC	

Ex-post (2021)	-0,72	ºC	
CH0101	**-2,02ºC / -154%**	**%**	**2020 as reference**

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

The discussion of the results of this KPI has been also done individually for each NBS because, as these NBS have building or street scale, the evaluation of all of them at district or city scale joining all the date, has no interest itself. However, the individual evaluation of each NBS will support the selection of the proper NBS when a temperature reduction is aiming in the hot season.

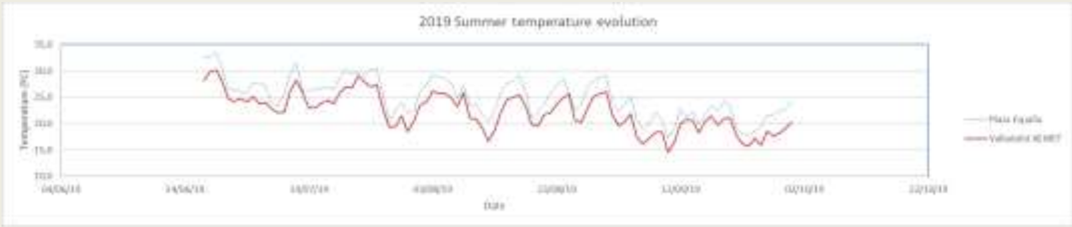
VAc25 Green Façade (Ending implementation date 30/06/2020)

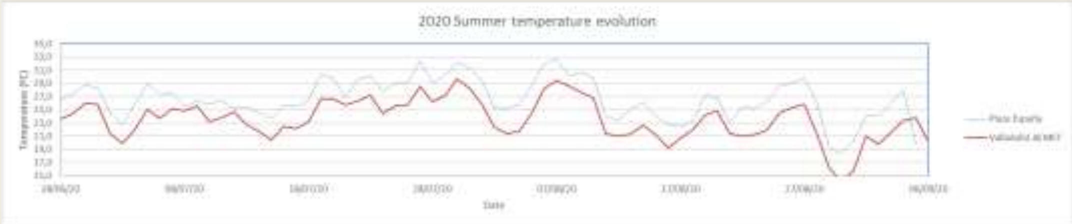
This result in 2021 indicates that the Green Façade (VAc25) has not significant impact on the temperature reduction in the area. It could be due to the fact the vertical garden is installed quite high (around 7 m high of the lower part) from the floor where people are (and thermometers too).

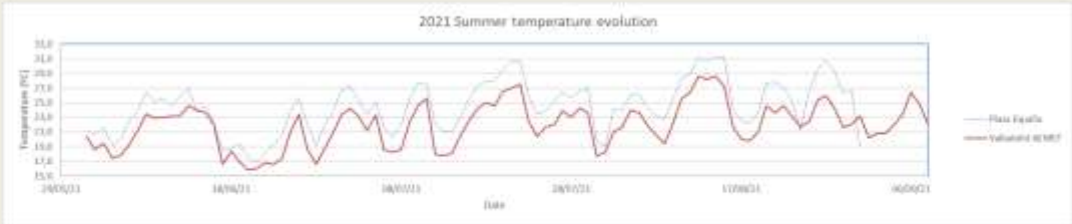
VAc 27 Green Covering Shelter (Ending implementation date 24/02/2020)

This result in 2021 indicates even a slightly increase in the temperature in comparison with the reference site in the Green covering shelter (VAc27). So, it has not significant impact on the temperature reduction in the area. It could be due to the fact the green covering layer has been installed on an existing shadow structure and the implementation of the vegetation on it has not significant impact over the area temperature in the hot season.

Additionally, if it is compared temperature profiles before and after the interventions, it can be seen that no differences are appreciated.







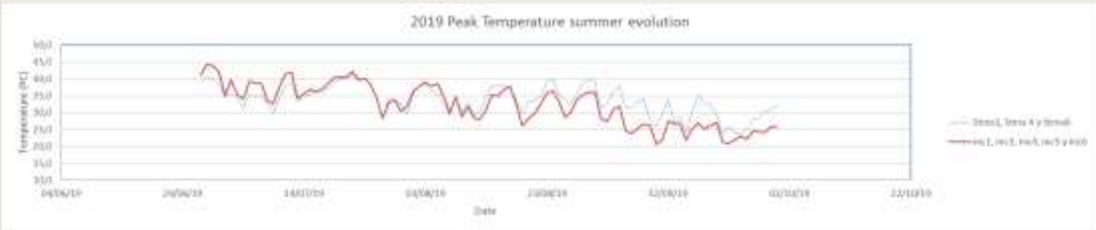
VAc29 Green shady structures (Ending implementation date 26/02/2021)

This result in 2021 seems to indicate that the implementation of the green shady structures in the Santa María St. provokes the reduction of the average temperature of around 2 ºC. It is a relevant impact considering that are average temperatures. In order to complete the analysis, an alternative study was carried out. CH0105 KPI was calculated again but considering only maximum daily temperatures.

Temperture reduction			Year
In maximum daily temperatures(ºC)	VALUE	UNITS	
Ex-ante (2019)	-0,23	ºC	
Ex-ante (2020)	5,14	ºC	
Ex-post (2021)	-2,02	ºC	
CH0101	-7,16ºC / -139%	%	2020 as reference

7ºC of reduction in daily maximum temperature is a very relevant impact of this intervention. Additionally, if maximum daily temperatures are compared between reference site and NBS site during the hot season, a change in the pattern clearly appears. Temperatures in Santa

María St. go under temperatures in Montero Calvo St. due to the Green shadow structures implementation.



Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No available wifi connections in the streets. Individual gprs or other systems for each sensor is to expensive.	Install Bluetooth connection system for the sensors. However, it requires on site data collection.
Economic barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
Temperature and humidity sensors. Some of them suffered vandalism or directly disappear. Some of the sensors could not be installed due to lack of available anchors in public domains. Some of private owners in the street refused to let us to install the sensons in their elements.	Some of the sensors were substituted. Some streets are not fully monitored with the planned sensors and were only partially monitored.

Environmental (including COVID)	How they have been addressed
During the lockdown some of the sensors required maintenance operations but we could not carry out them. Some data sets were lost because of it.	Hopefully, no more pandemics affect the world.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

As it has been previously introduced, impacts depend on the type of NBS and its location. Some of the interventions did not show a detectable impact on the temperature reduction during the hot season comparing with a no modified reference location.

However, the Green Canopies NBS intervention area (Santa María St.) showed a relevant temperature reduction during the hot season (June-August) in comparison with the reference area selected (a parallel street close to the intervention area, Montero Calvo St.). 2 ºC of the average temperature reduction and more then 7 ºC of the reduction in the daily peak temperatures.

What was the impact? (positive/negative, significant/non-significant)?

Regarding temperature reduction, the impact was positive, as it has been mentioned previously for the case of the Green canopies installed in the Santa María St.

Other comments

Optional: Any other relevant comments that you would like to include.

Other NBS in Valladolid have been partially monitored but data collected do not allow an adequate analysis and so these results have not been included in this document.

1.1.4 CH0108 Heatwave risks reduction (days, %)

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0108	Heatwave risks reduction (days, %)	CAR
CITY	*RELATED NBS*	
VAL	VAc24, VAc25, VAc27 & Vac29,	

Results and Discussion

Table of results of this KPIs for the relevant NBS interventions in the city of Valladolid. In this case, as introduction for each NBS is indicated the reference site selected to calculate the

CH0108 KPI. The selection of the reference site has been done according the NBS implementations site characteristics among the available reference data.

The calculation of this KPI has been done individually for each NBS because, as these NBS have building or street scale, the evaluation of all of them at district or city scale joining all the date, has no interest itself. However, the individual evaluation of each NBS will support the selection of the proper NBS when a temperature reduction is aiming in the hot season.

Of course, it is anyway a relevant KPI to be considered at city or district scale, but the scale of intervention of the proposed NBS and this KPI do not allow to assess the impact at these bigger scales. Anyway, results can be extrapolated and can be used to propose solutions regarding the heatwave risk reduction and the climate change impact in big cities. This KPI indicates the number of days with maximum temperatures over 35ºC and compares it with data before the intervention keeping in mind data from reference sites.

VAc25 Green Façade (Ending implementation date 30/06/2020)

NBS intervention site (El Corte Inglés Building in Constitución St.). Reference site (Rinconada Sq. in Valladolid).

Heatwave risk reduction (%)	VALUE	UNITS	Year
Ex-ante (2019)	45 / 79%	Days /%	
Ex-post (2020)	50 / 100%	Days /%	
Ex-post (2021)	50 / 94%	Days /%	
CH0108	**+15**	**%**	**2021**

VAc 27 Green Covering Shelter (Ending implementation date 24/02/2020)

NBS intervention site in España Sq. Reference site in Montero Calvo St. in Valladolid. The reference site is not a square such as the España Sq. but Montero Calvo St. is very close to it and on the other side España Sq is not a conventional open square. Anyway, the use of Rinconada Sq. data to calculate this KPI produces similar results in terms of impact.

Heatwave risk reduction (%)	VALUE	UNITS	Year
Ex-ante (2019)	67 / 248%	Days /%	
Ex-post (2020)	50/ 1000%	Days /%	
Ex-post (2021)	44 / 191%	Days /%	
CH0108	**- 57**	**%**	**2021**

VAc29 Green shady structures (Ending implementation date 26/02/2021)

NBS intervention site in Santa María St. Reference site in Montero Calvo St. in Valladolid. Both streets are parallel and very close and have a similar configuration.

Temperture reduction (ºC)	VALUE	UNITS	Year
Ex-ante (2019)	35 / 130%	Days /%	
Ex-ante (2020)	38 / 760%	Days /%	
Ex-post (2021)	16/ 70%	Days /%	
CH0108	**- 60**	**%**	**2021**

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

The discussion of the results of this KPI has been also done individually for each NBS because, as these NBS have building or street scale, the evaluation of all of them at district or city scale joining all the date, has no interest itself. However, the individual evaluation of each NBS will support the selection of the proper NBS when a temperature reduction is aiming in the hot season.

VAc25 Green Façade (Ending implementation date 30/06/2020)

This result in 2021 indicates that the Green Façade (VAc25) has not significant impact on the temperature reduction in the area. Anyway, it is difficult to assess the impact because data in different year differs quite a lot. Anyway, it is recommended to wait for an extra year to assess the impact.

VAc 27 Green Covering Shelter (Ending implementation date 24/02/2020)

This result in 2021 indicates a slightly reduction in risk of heatwaves in comparison with the reference site in the Green covering shelter (VAc27). However, data are quite variable and it is recommended to assess the impact during 2022 summer time in order to know if this intervention could affect maximum temperatures in the area.

VAc29 Green shady structures (Ending implementation date 26/02/2021)

This result in 2021 seems to indicate (in comparison with 2019 because data in 2020 are unexpectable) that the implementation of the green shady structures in the Santa María St. provokes a relevant reduction of the heatwave risk in the street. Anyway, it is recommended to assess this KPI also in 2022 in order to check this tendency.

Temperture reduction			Year
In maximum daily temperatures(ºC)	VALUE	UNITS	
Ex-ante (2019)	-0,23	ºC	
Ex-ante (2020)	5,14	ºC	
Ex-post (2021)	-2,02	ºC	
CH0108	**-7,16ºC / -139%**	**%**	**2020 as reference**

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No available wifi connections in the streets. Individual gprs or other systems for each sensor is to expensive.	Install Bluetooth connection system for the sensors. However, it requires on site data collection.
Economic barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
Temperature and humidity sensors. Some of them suffered vandalism or directly disappear. Some of the sensors could not be installed due to lack of available anchors in public domains. Some of private owners in the street refused to let us to install the sensons in their elements.	Some of the sensors were substituted. Some streets are not fully monitored with the planned sensors and were only partially monitored.
Environmental (including COVID)	How they have been addressed

During the lockdown some of the sensors required maintenance operations but we could not carry out them. Some data sets were lost because of it.	Hopefully, no more pandemics affect the world.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

As it has been previously introduced, impacts depend on the type of NBS and its location. Some of the interventions did not show a detectable impact on the temperature reduction during the hot season comparing with a no modified reference location.

However, the Green Canopies NBS intervention area (Santa María St.) showed a relevant temperature reduction during the hot season (June-August) in comparison with the reference area selected (a parallel street close to the intervention area, Montero Calvo St.).

What was the impact? (positive/negative, significant/non-significant)?

Regarding temperature reduction, the impact was positive, as it has been mentioned previously for the case of the Green canopies installed in the Santa María St.

Other comments

Optional: Any other relevant comments that you would like to include.

Other NBS in Valladolid have been partially monitored but data collected do not allow an adequate analysis and so these results have not been included in this document.

Additionally, it is recommended to assess this KPI during 2022 in order to value the real impact of the interventions thinking that the vegetation is fully developed this year.

1.1.5 CH0109 Energy saving from reduced building consumption

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0109	Energy saving from reduced building consumption	LEITAT

CITY	*RELATED NBS*
VALLADOLID	Green roof (“Campillo”market). Vertical façade (El Corte Inglés)

Results and Discussion

Table of results (summary, from Task 5.4)

NBS Surface

Vac28	Mercado "El Campillo"	524,09	*m2*
Vac25	Corte Inglés	351,05	*m2*

Envelope characterization - AFTER RENOVATION (NBS)

Vac28 Mercado		Layer 1	Layer 2	Layer 3	Layer 4
Material	-	Rock wool	Integrated Sedum system	lightweight concrete	slab with beams
di	*m*	0,05		0,1	0,3
Li	*W/mK*	0,04		0,19	0,846
R-value i	*m2K/W*	1,25	0,4158	0,52631578	0,35460992

Vac25 Corte Inglés		Layer 1	Layer 2	Layer 3	Layer 4
Material	-	air chamber	PVC panel	Rock wool	vegetation layer
di	*m*	0,05	0,035	0,04	0,07
Li	*W/mK*	0,0256	0,021	0,032	0,12
R-value i	*m2K/W*	1,953125	1,6666667	1,25	0,5833333

Thermal resistance of the building envelope **- BEFORE RENOVATION**

Vac28	Mercado "El Campillo"	1,18	*m2K/W*
Vac25	Corte Inglés	1,18	*m2K/W*

Thermal resistance of the building envelope **- AFTER RENOVATION (NBS)**

Vac28	Mercado "El Campillo"	2,55	*m2K/W*
Vac25	Corte Inglés	3,65	*m2K/W*

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Methodology 2: Estimation from thermal transmittance

Assuming an average temperature reduction of a 2% due to passive NBS system (Chafer et al, 2021), we have calculated the following energy saving:

Vac28 Mercado	**Mercado "El Campillo"**

		YEAR 1 (19-20)	**YEAR 2 (20-21)**	**YEAR 3 (21-22)**
E. savings	*KWh/year*	622,27	584,00	568,84

Vac25 Corte Inglés	**El Corte inglés**

		YEAR 1 (20-21)	**YEAR 2 (21-22)**	**YEAR 3 (22-23)**
E. savings	*KWh/year*	469,65	450,72	564,70

UGUP	**Urban GreenUP**

		YEAR 1	**YEAR 2**	**YEAR 3**
E. savings	*KWh/year*	1091,92	1034,72	1133,54

Methodology 3: Estimation from electrical building consumption

Energy savings will be calculated taking into account electrical building consumption pre and post intervention and the corresponding climatical conditions.

Vac28 Mercado	**Mercado "El Campillo"**

		Mean (17-19)	**2020**	**2021**	**2022**
E. savings	*KWh/year*	145404	25380	14474	42170
	SD	7670			

Vac25 Corte Inglés	El Corte inglés				
		Mean (17-19)	2020	2021	2022
E. savings	*KWh/year*	4165468	807740	399348	#¡VALOR!
	SD	88270			

UGUP	Urban GreenUP				
		Mean (17-19)	2020	2021	2022
E. savings	*KWh/year*	95940	833120	413822	42170

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Installation of temperature sensor inside the market to calculate KPIi. Installed climate-controlled system in El Corte Inglés.	Cartif (responsible of this installation) is in process to install this sensor in campillo market. El Corte Inglés in/out temperature difference should be calculated from literature and/or use an energy consumption approach.
Economical barriers	**How they have been addressed**
Not identified.	Not identified.
Social barriers	**How they have been addressed**
Not identified.	Not identified.
Environmental (including COVID)	**How they have been addressed**
Covid situation caused several delays in the calculation of energy saving KPI.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

There is a significative aesthetic impact, but we don't have enough data to assure a significant energy reduction due to the NBS implementation. In one hand, the relative size of the NBS compared to the total building envelope, building complexity may have influenced thermal methodology approach. On the other hand, energy consumption approach may have been affected by many factors like: COVID lockdown, energy saving measures in lightning, changes in electricity provider, etc.

What was the impact? (positive/negative, significant/non-significant)?

not measurable

1.1.6 CH0110 Carbon savings from reduced building energy consumption

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0110	Carbon savings from reduced building energy consumption	LEITAT

CITY	*RELATED NBS*
VALLADOLID	Green Roof ("El Campillo" market) Vertical façade (El Corte Inglés)

Results and Discussion

Table of results (summary, from Task 5.4)

Energy savings		**2020**	**2021**	
Vac25	El corte Inglés Constitución	807740	399348	*KWh*
Vac28	Mercado del Campillo	25380	14474	*KWh*

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Carbon savings		2020	2021	
Vac25	El corte Inglés Constitución	24240277.4	11984433	*Kg CO2*
Vac28	Mercado del Campillo	761653.8	434365	*Kg CO2*

UGUP	**Urban GreenUP**

		2020	2021
CO2 savings	*Kg CO2*	25001931	12418798

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Historical data collection of energy consumption.	Ayto Valladolid has been addressing these issues with the demonstrator administrators.
Economical barriers	How they have been addressed
Not identified.	Not identified.
Social barriers	How they have been addressed
Not identified.	Not identified.
Environmental (including COVID)	How they have been addressed
Covid situation caused several delays in the calculation of energy saving KPI and lockdown affected energy consumption records.	We have compared 2020 results with an average of the past 5 years.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

There is a significative aesthetic impact, but we don't have enough data to assure a significant energy reduction due to the NBS implementation. Energy consumption approach may have been affected by many factors like: COVID lockdown, energy saving measures in lightning, changes in electricity provider, etc.

What was the impact? (positive/negative, significant/non-significant)?

not measurable

1.1.7 CH0201 Run-off coefficient

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0201	RUN-OFF COEFFICIENT	CEN
CITY	*RELATED NBS*	
VAL	SUB-DEMO C	

Results and Discussion

Table of results (summary, from Task 5.4)

Estimated:

Actuación: Jardín de lluvia Av. Mundial 82
Tipo: Rain Garden
Superficie ocupada (m2): 964
ΔV (m3): 25.70
Cr (%): 0.81

Actuación: Balsa de retención
Tipo: SuDS
Superficie ocupada (m2): 290
ΔV (m3): 7.73
Cr (%): 0.81

Actuación: Pavimento permeable
Tipo: Green Parking pavements
Superficie ocupada (m2): 611
ΔV (m3): 16.29
Cr (%): 0.81

No data recorded (see conclusions section)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The calculated values of ΔV and Cr has been assessed before the installation of the NBS for each intervention.

A higher DV value means greater potential hydrologic benefits provided by the NBS studied, whereas a higher Cr indicates less need to improve future urban rainwater management in a specific area.

This is an estimated KPI using a cost-effective hydrologic model based on the Soil Conservation Service Curve Number (SCS-CN) method (NRCS, 1986).

No data recorded (see conclusions section).

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Lack of qualified technical personnel in the entity.	Not addressed within the project.
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

What was the impact? (positive/negative, significant/non-significant)?

1.1.8 CH0202 Absorption capacity (m3/m2)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0202	ABSORPTION CAPACITY (m3/m2)	CEN
CITY	*RELATED NBS*	
VAL	SUB-DEMO C	

Results and Discussion

Table of results (summary, from Task 5.4)

No data recorded (see conclusions section)
Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.
No data recorded (see conclusions section)

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Lack of qualified technical personnel in the entity	Not addressed within the project.
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
What was the impact? (positive/negative, significant/non-significant)?

1.1.9 CH0203 Absorption capacity (m3/tree)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0203	ABSORPTION CAPACITY (m3/tree)	CEN
CITY	*RELATED NBS*	
VAL	SUB-DEMO C	

Results and Discussion

Table of results (summary, from Task 5.4)
No data recorded (see conclusions section)
Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.
No data recorded (see conclusions section)

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Lack of qualified technical personnel in the entity	Not addressed within the project.
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
What was the impact? (positive/negative, significant/non-significant)?

1.1.10 CH0206 Intercepted rainfall

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0206	INTERCEPTED RAINFALL	CEN
CITY	*RELATED NBS*	
VAL	SUB-DEMO C	

Results and Discussion

Table of results (summary, from Task 5.4)
No data recorded (see conclusions section)
Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.
No data recorded (see conclusions section)

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*

Lack of qualified technical personnel in the entity	Not addressed within the project.
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
What was the impact? (positive/negative, significant/non-significant)?

1.1.11 CH0210 Irrigation water provision

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0210	IRRIGATION WATER PROVISION	CEN
CITY	*RELATED NBS*	
VAL	SUB-DEMO C	

Results and Discussion

Table of results (summary, from Task 5.4)
No data recorded (see conclusions section)
Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.
No data recorded (see conclusions section)

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Lack of qualified technical personnel in the entity	Not addressed within the project.
Economical barriers	How they have been addressed
Social barriers	How they have been addressed

Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

What was the impact? (positive/negative, significant/non-significant)?

1.1.12 CH0211 Nutrient abatement (Chemical Oxygen Demand, COD)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0211(old) **CH0206**	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	LEITAT
CITY	*RELATED NBS*	
VALLADOLID	Electrowetland	

Results and Discussion

Table of results (summary, from Task 5.4)

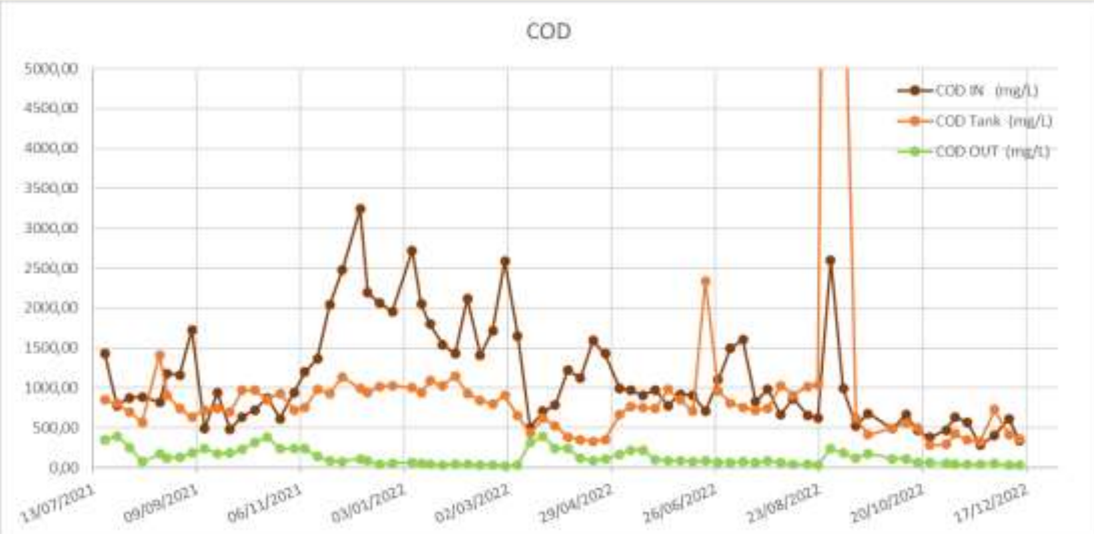
This KPI is complementary with CH0212 and CH0213 related to nutrient abatement (biochemical oxygen demand and total solids). Results are expressed in *kg COD/year*

EX ANTE		**EX POST**					
2020 (Jan-May) M36	**Baseline tot**	**2021**	**2022 (Jan-May) M60**	**2022 (Jun-Dec)**	**2022 tot**	**2023 (Jan-May) M72**	**Post Total**
73.60	73.60	6.94	4.52	2.95	3.56	1.13	3.88

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Evolution of COD degradation is being shown below, from the beginning of the implementation of electrowetland until now. We can see that COD was reduced by an average of 87% (87,06±11,90).

There was a peak value inside the tank (17000 mg/L) in 29/08/2022 but the electrowetland outlet kept values under 250 mg/L. This peak is due to the flush effect of a storm event of 25L/m^2 in less than 10 min after a period of drought.



Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Sampling frequency and maintenance of the electrowetland.	We had to modify the subcontract with the company in charge of maintenance of the electrowetland.
Economical barriers	How they have been addressed
Not identified.	Not identified.
Social barriers	How they have been addressed
Not identified.	Not identified.
Environmental (including COVID)	How they have been addressed
Not identified.	Not identified.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes, Electrowetland is obtaining chemical oxygen demand removals around 87%.

What was the impact? (positive/negative, significant/non-significant)?

It's having a positive and significant impact in COD reduction from wastewater.

1.1.13 CH0212 Nutrient abatement (Biochemical Oxygen Demand, BOD)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0212 (old) **CH0207**	NUTRIENT ABATEMENT (Biochemical Oxygen Demand, BOD)	LEITAT
CITY	*RELATED NBS*	
VALLADOLID	Electrowetland	

Results and Discussion

Table of results (summary, from Task 5.4)

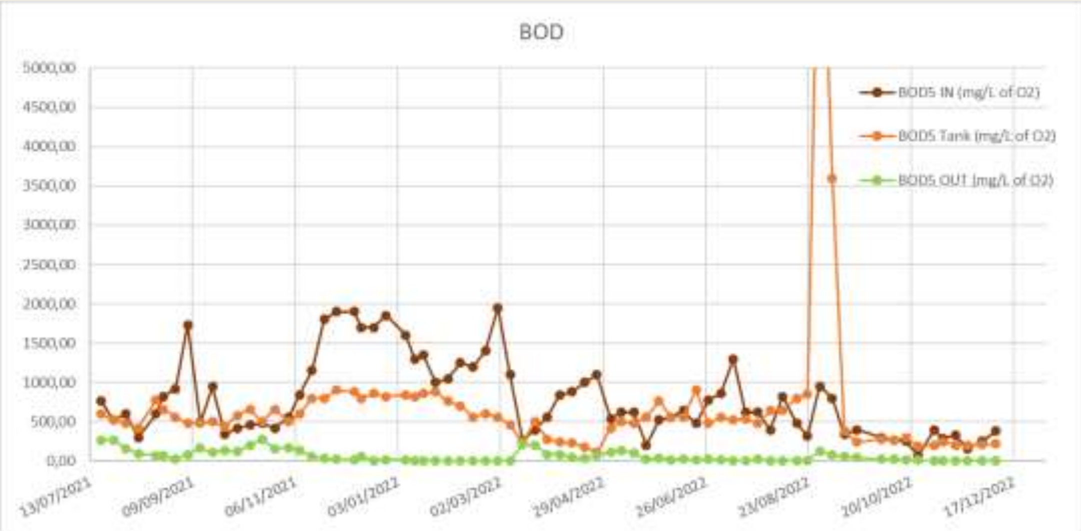
This KPI is complementary with CH0211 and CH0213 related to nutrient abatement (chemical oxygen demand and total solids). Results are expressed in *kg BOD/year*

EX ANTE		**EX POST**					
2020 (Jan-May) M36	**Baseline tot**	**2021**	**2022 (Jan-May) M60**	**2022 (Jun-Dec)**	**2022 tot**	**2023 (Jan-May) M72**	**Post Total**
25.71	25.71	4.16	2.01	0.78	1.29	0.15	1.87

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Evolution of BOD degradation is being shown below, from the beginning of the installation of electrowetland until now. BOD was reduced by 88% (87,92±16,42).

There was a peak value inside the tank (8000 mg/L O_2) in 29/08/2022 but the electrowetland outlet kept values under 125 mg/L. This peak is due to the flush effect of a storm event of 25L/m^2 in less than 10 min after a period of drought.



Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Climatology Sampling frequency	We readjust the sampling for water analytics
Economical barriers	How they have been addressed
Not identified.	Not identified.
Social barriers	How they have been addressed
Not identified.	Not identified.
Environmental (including COVID)	How they have been addressed
Not identified.	Not identified.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes, Electrowetland is obtaining biochemical oxygen demand removal around 88%.

What was the impact? (positive/negative, significant/non-significant)?

It's having a positive and significant impact in BOD reduction from wastewater.

1.1.14 CH0213 Nutrient abatement (Total Solids, TSS)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0213 (old) **CH0208**	NUTRIENT ABATEMENT (Total Solids, TSS)	LEITAT
CITY	*RELATED NBS*	
VALLADOLID	Electrowetland	

Results and Discussion

Table of results (summary, from Task 5.4)

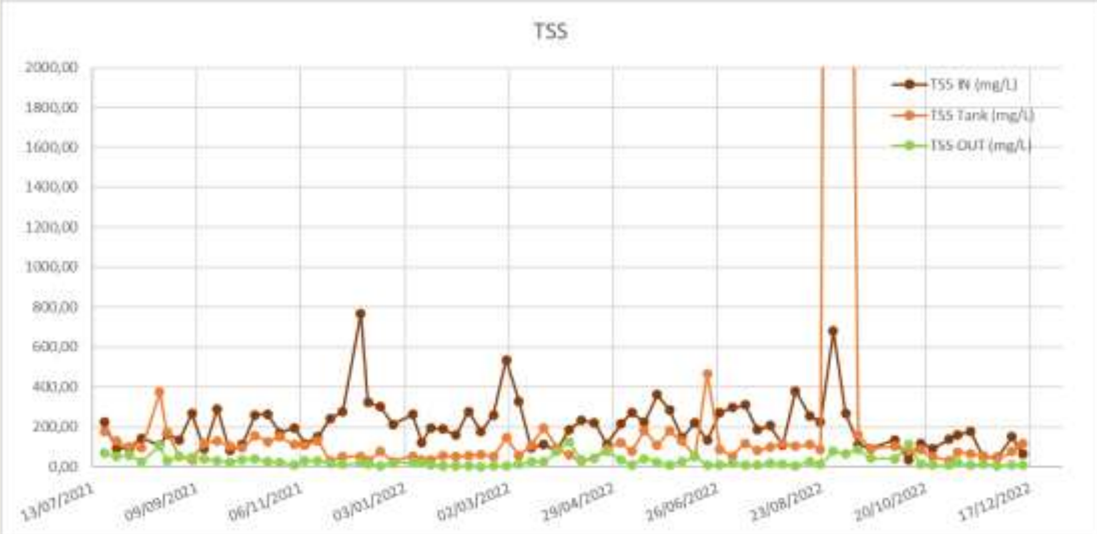
This KPI is complementary with CH0211 and CH0212 related to nutrient abatement (chemical oxygen demand and biochemical oxygen demand). Results are expressed in *kg TSS/year*

EX ANTE		**EX POST**						
2020 (Jan-May) M36	**Baseline tot**	**2021**	**2022 (Jan-May) M60**	**2022 (Jun-Dec)**	**2022 tot**	**2023 (Jan-May) M72**	**Post Total**
7.36	7.36	1.24	1.01	0.98	0.97	0.19	0.80

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Evolution of TSS reduction is being shown below, from the beginning of the installation of electrowetland until now. TSS was reduced by 76% (76,50±43,01).

There was a peak value inside the tank (10500 mg/L) in 29/08/2022 but the electrowetland outlet kept values under 77 mg/L. This peak is due to the flush effect of a storm event of 25L/m^2 in less than 10 min after a period of drought.



Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Climatology Sampling frequency Data for baseline	We readjust the sampling for water analytics
Economical barriers	**How they have been addressed**
Not identified.	Not identified.
Social barriers	**How they have been addressed**
Not identified.	Not identified.
Environmental (including COVID)	**How they have been addressed**
Not identified.	Not identified.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes, Electrowetland is obtaining total solids removal around 76%.

What was the impact? (positive/negative, significant/non-significant)?

It's having a positive and probably significant impact in TSS reduction from wastewater.

1.1.15 CH0218 Savings in treatment of stormwater

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0218	SAVINGS IN TREATMENT OF STORMWATER	CEN
CITY	*RELATED NBS*	
VAL	SUB-DEMO C	

Results and Discussion

Table of results (summary, from Task 5.4)

No data recorded (see conclusions section)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

No data recorded (see conclusions section)

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Lack of qualified technical personnel in the entity	Not addressed within the project.
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

What was the impact? (positive/negative, significant/non-significant)?

1.1.16 CH0401 Green space distribution (m2/capita)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0401	GREEN SPACE DISTRIBUTION (m2/capita)	CAR
CITY	*RELATED NBS*	
VAL	VAc07 VAc09 VAc10 VAc14 VAc14 vac23 Vac25 VAc27 VAc28 vac29 VAc30 VAc31 VAc33	

Results and Discussion

Table of results (summary, from Task 5.4)

DISTRICTS	CH0401 BASELINE	CH0401 POST	% CH0401
Universidad	3,746	3,749	0,092
Girón	124,964	125,382	0,334
Centro	19,748	19,860	0,571
Las Villas-Cañada Puente Duero-Covaresa-Parque Alam	17,509	17,823	1,792
Campo Grande	2,081	2,201	5,761
Pilarica	13,079	21,555	64,813
Average	**30,188**	**31,762**	**12,227**

CH0401 Baseline (M2/CAPITA): GI_SURFACE (M2)/DI_inhab

CH0401 POST (M2/CAPITA): (GI_SURFACE (M2) + UGU_AREA)/DI_inhab

% CH0401: (CH0401 POST - CH0401 Baseline)*100/ CH0401 POST

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The following map shows the **baseline** for this KPI. Districts with the highest ratio of green spaces (m2) per inhabitant in green, and in red those with the lowest.

After the URBAN GreenUP interventions, there are 6 districts which has increased the green areas surfaces per inhabitant. The increase has been especially relevant in the District located at the East of Valladolid, due mainly to the VaC07 action (Urban Carbon Sink). This area has increased in a 65% green areas surface.

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
-	
Economical barriers	How they have been addressed
-	
Social barriers	How they have been addressed
-	
Environmental (including COVID)	How they have been addressed
-	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The overall impact of the project on this KPI in the city of Valladolid has not been very significant. The NBS with the greatest impact was the Urban Carbon Sink (VaC7), which with approximately 50,000 m2 is the largest project in the city.

What was the impact? (positive/negative, significant/non-significant)?

The impact is positive in the identified districts, although not significant in many of them. The average impact has been 12.27%, considering only the districts where the impact has occurred. In total there are 6 districts of the city where the project has had an impact with respect to this KPI.

1.1.17 CH0402 Green space distribution (km cycle lane/capita)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0402	GREEN SPACE DISTRIBUTION (km cycle lane/capita)	CAR
CITY	*RELATED NBS*	
VAL	VAc01	

Results and Discussion

Table of results (summary, from Task 5.4)

TIPO	LENGTH (M)	INHABITANTS	CH0402 (KM/1000 INHAB)	% CH0402
BASELINE	82910,375	298866	0,277	
POST	90858,570	298866	0,304	9,586

CH0402 BASELINE (M/CAPITA): GI_SURFACE (M)/DI_inhab

CH0402 POST (M/CAPITA): (GI_SURFACE (M2) + UGU_AREA)/DI_inhab

% CH0402: (CH0402 POST - CH0402 Baseline)*100/ CH0402 POST

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Vac01 action involves the creation of a new interconnected network of almost 8 km in length. Over the total of the city, it has meant an increase of 9.6% of linear metres of new cycle lanes with respect to the existing one.

The following image shows in red the new sections corresponding to the Vac01 action. In yellow, the pre-existing route is shown.

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
-	
Economical barriers	How they have been addressed
-	
Social barriers	How they have been addressed
-	

Environmental (including COVID)	How they have been addressed
-	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

This KPI has contribute with the challenge in a positive way, as the Vac01 has increased the accessibility to Green Space to population by cycling.

What was the impact? (positive/negative, significant/non-significant)?

The impact has been positive and significant, as the connection between different areas of the city has increased.

1.1.18 CH0403 Green space accessibility (m/min)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0403	GREEN SPACE ACCESSIBILITY (m/min)	CAR
CITY	*RELATED NBS*	
VAL	all	

Results and Discussion

Table of results (summary, from Task 5.4)

	KPI_CH0405
EXANTE (m)	83,73
EXPOST (m)	80,92
KPI INCREASE (%)	-2,33%

Average distance from houses to the nearest Green Infrastructure (m).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The following map shows the average distance between each house in the city and the nearest green infrastructure (baseline). As can be seen, there are areas of concentration of yellow and red dots. These are areas where green infrastructure is scarcer.

One such area is the central district, where several project actions have been implemented. In this particular district, the average distance to green infrastructure has changed from 102 to 51 metres.

DISTRICTS	KPI INCREASE (%)	EXANTE	EXPOST
Centro	-38,7%	102,88	51,22
Caño Argales	-24,3%	125,46	94,64
San Juan	-12,6%	60,51	47,21
Pajarillos Bajos	-8,0%	62,75	55,23
Circular	-7,8%	86,39	79,89
Pajarillos Altos	-6,5%	81,98	74,09
Universidad	-4,9%	62,42	57,22
San Miguel	-2,9%	64,70	61,35
Total general	-2,3%	83,69	80,89
Campo Grande	-2,2%	74,79	72,83
Delicias	-2,2%	69,01	66,62

Huerta del Rey (Baja)	-1,5%	15,83	15,68
Pilarica	-1,4%	75,99	75,03
Las Villas-Cañada Puente Duero-Covaresa-Parque Alam	-0,3%	47,49	47,31
Girón	-0,1%	48,06	48,06

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers have been detected, although it can be said that this KPI depends on the availability of census data and that these are up to date.	
Economical barriers	How they have been addressed
-	
Social barriers	How they have been addressed
-	
Environmental (including COVID)	How they have been addressed
-	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

This KPI has contribute with the challenge in a positive way, especially in areas with a low rate of GI and high rate of population.

What was the impact? (positive/negative, significant/non-significant)?

The impact has been positive and significant, as the accessibility has increased in the areas affected by the Urban GreenUP project.

1.1.19 CH0404 Green infrastructure connectivity (%)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0404	GREEN INFRASTRUCTURE CONNECTIVITY (%)	CAR
CITY	*RELATED NBS*	
VAL	All (VAC2, VAC3, VAC4, VAC5 excluded)	

Results and Discussion

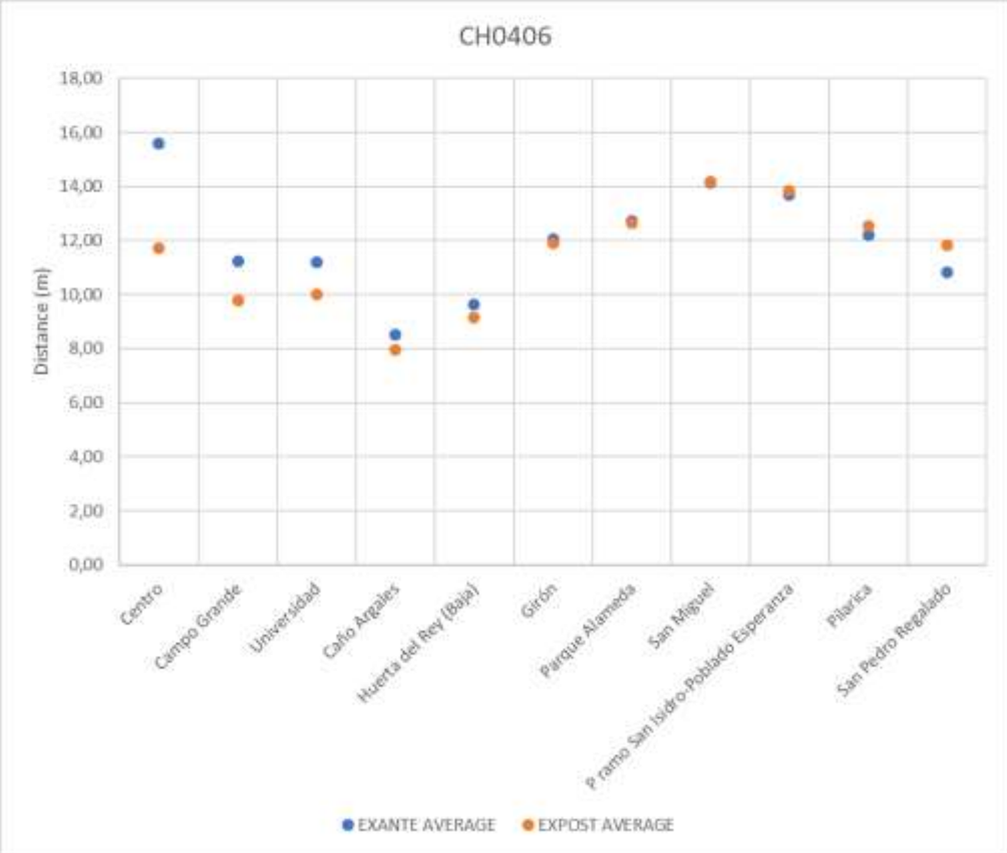
Table of results (summary, from Task 5.4)

	KPI_CH0406
EXANTE (m)	11,99
EXPOST (m)	11,41
KPI INCREASE (%)	-4,45%

Average distance from one Green Infrastructure to the nearest (m) considering neighborhoods with URBAN GreenUP actions.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

In the districts where interventions have taken place, the distance between green infrastructure has decreased by 4.45%. This was particularly significant in the Centro district, where the distance between a green infrastructure and its nearest neighbour decreased by 25%, from 16m to 12m.



Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Tree-planting actions has not been evaluated since location of the plantations has not been provided	VAC2, VAC3, VAC4, VAC5 not included in the analysis.
Economical barriers	How they have been addressed
-	
Social barriers	How they have been addressed
-	

Environmental (including COVID)	How they have been addressed
-	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

This KPI has contribute with the challenge in a positive way, especially in areas with a low rate of GI. That is the case of the Central district.

What was the impact? (positive/negative, significant/non-significant)?

The impact has been positive and significant, as the connectivity between green infrastructure has increased in the areas affected by the Urban GreenUP project.

1.1.20 CH0406 Recreational value

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0406	RECREATIONAL VALUE	VAL
CITY	*RELATED NBS*	
VALLADOLID	Non-technical (VAc39 Ecological reasoning, Vac41 Support NBS)	

Results and Discussion

Table of results

Quantify the number of people participating in the recreational activities per year, related to any NBS, both recreational (number of visitors, number of recreational activities) or cultural value (number of cultural events, people involved, children in educational activities), expressed in (nº people/year).

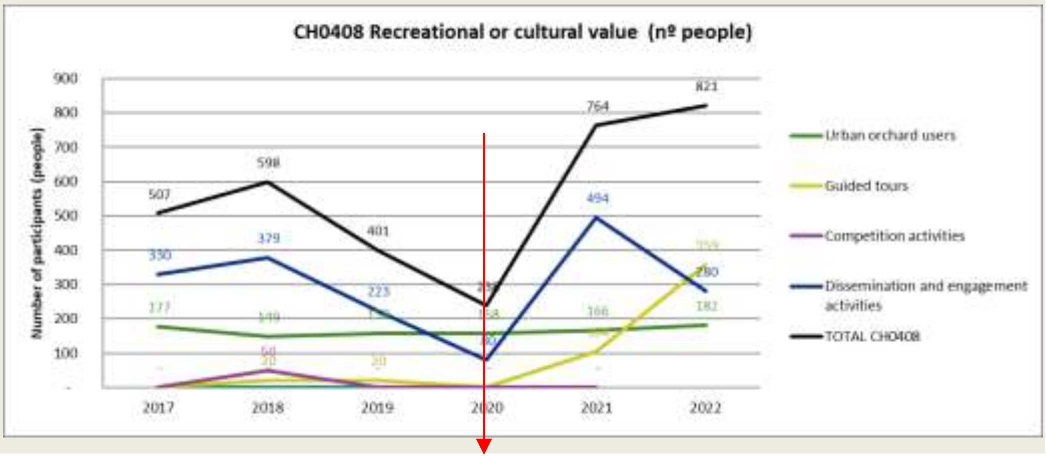
EX ANTE (BASELINE)				
2017	2018	2019	2020 (Jan-May)	Σ Baseline
507 people	598 people	401 people	238 people	502 people

EX POST			
2020	2021	2022	Σ Post
238 people	764 people	821 people	608

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Trends: Clear recovery of the number of citizens who have been reached with non-technical activities (dissemination, engagement), after the fall due to the Covid-19 pandemic (march 2020). In 2021 most of the activities were online.

Name	Unit	2017	2018	2019	2020	2021	2022	Total
Urban orchard users	nº gardener	177	149	158	158	166	182	**808**
Guided tours	nº participants	-	20	20	-	104	359	**144**
Competition activities	nº competitors	-	50	-	-	-		**50**
Dissemination and engagement activities	nº participants	330	379	223	80	494	280	**1.506**
TOTAL CH0408		**507**	**598**	**401**	**238**	**764**	**821**	**2.508**



Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
The quantification of the number of people who attend a non-technical activity is sometimes estimated.	Estimated number of participants, for those events in which there is no list.
Economical barriers	**How they have been addressed**
Not identified.	

Social barriers	How they have been addressed
In some non-technical activities there is low citizen participation.	▪Reinforcement of the dissemination of the event. ▪Invitation campaigns to specific groups of stakeholders.

Environmental (including COVID)	How they have been addressed
▪The Covid-19 pandemic forced the cancellation of several non-technical events for 2020.	▪Non-technical actions recovered early but virtual, starting in fall 2020. The activities of 2020 and 2021 have been mostly virtual.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Yes. The KPI CH0408 is part of the CHALLENGE 4: Green Space Management. This KPI clearly shows the number of citizens who have been reached with non-technical actions, both cultural and recreational. The results show that the scope of the actions has been increasing, despite the pandemic.

What was the impact? (positive/negative, significant/non-significant)?
Positive and Significant.

Other comments

Optional: Any other relevant comments that you would like to include.
This indicator is easy to monitor, and to feed mostly real data. An updated inventory can be made of all the non-technical activities carried out in the city on the occasion of URBAN GreenUP, and the number of people participating can be recorded. This KPI includes the farmers that use the municipal urban orchards, as well as the nº participants in guided tours, dissemination & engagement activities, as well as nº competitors that participate in the specific competitions organized for URBAN GreenUP.

1.1.21 CH0408 Green areas sustainability

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0408	GREEN AREAS SUSTAINABILITY	VAL
CITY	*RELATED NBS*	

VALLADOLID	VAc24 Green Vertical mobile garden VAc27 Green Covering Shelter VAc25 Green Façade VAc28 Green Roof VAc29 Green Shady Structures VAc22-VAc23 Green noise barriers VAc30 Urban Garden Bio-Filter VAc26 Electro-wetland VAc2 Planting 1,000 trees VAc3 Tree shady places (500 trees) VAc4 Shade and cooling trees (600 trees) VAc5 Re-naturing parking trees (250) VAc31 Urban orchard VAc32 Community composting VAc1 New green cycle lane and re-naturing existing bike lanes VAc15 Cycle-pedestrian green paths VAc6 Installation of 3 Green Resting areas (C1, B, C3) VAc7 Urban Carbon Sink VAc20 Compacted Pollinator's modules VAc19-VAc21 Natural pollinator's modules VAc9 SUDs for re-naturing parking VAc10 Rain gardens VAc14 Green Parking Pavements

Results and Discussion

Table of results

The methodology evaluates different aspects (requisites) for every NbS implemented in Valladolid, organized in three different topics: 1) Impact on ecosystem, 2) Construction and operation, 3) Impact on society.

The score table is completed only in the Expost scenario. Basline is 0 (before implementation).

EX ANTE	EX POST				
Baseline	2020	2021	2022	2023	Expost
Score = 0	54	51	49	49	51

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The KPI is calculated individually for each of the NbS implemented in Valladolid. Each NbS gets a numerical (score) and qualitative rating (Very good: 65-100, Good: 40-65, Bad: 20-40, Very bad: 0-20)

		Ex-post						
Name	NBS	Ecosystem	Construction/ operation	Society	Score	Category	Implementation date	
Vertical and horizontal interventions								
Green infraestructure	VAc24 Green Vertical mobile garden	13,3	3,3	16,7	33	Bad	08/05/2020	M36
	VAc27 Green Covering Shelter	13,3	13,3	23,3	50	Good	24/02/2020	M33
	VAc25 Green Façade	16,7	20,0	23,3	60	Good	30/06/2020	M37
	VAc28 Green Roof	20,0	20,0	20,0	60	Good	15/08/2020	M39
	VAc29 Green Shady Structures	16,7	13,3	16,7	47	Good	26/02/2021	M45
	VAc22-VAc23 Green noise barriers	16,7	10,0	20,0	47	Good	04/03/2022	M58
Singular infraestructure								
BioFilter	VAc30 Urban Garden Bio-Filter	10,0	16,7	16,7	43	Good	25/11/2021	M54

EW	VAc26 Electro wetland	23,3	16,7	23,3	63	Good	02/07/2021	M50
Tree related actions								
Trees	VAc2 1,000 trees	26,7	10,0	20,0	57	Good	octubre-20	M41
	VAc3 Tree shady	26,7	13,3	20,0	60	Good	January-20	M32
	VAc4 Shade &cooling trees	23,3	16,7	23,3	63	Good	octubre-20	M41
	VAc5 Re-naturing parking trees	26,7	13,3	20,0	60	Good	enero-20	M32
Urban orchards								
Urban orchards	VAc31 Urban orchard	13,3	6,7	20,0	40	Good	sept-20	M40
	VAc32 Community composting	6,7	26,7	20,0	53	Good	Sept 2020	M40
Green corridor								
Cycle lane	VAc1 New green cycle lane	6,7	13,3	26,7	47	Good	abril-22	M59
	VAc15 Cycle-pedestr green paths	13,3	6,7	23,3	43	Good	abril-22	M59
Resting areas	VAc6 Installation of 3 Green Resting areas	13,3	16,7	26,7	57	Good	abril-22	M59
Urban carbon sink	VAc7 Urban Carbon Sink	26,7	16,7	23,3	67	Very good	abril-22	M59
Pollinator's modules								
Compacted	VAc20 Compacted Pollinator's modules	10,0	6,7	23,3	40	Good	abril-22	M59
Natural	VAc19-VAc21 Natural pollinator's modules	16,7	13,3	13,3	43	Good	abril-22	M59
Stormwater management systems								
SUDs	VAc9 SUDs for re-naturing parking	26,7	16,7	6,7	50	Good	mayo-23	M72
	VAc10 Rain gardens	26,7	16,7	6,7	50	Good	mayo-23	M72
	VAc14 Green Parking Pavements	20,0	16,7	10,0	47	Good	mayo-23	M72

CH0417 Green areas sustainability	Ecosystem	Construction/ operation	Society	
AVERAGE TOTAL SCORE NBS	18,0	13,7	21,0	51

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
The assessment of the questions that make up each of the three criteria has a certain degree of subjectivity.	Questions can be answered with yes/No, so this minimize the subjectivity.

Economical barriers	How they have been addressed
Not identified.	

Social barriers	How they have been addressed
Not identified. The opinion of citizens is evaluated through a Citizen Participation Survey (launched in September 2021). This KPI CH0417 is calculated by technicians from the City Hall of Valladolid.	The opinion, perception and knowledge of the citizens is addressed with KPI CH0703 Citizen Perception.

Environmental (including COVID)	How they have been addressed
Not identified. The calculation of this KPI has not been directly influenced by the Covid pandemic. It has only delayed the execution of some NbS.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes. This KPI CH0412 belongs to CHALLENGE 4: Green Space Management. This KPI is defined by a methodology of 30 questions for three criteria (10 questions each). It is a robust method of identifying the degree of sustainability of the NbS. To make the analysis more robust, it could be completed by other technicians and stakeholders directly involved in Valladolid Demo, and calculate an average of results.

What was the impact? (positive/negative, significant/non-significant)?

Positive and Significant. The impact of this KPI is positive since it assigns a score to each NbS of Valladolid Demonstration, which allows determining the degree of sustainability as Very high, high, medium, low or very low (Likert scale of 5).

It is considered Significant since it is calculated individually for each of the NbS. And the methodology is easily replicable to other cities with any NbS.

1.1.22 CH0409 Food production

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0409	FOOD PRODUCTION	VAL

CITY	*RELATED NBS*
VALLADOLID	Vac31-Urban orchard; Vac32-Community composting

Results and Discussion

Table of results (summary, from Task 5.4)

EX ANTE (BASELINE)				
2017	2018	2019	2020 (Jan-May)	Σ Baseline
58,61 t	50,76 t	53,28 t	53,28 t	53,98 t

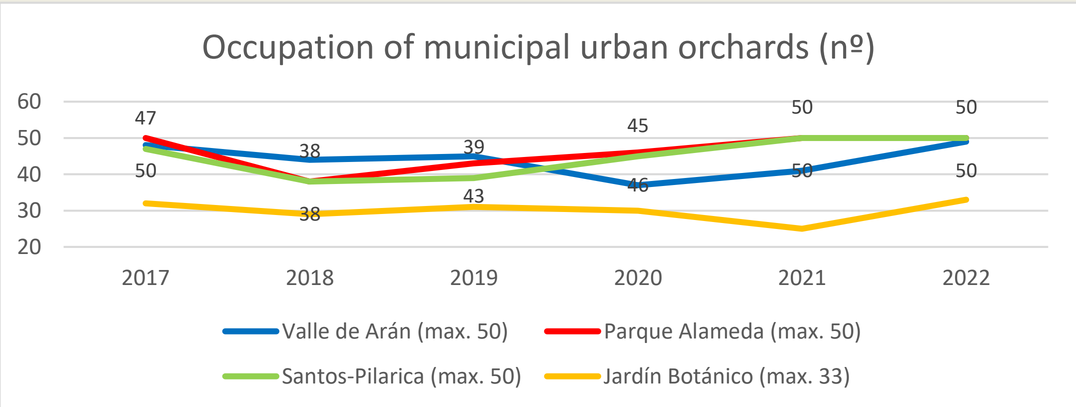
EX POST			
2020 (Jun-Dec)	2021	2022	Σ Expost
53,28 t	55,45	55,45 t	60,01 t

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

For the calculation of the production of food in the municipal orchards, we calculated an average factor (kg food/m^2) with measured data taken in the municipal plot of the *Communitary orchard 'Valle de Arán'*. The food production rate is 5,61 kg/m^2. This factor is applied to the area occupied in each municipal garden, annually.

Orchard	Individual plot (nº) [50m2/plot]	Surface (m2)	2017	2018	2019	2020	2021	2022	Total
Valle de Arán	50	3.300	17,95 t	16,83 t	17,11 t	14,86 t	15,98 t	18,23 t	100,95 t
Parque Alameda	50	2.800	14,02 t	10,66 t	12,06 t	12,90 t	14,02 t	14,02 t	77,68 t
Santos-Pilarica	50	3.300	17,67 t	15,14 t	15,42 t	17,11 t	18,51 t	18,51 t	102,35 t
Jardín Botánico	33	1.650	8,97 t	8,13 t	8,69 t	8,41 t	6,94 t	9,25 t	50,40 t
	183	11.050 m2	**58,61 t**	**50,76 t**	**53,28 t**	**53,28 t**	**55,45 t**	**60,01 t**	**331,38 t**

Average occupation of urban orchards is around 90% yearly. No significant variations in the orchards' occupancy are observed after the application of improvements in urban gardens (VAc31, VAc32).



Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
The amount of food produced in each plot of each garden is not measured. On average there are 50 plots of 50m2 each in each of the 4 municipal gardens.	The KPI is calculated on an estimated basis with a production factor measured in a pilot experience.

Economical barriers	How they have been addressed
There is no economic relationship with the market gardeners. All food production from each plot is for personal use. The food from the community gardens is transferred to the Food Bank, social kitchens or others.	

Social barriers	How they have been addressed
They do not exist. The reception of the urban orchards and the improvements on the part of the gardeners is good. The occupancy rate is always high.	

Environmental (including COVID)	How they have been addressed
The exploitation of urban orchards was affected during the closure of the pandemic (March-June 2020).	The orchards reopened again in 2021.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
This KPI CH0412 belongs to CHALLENGE 4: Green Space Management. Impact can be identified as Medium. The municipal gardens work before the arrival of URBAN GreenUP. The improvements implemented and community composting have been well received, but have not been reflected in improved results for this KPI. But the results continue to be positive in the 4 municipal gardens.

What was the impact? (positive/negative, significant/non-significant)?

Positive and Partially significant.

1.1.23 CH0410 Elderly People Life Quality

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH...0410	Elderly People Life Quality	GMV-S
CITY	*RELATED NBS*	
VALLADOLID	Green cycle lane; Tree related actions; Vertical and horizontal GI; Green resting areas; Cycle-pedestrian green paths; Urban carbon sink	

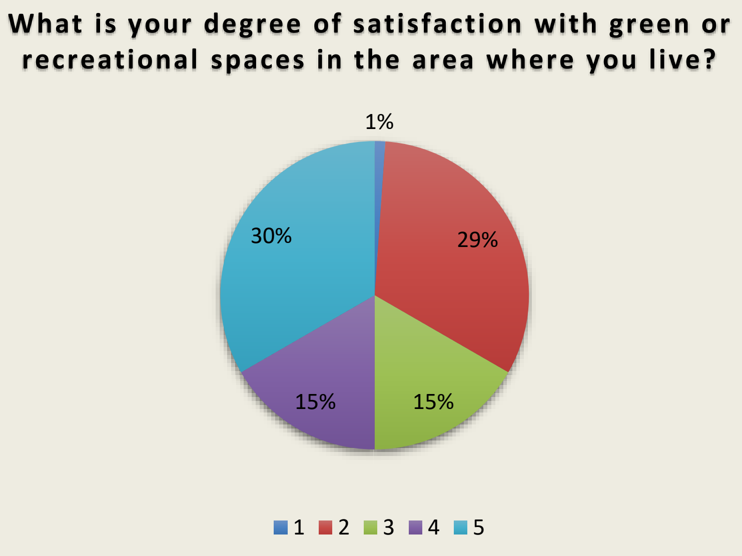
Results and Discussion

Table of results (summary, from Task 5.4)

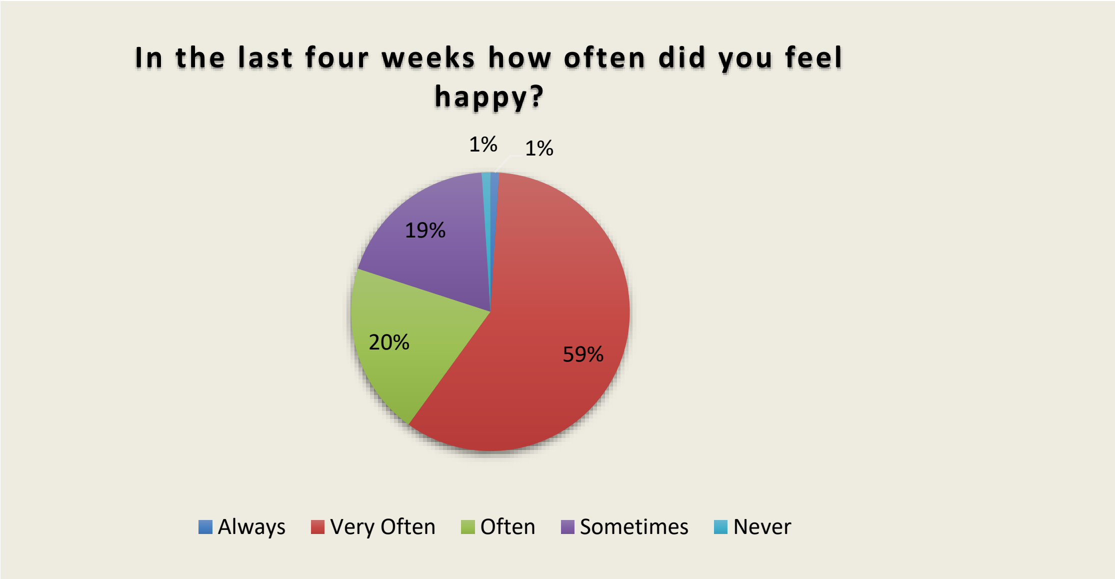
The KPI is calculated as a numeric value on a likert scale (from 1 to 5) using the results of the survey. The application used to present the surveys was not available prior to the deployment of the NBSs (the initial deployment was in September 2021, so there are not previous values for the baseline.

The current value is 3.775, which is quite positive, although more samples are required to see the evolution of the value.

Sample responses for the period are represented below:



Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.



Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Deployment of the application was late, since it needed to display information about the NBSs. Also, interventions in the Green Corridor needed to be in place for the monitoring	When a sufficient amount of information was available and enough NBSs were deployed, the application was published to the public.
Economical barriers	How they have been addressed
N/A	N/A
Social barriers	How they have been addressed
The user base for the application is still low, and elderly people within the user base are only a small fraction	The Valladolid municipality has published ads and press articles about the application to promote its use.
Environmental (including COVID)	How they have been addressed
N/A	N/A

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further values are required to measure the impact of the interventions on the KPI, but the initial scores gathered are positive.

What was the impact? (positive/negative, significant/non-significant)?

N/A

Other comments

Optional: Any other relevant comments that you would like to include.

There is not enough expertise in the consortium about sociological analysis to develop a survey tailored for this KPI. Therefore, existing surveys in the public domain have been used as the basis for the surveys used in the project (slightly simplified for the presentation in a smartphone).

Such considerations shall be taken into account when building the consortium, to ensure that not only the technical know-how but also other areas are sufficiently covered.

1.1.24 CH0411 Connectivity Perception

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH…0411	Connectivity Perception	GMV-S
CITY	*RELATED NBS*	
VALLADOLID	Green cycle lane; Tree related actions; Vertical and horizontal GI; Green resting areas; Cycle-pedestrian green paths; Urban carbon sink	

Results and Discussion

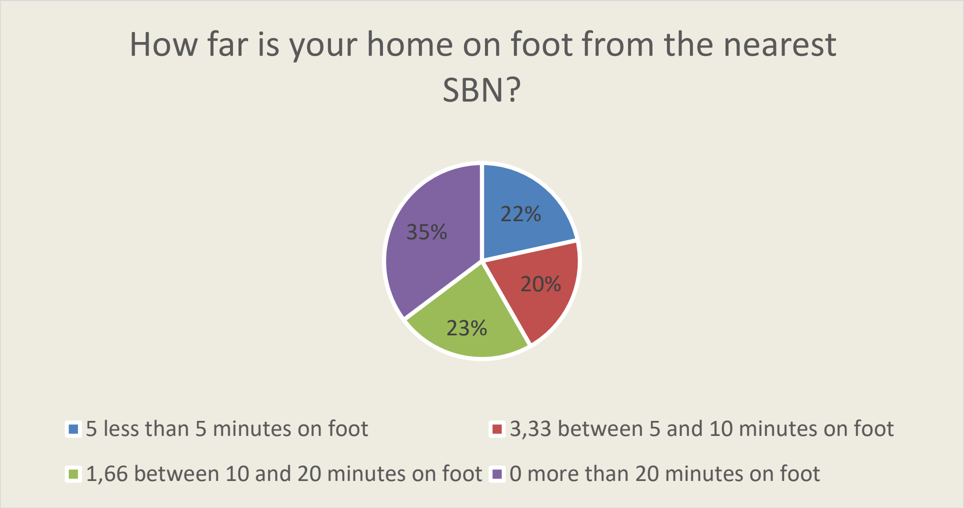
Table of results (summary, from Task 5.4)

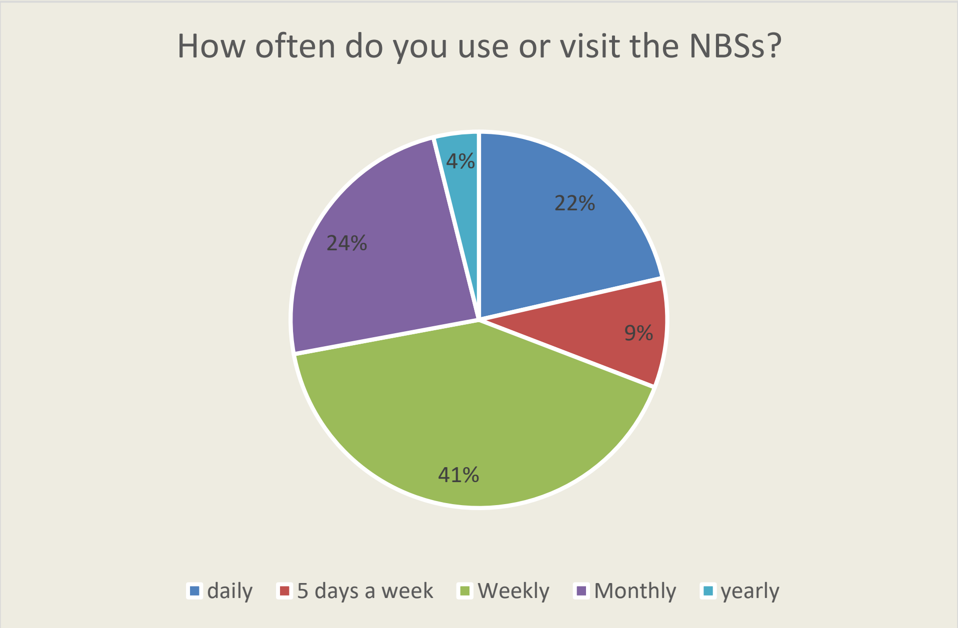
The KPI is calculated as a numeric value on a likert scale (from 1 to 5) using the results of the survey. The application used to present the surveys was not available prior to the deployment of the NBSs (the initial deployment was in September 2021) so Valladolid Municipality presented a manual survey to gather information.

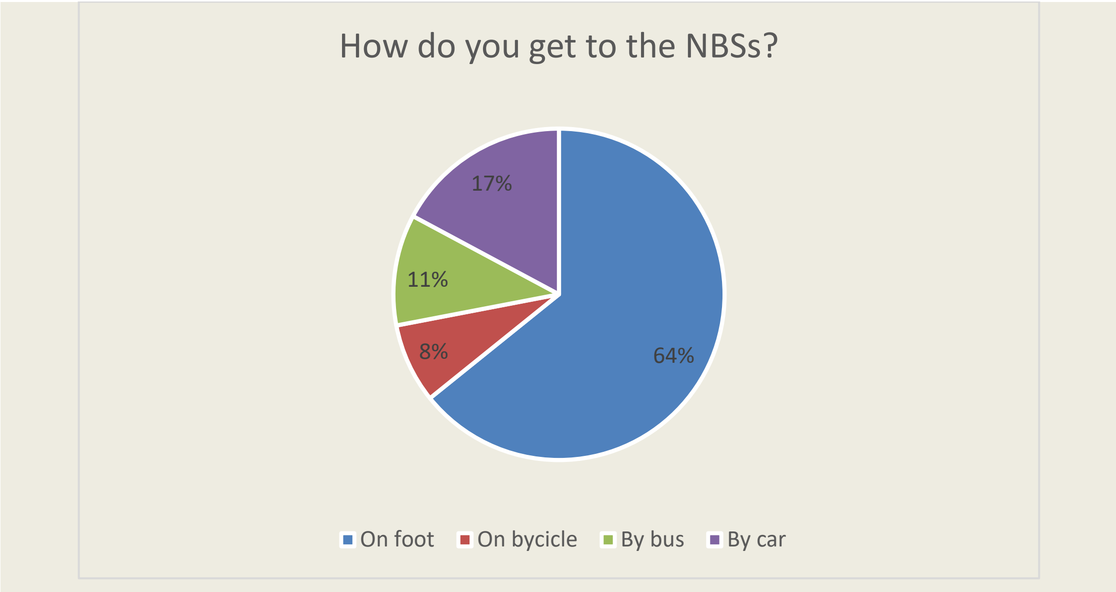
The current value measured is 2.85 which is slightly above average, although more samples are required to measure the evolution of the indicator.

Sample responses for the period are represented below:

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.







Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Deployment of the application was late, since it needed to display information about the NBSs. Also, interventions in the Green Corridor needed to be in place for the monitoring	Valladolid's municipality performed a manual survey to gather information before the application was published
Economical barriers	**How they have been addressed**
N/A	N/A
Social barriers	**How they have been addressed**
There is opposition from some individuals towards the NBS, so they responded nonsensical answers to the survey	They have been interpreted as the lowers score (rather than filtered out)
Environmental (including COVID)	**How they have been addressed**
N/A	N/A

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further information is required to measure the impact of the interventions on the KPI

What was the impact? (positive/negative, significant/non-significant)?

N/A

Other comments

Optional: Any other relevant comments that you would like to include.

Further data will be gathered with the smartphone application in order to track the evolution of the value

1.1.25 CH0413 Pollinator species increase

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0413	POLLINATOR SPECIES INCREASE	CARTIF
CITY	*RELATED NBS*	
VAL	POLLINATOR MODULES	

Results and Discussion

Table of results (summary, from Task 5.4)

TYPE OF INDICATOR: Biological

UNIT: % , Nº

SCALE: Urban and street

ECOSYSTEM SERVICES: Supporting

DEFINITION: Increased habitat for pollinators in NBS GI may contribute to increased abundance of pollinators in the wider urban area.

METHODOLOGY: Measured pollinator's species richness and nº of visits by pollinating insects in located samples.

METERING SPECCIFICATIONS: Statistical data measured

DATA SOURCE: Measuring through observations (statistics)

FRECUENCY OF DATA COLLECTION: monthly

OUTPUT DATA: table values (.xlsx)

BASELINE: Just completed. Module locations are not known until March 2022. (pollinators modules)

POST-INTERVENTION: Not started, implementation of pollinator modules has not finish. The implementation of the modules structure has not been completed and they have not been correctly installed.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

STATUS:

2020:

Monitoring started in February 2020 and was suspended during the months of March to May due to COVID-19.

At the end of May - June , it was restarted.

Monitoring was suspended in September for various reasons: abundant rainfall, review meeting and average temperatures below 15º.

The first frosts occurred in 12th October. Therefore, monitoring was ruled out for that month and the following months.

2021:

The mild temperatures at the end of January meant that many plants had already started to sprout, so the monitoring was restart in February with the beginning of the flowering season.

2022:

The month of February was characterised by frequent frosts but with high hours of sunshine, so that some plants that resisted the night frosts began to flower, such as the almond trees. Monitoring began in March, despite being a very rainy month.

April 2022 status:

During the 2022 monitoring, the original sampling points were adapted to suit the locations of the pollinator modules, which in March and April were still under construction.

Therefore, the baseline will continue until the infrastructures are prepared and the plants are installed.

The KPI specifies that the unit must be % or Nº, so during the monitoring the number of pollinators observed in the are is recorded without capture for later exact identification. In order to obtain more data, a more specific classification is made by dividing the observed biodiversity into four large groups:

- Butterflies
- Flies
- Beetles
- Bees
- Others

‘Others’ include:

- Ants: that collaborate in the seeds dispersal.
- Ladybugs: they act as a biological control of pests so they favor the health of flowers and therefore more pollinators.
- Spiders: reduction of pollinators
- Lizzards: also pollinators, dragging pollen from certain plants

There are 4 sampling areas: Urban Carbon Sink (UCS), Natural Wastewater Plant (NWP), Orchards Park Alameda (OPA), City Centre Route (CCR).

EX ANTE (BASELINE)					
Ref. 2017	Ref. 2018	Ref. 2019	Ref. 2020	Ref. 2021	Ref. Baseline (1 data)
Baseline Value_1	Baseline Value_2	Baseline Value_3	Baseline Value_4	Baseline Value_5	Final Value
-	-	-	26,58	44,4	35,49

Figure 1.1. Baseline total values (number)

		Butterflies	Flies	Beetles	Bees	Others	Average
UCS	2020	2,67	4,89	0,78	1,64	0,92	**9,97**
	2021	4,1875	3,00	0,28	2,19	1,47	**9,66**
NWP	2020	1,47	2,13	0,07	0,20	2,20	**3,87**
	2021	0,48	2,78	0,40	0,93	1,58	**4,58**
OPA	2020	0,48	1,81	1,71	1,38	1,10	**5,38**
	2021	1,25	3,57	0,30	4,14	1,39	**9,27**
	2020	0,21	0,57	0,10	0,37	0,28	**1,25**

CCR	2021	0,16	1,80	0,09	1,28	0,74	**3,33**

Figure 1.2. Summary of the average values according sampling area and type of pollinator

The presence of pollinators has significantly increased from one year to the next due to several factors:

- There are more Green Infrastructures, overall in city centre which increase connectivity between green areas.
- In 2020 less sampling was done due to the lockdown. Moreover, printemps is the season where more presence of pollinators is recorded and due to the lockdown, the monitoring started at the end of this season when high temperatures starts and pollinators found less food.
- It is expected that the implementation of the pollinator modules will have a positive effect on the increase of pollinators, although it depends on the development of the installed plants, since the first year they usually have less flower production due they are in the root prospecting phase. That is why two years of monitoring is necessary once the NBS have been installed.

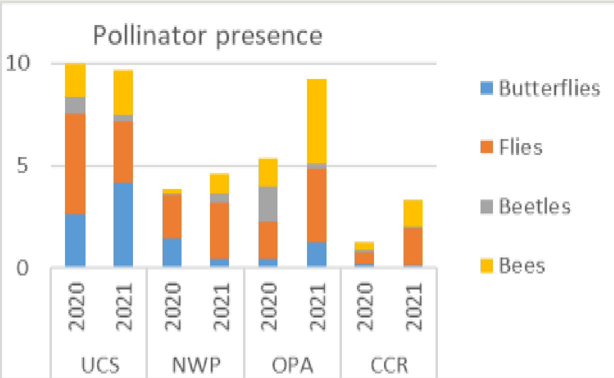


Figure 1.3. Pollinator presence average per year

Beetles

Butterflies

Bombus

Bees

Flies

Figure 1.4. Examples of the relevant pollinators categories found in the sampling areas

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Lack of knowledge of the final location of both natural and compact pollinator modules; The frequency of mowing and weeding of green areas cancels out the presence of pollinators, significantly altering data collection; In the urban area, relocations of NBS and accesses cut off due to activities and social events prevent data collection of some points;	The number of sampling points for the baseline has been doubled and other NBS that were not originally going to be monitored in this KPI has been included as baseline; The closest accessible points to NBS has been chosen as monitoring point;

Inability to monitor some of the NBS due to their height;	
Economical barriers	How they have been addressed
Field surveys require high time dedication and qualified personnel for the identification of species. This means high personnel costs.	To optimize times, the frequency of data collection is monthly instead of weekly.
Social barriers	How they have been addressed
Citizens have not been involved as part of engagement activities due to data needs to be collected by trained staff.	Dissemination days have been held, through articles and photographs.
Environmental (including COVID)	How they have been addressed
During the lockdown (March, April and May 2020), field surveys could not carry out, affecting baseline data collection. The deconfinement caused the population to occupy green spaces for recreation and sports, so that in some places the presence of pollinators was reduced.	There is baseline for those months in 2021 and 2022 to complement the shortcomings of the unaccounted months.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
The presence of GI favours the presence of pollinators. The plant species provide food almost all year round, but it is scarce and not constant. Larger pollinators such as large bees and butterflies are sighted in peri-urban areas. There is currently no connectivity in the NBSs corridor. There is still no post-implementation data of pollinator modules so no final conclusions can be drawn.
What was the impact? (positive/negative, significant/non-significant)?
Positive impact in the GI; Non-significant impact in control points

Other comments

Optional: Any other relevant comments that you would like to include.

The monitoring is carried out only during day-hours, firstly in the morning. Therefore, no nocturnal species are being counted.

The constant weeding of green areas and GI makes it impossible to maintain pollinator friendly areas.

1.1.26 CH0501 Annual levels of fine particles, $PM_{2,5}$

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0501	Annual levels of fine particles, $PM_{2,5}$	CAR
CITY	*RELATED NBS*	
VAL	VAc24, VAc25, VAc27 & Vac29,	

Results and Discussion

Table of results of this KPIs for the relevant NBS interventions in the city of Valladolid. In this case, as introduction for each NBS is indicated the reference site selected to calculate the CH0501 KPI. The selection of the reference site has been done according the NBS implementation site characteristics among the available reference data.

The calculation of this KPI has been done individually for each NBS because, as these NBS have building or street scale, the evaluation of all of them at district or city scale joining all the date, has no interest itself.

VAc25 Green Façade (Ending implementation date 30/06/2020)

NBS intervention site (El Corte Inglés Building in Constitución St.) is an urban space with PM background levels because there is no traffic in the area. Reference site (Montero Calvo St. in Valladolid) is also considered an urban space with background levels because has no traffic.

$PM_{2,5}$ reduction	VALUE	UNITS	Year
Ex-ante (2019)	98	%	
Ex-post (2020)	66	%	
Ex-post (2021)	49	%	
CH0501	**49**	**%**	**2021**

VAc 27 Green Covering Shelter (Ending implementation date 24/02/2020)

NBS intervention site in España Sq. Reference site (Rinconada Sq. in Valladolid). Both sites are squares and have similar levels of traffic.

$PM_{2,5}$ reduction	VALUE	UNITS	Year
Ex-ante (2019)	102	%	
Ex-post (2020)	111	%	
Ex-post (2021)	97	%	
CH0501	**97**	**%**	**2021**

VAc29 Green shady structures (Ending implementation date 26/02/2021)

NBS intervention site in Santa María St. Reference site (Montero Calvo St. in Valladolid). Both places are considered with urban background pollution levels without traffic.

$PM_{2,5}$ reduction	VALUE	UNITS	Year
Ex-ante (2019)	123	%	
Ex-post (2020)	97	%	
Ex-post (2021)	127	%	
CH0501	**127**	**%**	**2021**

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

The discussion of the results of this KPI has been also done individually for each NBS because, as these NBS have building or street scale, the evaluation of all of them at district or city scale joining all the date, has no interest itself. However, the individual evaluation of each NBS will support the selection of the proper NBS when a PM concentration reduction is being aimed.

VAc25 Green Façade (Ending implementation date 30/06/2020)

The assessment of this KPI show that this NBS has a positive influence in the $PM_{2,5}$ city background levels. The reference location also with city background levels is close to the NBS intervention site. Additionally, this result should be checked with further studies to check this conclusion.

VAc 27 Green Covering Shelter (Ending implementation date 24/02/2020)

This result in 2021 indicates that the Green covering shelter (VAc27) has no influence on $PM_{2,5}$ concentration in the urban air. It is a location with relevant traffic levels (also in the reference site).

VAc29 Green shady structures (Ending implementation date 26/02/2021)

This result in 2021 seems to indicate (in comparison with 2019) that the implementation of the green shady structures in the Santa María St. has no influence in the PM2,5 concentration in air.

Anyway, it is relevant that collected values are most of them under the legal limits. However, data are quite variable and it is recommended to assess the impact during 2022 summer time in order to know if this intervention could affect maximum temperatures in the area.

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Measurements are highly affected by punctual high emitters such a car started but unmoved. It is especially relevant for pedestrian streets.	It would be better to propose a monitoring campaign shorter but denser in terms or data in order to assess the impact of the NBS. In this way it can be reduced the influence of external factors in the measurements.
Economic barriers	How they have been addressed
PM monitoring tools are quite expensive and it is not possible to install one device in all the monitoring sites selected. Additionally, the ones with highly connectivity are too expensive.	One portable tool was acquired and periodic monitoring campaigns were performed. This procedure has the limitation of the reduced representativity because
Social barriers	How they have been addressed

It is a highly extended practice to keep the engine on when vehicles (especially diesel ones) are stopped for some minutes.	Continuous monitoring campaigns with autonomous devices are better to identify potential outlayers. For pedestrian streets, data for analysis can be limited to hours without vehicles (out of commercial schedule).
Environmental (including COVID)	How they have been addressed
During the lockdown, in general, all the parameters associated to air pollution decreased due to the lack of traffic.	In that case, monitoring campaign should be moved.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

As it has been previously introduced, impacts depend on the type of NBS and its location. Anyway, this KPI assess the impact of vegetation on the PM concentration. Many research papers report about it, and most of the agreed that even when PM can be captured by tree's leaves, the impact on PM concentration in urban air is very reduced due to the emission levels are much higher than capture capacity by the green infrastructure.

In this sense, NBS assessed with this KPI show similar conclusions by resulting in no differences appreciated after the implementations of the NBS except for the green façade.

What was the impact? (positive/negative, significant/non-significant)?

VAc25 Green Façade – Positive, significant

VAc 27 Green Covering Shelter – Non-significant

VAc29 Green shady structures – Non-significant

Other comments

Optional: Any other relevant comments that you would like to include.

Other NBS in Valladolid have been partially monitored but data collected do not allow an adequate analysis and so these results have not been included in this document.

Additionally, it is recommended to assess this KPI during 2022 in order to value the real impact of the interventions thinking that the vegetation is fully developed this year.

1.1.27 CH0502 Annual levels of fine particles, PM_{10}

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*

CH0502	Annual levels of fine particles, PM10	CAR
CITY	*RELATED NBS*	
VAL	VAc24, VAc25, VAc27 & Vac29,	

Results and Discussion

Table of results of this KPIs for the relevant NBS interventions in the city of Valladolid. In this case, as introduction for each NBS is indicated the reference site selected to calculate the CH0502 KPI. The selection of the reference site has been done according the NBS implementation site characteristics among the available reference data.

The calculation of this KPI has been done individually for each NBS because, as these NBS have building or street scale, the evaluation of all of them at district or city scale joining all the date, has no interest itself.

VAc25 Green Façade (Ending implementation date 30/06/2020)

NBS intervention site (El Corte Inglés Building in Constitución St.) is an urban space with PM background levels because there is no traffic in the area. Reference site (Montero Calvo St. in Valladolid) is also considered an urban space with background levels because has no traffic.

$PM_{2,5}$ reduction	VALUE	UNITS	Year
Ex-ante (2019)	94	%	
Ex-post (2020)	93	%	
Ex-post (2021)	44	%	
CH0501	**44**	**%**	**2021**

VAc 27 Green Covering Shelter (Ending implementation date 24/02/2020)

NBS intervention site in España Sq. Reference site (Rinconada Sq. in Valladolid). Both sites are squares and have similar levels of traffic.

$PM_{2,5}$ reduction	VALUE	UNITS	Year
Ex-ante (2019)	108	%	
Ex-post (2020)	90	%	
Ex-post (2021)	98	%	
CH0501	**98**	**%**	**2021**

VAc29 Green shady structures (Ending implementation date 26/02/2021)

NBS intervention site in Santa María St. Reference site (Montero Calvo St. in Valladolid). Both places are considered with urban background pollution levels without traffic.

$PM_{2,5}$ reduction	VALUE	UNITS	Year
Ex-ante (2019)	123	%	
Ex-post (2020)	85	%	
Ex-post (2021)	54	%	
CH0501	**54**	**%**	**2021**

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

The discussion of the results of this KPI has been also done individually for each NBS because, as these NBS have building or street scale, the evaluation of all of them at district or city scale joining all the date, has no interest itself. However, the individual evaluation of each NBS will support the selection of the proper NBS when a PM concentration reduction is being aimed.

VAc25 Green Façade (Ending implementation date 30/06/2020)

The assessment of this KPI show that this NBS has a positive influence in the PM_{10} city background levels. The reference location also with city background levels is close to the NBS intervention site. Additionally, this result should be checked with further studies to check this conclusion.

VAc 27 Green Covering Shelter (Ending implementation date 24/02/2020)

This result in 2021 indicates that the Green covering shelter (VAc27) has no influence on PM_{10} concentration in the urban air. It is a location with relevant traffic levels (also in the reference site).

VAc29 Green shady structures (Ending implementation date 26/02/2021)

This result in 2021 seems to indicate (in comparison with 2019) that the implementation of the green shady structures in the Santa María St. has a positive influence in the PM_{10} concentration in air.

Anyway, it is relevant that collected values are most of them under the legal limits. However, data are quite variable and it is recommended to assess the impact during 2022 summer time in order to know if this intervention could affect maximum temperatures in the area.

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Measurements are highly affected by punctual high emitters such a car started but unmoved. It is especially relevant for pedestrian streets.	It would be better to propose a monitoring campaign shorter but denser in terms or data in order to assess the impact of the NBS. In this way it can be reduced the influence of external factors in the measurements.
Economic barriers	How they have been addressed
PM monitoring tools are quite expensive and it is not possible to install one device in all the monitoring sites selected. Additionally, the ones with highly connectivity are too expensive.	One portable tool was acquired and periodic monitoring campaigns were performed. This procedure has the limitation of the reduced representativity because
Social barriers	How they have been addressed
It is a highly extended practice to keep the engine on when vehicles (especially diesel ones) are stopped for some minutes.	Continuous monitoring campaigns with autonomous devices are better to identify potential outlayers. For pedestrian streets, data for analysis can be limited to hours without vehicles (out of commercial schedule).
Environmental (including COVID)	How they have been addressed
During the lockdown, in general, all the parameters associated to air pollution decreased due to the lack of traffic.	In that case, monitoring campaign should be moved.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
As it has been previously introduced, impacts depend on the type of NBS and its location. Anyway, this KPI assess the impact of vegetation on the PM concentration. Many research papers report about it, and most of the agreed that even when PM can be captured by tree’s leaves, the impact on PM concentration in urban air is very reduced due to the emission levels are much higher than capture capacity by the green infrastructure.

In this sense, NBS assessed with this KPI show similar conclusions by resulting in no differences appreciated after the implementations of the NBS except for the green façade.

What was the impact? (positive/negative, significant/non-significant)?

VAc25 Green Façade – Positive, significant

VAc 27 Green Covering Shelter – Non-significant

VAc29 Green shady structures – Positive, significant

Other comments

Optional: Any other relevant comments that you would like to include.

Other NBS in Valladolid have been partially monitored but data collected do not allow an adequate analysis and so these results have not been included in this document.

Additionally, it is recommended to assess this KPI during 2022 in order to value the real impact of the interventions thinking that the vegetation is fully developed this year.

1.1.28 CH0508 Air quality parameters. NOX and PM

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0508	Air quality parameters. NO_X and PM.	CAR
CITY	*RELATED NBS*	
VAL	Vac30	

Results and Discussion

Initially, the plan involved measuring air concentrations of NO, NO_2, and $PM_{2.5}$ at sampling points located at varying distances from the NBS site both before and after the intervention. These measurements would be compared to data collected at equivalent locations on comparable stretches of street without NBS, at similar times of the day and on the same dates. In the case of the biofilter, which was the main focus of this key performance indicator (KPI), the plan also included taking measurements inside the underground car park.

However, it was not feasible to install an air quality measurement device outside the underground car park as originally planned, necessitating a modification in the methodology for evaluating this indicator. Nevertheless, an air quality measurement device was successfully installed inside the underground car park. Consequently, this information can be utilized in conjunction with the airflow recorded by the biofilter extractor and its capture efficiencies to estimate the quantity of contaminants captured by the biofilter.

As mentioned, an air quality monitor was not installed outside the biofilter after all. Therefore, the analysis of the designated reference locations collected from the Air Quality

Control Network of the Valladolid City Council is also not included.

Due to the limitations in installing the outdoor air quality monitor, a new indicator has been designed utilizing the available information: the indoor air quality within the parking facility, the airflow filtered by the biofilter, and the nominal efficiencies of the biofilter in capturing PM, NO, and NO_2.

Thus, the average annual concentrations have been calculated for the 12 hours of daily operation of the biofilter. With these values, knowing that the nominal flow rate of the biofilter is 3,000 m^3 per hour, and the capture efficiencies for PM, NO, and NO_2 are 95%, 95%, and 99% respectively, the annual quantities of these pollutants captured by the system have been calculated.

The calculation of this specific KPI has been tailored for each biofilter individually due to its high potential in capturing pollutants. However, it should be noted that this KPI entails significant investments of both time and financial resources, making it less feasible for application to the majority of NBS projects.

VAc30 Urban Garden Biofilter (Ending implementation date November 2021)

NBS intervention site (Portugalete square in Valladolid) is an urban space with PM background levels because there is no heavy traffic in the area.

Parameter	Annual mean concentration indoor (µg/m^3)	Biofilter Capture yield (%)	Annual amount capture (kg)
$PM_{2,5}$	4,64 (max. 252)	95	0,06
NO	237 (max. 2543)	95	3,13
NO_2	51 (max. 734)	99	0,70

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

The assessment of this KPI show that this NBS has a positive influence in the $PM_{2.5}$ (and consequently in the PM_{10}), NO and NO_2 city background levels. The implementation of this easy solution in stationary sources of pollution coming from vehicles such as underground car parks (public and private) or tunnels will have a positive impact on the city.

However, due to the cost associated with installing this solution, particularly in existing infrastructure, it is necessary to select locations where installation is straightforward and does not require significant construction work. Additionally, it is highly recommended for any new construction or remodeling projects planned in urban environments.

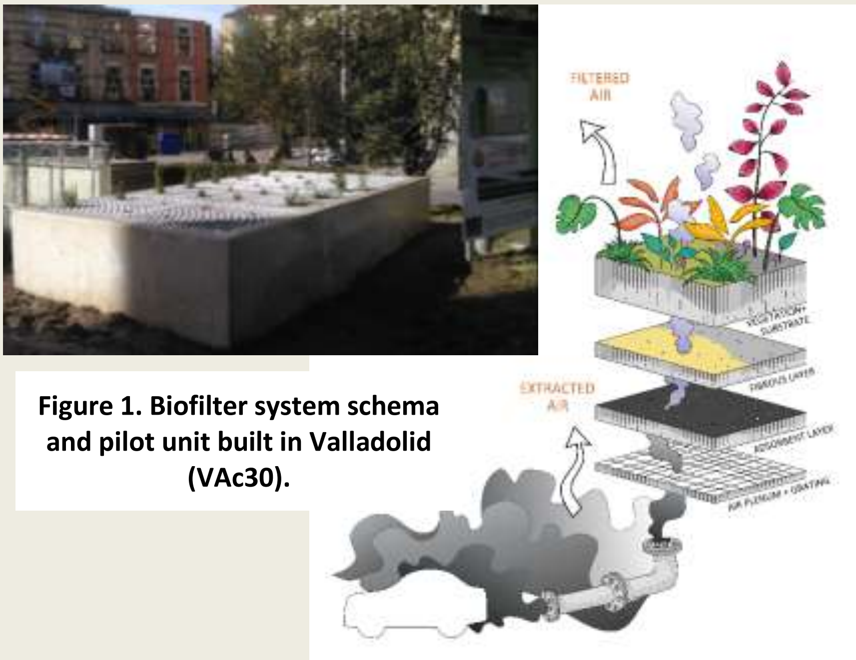


Figure 1. Biofilter system schema and pilot unit built in Valladolid (VAc30).

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Most air quality measurement stations require an electrical connection, which complicates their installation due to limited available connection points.	A strong involvement from the competent authority is necessary, mobilizing all relevant departments that may have jurisdiction. These departments can include mobility and lighting departments, as potential installation points could be traffic lights or street lamps.
Economic barriers	How they have been addressed
PM and NO_X monitoring tools are quite expensive and it is not possible to install one device in all the monitoring sites selected. Additionally, the ones with highly connectivity are too expensive.	Invest money in three units even when finally, only 1/2 were used in the project because of administrative issues. Once the impact of the biofilter has been studied other cheaper indicators can be proposed such the used of periodic passive measurements in the area and apply for the collaboration of the car park managers.
Social barriers	How they have been addressed
Vandalism	Awareness campaigns and education

Environmental (including COVID)	How they have been addressed
During the lockdown, in general, all the parameters associated to air pollution decreased due to the lack of traffic.	In that case, monitoring campaign should be moved.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
As it has been previously introduced, impacts depend on the type of NBS and its location. Anyway, this KPI assess the impact of vegetation on the PM concentration. Many research papers report about it, and most of the agreed that even when PM can be captured by tree's leaves, the impact on PM concentration in urban air is very reduced due to the emission levels are much higher than capture capacity by the green infrastructure. In this sense, NBS assessed with this KPI show similar conclusions by resulting in no differences appreciated after the implementations of the NBS except for the green façade.

What was the impact? (positive/negative, significant/non-significant)?
VAc30 Urban Garden Biofilter – Positive, significant

Other comments

Optional: Any other relevant comments that you would like to include.
For the proper evaluation of the impact of this solution, the information gathered here should be combined with the parking occupancy levels and the electricity consumption related to ventilation before and after the implementation of the biofilter. Furthermore, as mentioned earlier, it would be necessary to assess the air quality outside the parking facility in the vicinity of the biofilter with the system turned on and off for periods not less than one month.

1.1.29 CH0514 Air Quality Monetary Values

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0514	Air Quality Monetary Values	ACC
CITY	*RELATED NBS*	
VAL	VAC07 and Tree-planting actions: VAC2, VAC3, VAC4, VAC5	

Results and Discussion

Table of results (summary, from Task 5.4)

Challenge	KPI	Weight	Results
Air Quality	25.823.652 %	3,533	91.234.962,5

Data provided for the KPI calculation is referred to the Urban Carbon Sink action (VaC07) and Urban Tree Plantation (VaC2, VaC3, VaC4, VaC5).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Having calculated the Co2 Emission Data due to the implementation of trees in Valladolid, and taking into account the price of Co2 for March 2020 and 2022, we have been able to calculate the savings in euros that this solution has meant for the city of Valladolid.

URBAN TREE PLANTATION Number of trees * CO2 fixation/tree

Number of trees	20 years	25 years	30 years	35 years	40 years	Total Tons Co2	Price (March 2020)	Cost
2.391,00	254,42	467,74	662,85	944,20	1.204,17	3.533,38	19,83	70.066,93 €

URBAN CARBON SINK Number of trees * CO2 fixation/tree

Number of trees	20 years	25 years	30 years	35 years	40 years	Total Tons Co2	Price (March 2022)	Cost
1.989,00	176,43	325,91	492,57	640,98	868,71	2.504,60	75,13	188.170,60 €
							TOTAL	258.237,52 €

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers detected.	
Economical barriers	How they have been addressed
No economic barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The Air Quality Monetary Values has been increased 258.237,52€ between the Urban Tree Plantation and the Urban carbon Sink.

What was the impact? (positive/negative, significant/non-significant)?

Regarding the Urban Carbon Sink and Tree planting actions, the contribution to the Air Quality and its translations to Monetary Values has been a success.

1.1.30 CH0602 Benefits from interventions

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0602	BENEFITS FROM INTERVENTIONS	
CITY	*RELATED NBS*	
VAL		

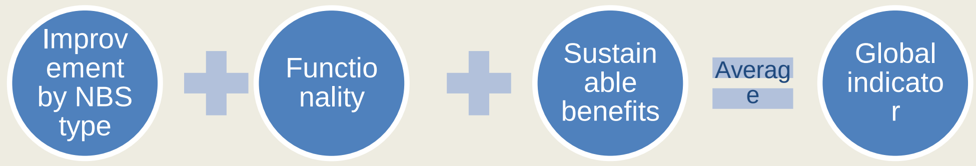
Results and Discussion

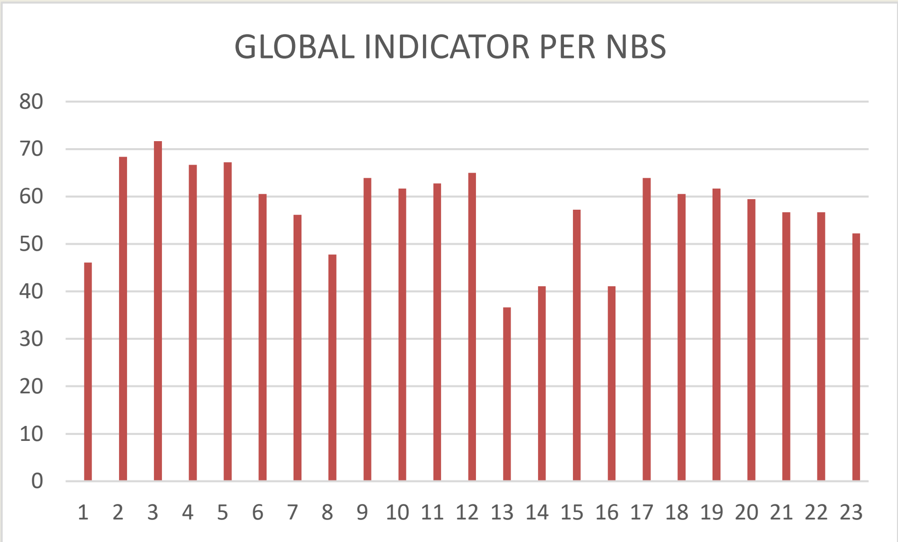
Table of results (summary, from Task 5.4)

EX POST	
TOTAL NBS AVERAGE	58%

Global between	Number of NBS
0-25%	0
25-50%	5
50-75%	18
75-100%	0

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.





Results from a total of 23 NBS have been calculated. Only 5 interventions have obtained a reults lower than 50%, and the rest are between 50% and 75%. The average of all of them is 58%.

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The assessment of the questions that make up each of the three criteria has a certain degree of subjectivity.	Questions can be answered with yes/No, so this minimize the subjectivity.
The results depend on the calculation of other KPIs	Methodology has changed to solve the lacks
Economical barriers	How they have been addressed
Not identified	
Social barriers	How they have been addressed

Not identified	
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

To make the analysis more robust, other technicians could complete it and stakeholders, and calculate an average of results.

What was the impact? (positive/negative, significant/non-significant)?

Positive and Significant. The impact of this KPI is positive since it assigns a score to each NbS of Valladolid Demonstration, which allows determining the degree of sustainability as Very high, high, medium, low or very low (Likert scale of 5).

It is considered Significant since it is calculated individually for each of the NbS. And the methodology is easily replicable to other cities with any NbS.

1.1.31 CH0701 OPPENNESS OF PARTICIPATORY PROCESSESS

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0701	OPPENNESS OF PARTICIPATORY PROCESSESS	VAL
CITY	*RELATED NBS*	
VALLADOLID	Non-technical activities (VAc38 Sponsoring, Vac41 Support NBS, Vac42 City mentoring)	

Results and Discussion

Table of results

Quality and openness of the participatory processes' analysis. This KPI is based on the participation actions delivered in the city of Valladolid. The qualitative score evaluates from 1-5 points, where 1-Low quality and 5-High quality.

EX ANTE (BASELINE)				
2017	2018	2019	2020	Σ Baseline
-	2,950	3,272	3,090	Score 3,104

EX POST			
2020	2021	2022	Σ Expost
3,090	3,360	2,750	Score 3,104

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The methodology defines two steps: ▪Step 1. Data collection and characterization: There is a scoring that differentiates Participation techniques, Degrees of participation, Co-creation & Co-production agent.

▪Step 2. Evaluation of participatory processes: A quantitative evaluation (nº processes /year) and a qualitative evaluation (Score 1-5).

There are included: Participatory actions (scientific, civil society, economic agents) and Participatory Budgets.

The result of the KPI is expressed in the Average score of the total Participatory actions (score 1-5).

Table. Qualitative scoring for "Openness of participatory processes"

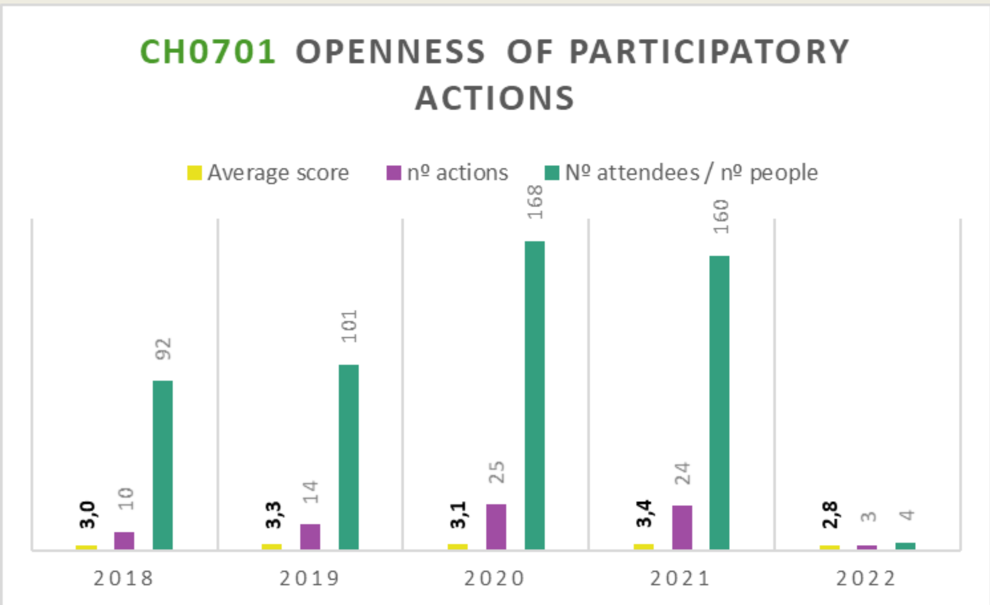
Criteria	Type	Score (points)
Scope	Quantitative	International, National, Regional = 1 point. Local = 0 points.
Communication model	Quantitative	In-person meeting = 1 point. Video conference/Online meeting/Audio conference/Call = 0,5 points. Email = 0 points.
Participation technique	Qualitative	From 0-1 depending on the quality and different types (Newsletter, Reports, Presentations, public hearings, Internet webpage, Interviews, questionnaires and surveys, Field visit and interactions, Workshop, Participatory mapping, Focus group, Citizen jury, Geospatial/ decision support system, Cognitive map, Role playing, Multicriteria analysis, Scenario analysis, Consensus conference)
Degree of participation	Quantitative	Information, Consultation = 0 points. Collaboration = 0,5 points. Co-decission, Empowerment = 1 point.
Attendees type	Quantitative	For >1 type = 1 point. Only 1 type = 0 points.

The following table shows the results broken down for each type of participatory activity (with the Scientific Community, with Economic Agents, and Others stakeholders such as cities, politicians or citizens), and the score assigned.

The graph shows that both the number of annual citizen participation activities and the number of citizens who have attended them have increased, despite the decrease in 2020 due to the pandemic Covid-19. Likewise, the quality of this type of participation actions, shown by the score, indicates that quality has also been improved (for example, actions aimed at the high-impact scientific community, or actions of an international nature, etc., which are consider with higher score).

Name	Unit	2017	2018	2019	2020	2021	2022	Total
Participatory actions (Total)	nº actions	-	10	14	25	24	3	**73**
	Nº people	-	92	101	168	160	4	**521**
	Average score	-	**2,950**	**3,272**	**3,090**	**3,360**	**2,750**	**3,104**
Participatory actions	nº actions	-	5	5	8	9	2	**25**

(Scientific Community)	Nº people	-	37	23	16	8	2	**84**
	Average score	-	3,200	3,600	3,714	3,125	2,750	**3,505**
Participatory actions (Economic Agents)	nº actions	-	5	9	9	5	1	**28**
	Nº people	-	55	78	74	8	2	**215**
	Average score	-	2,700	2,944	3,333	3,500	3,000	**2,993**
Participatory actions (Other)	nº actions	-	-	-	9	11	-	**20**
	Nº people	-	-	-	78	144	-	**222**
	Average score	-	-	-	2,222	3,455	-	**2,222**



Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Greater difficulty in interpreting the results of the actions of the Participatory Budgets,	Participatory Budgets have been included since 2020.

because the data of the actions requested to the actions finally executed are not clear.	
Economical barriers	How they have been addressed
Most of the actions have no cost for the citizen or interested party. On the part of the City Council, the cost is passed on as personnel cost. Some more far-reaching citizen participation actions do have a cost for the City Council (local communication & dissemination activities)	Actions with cost (subcontracted) must be foreseen with municipal funds since it is not covered by EU funds.
Social barriers	How they have been addressed
Low participation in some of the participation actions organized by the Valladolid City Council, with greater effort in terms of resources, time and cost.	Citizens go to the Single desk of the Valladolid City Council to request all kinds of participation actions: interviews, field visits, workshops, etc. Tailored actions have been provided.
Environmental (including COVID)	How they have been addressed
▪The Covid-19 pandemic forced the cancellation of several non-technical events for 2020.	▪Non-technical actions recovered early but virtual, starting in fall 2020. The activities of 2020 and 2021 have been mostly virtual.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes. The KPI CH0408 is part of the CHALLENGE 7: Participatory Planning and Governance. The methodology defined for this KPI CH0701 includes several criteria such as the degree of participation, the type of stakeholder, scope, etc. that allows scoring quite well every action delivered by Valladolid City Council for URBAN GreenUP, as well as, it identifies the quality of the participatory processes.

What was the impact? (positive/negative, significant/non-significant)?

Positive and Significant. The City Council has an updated inventory of every non-technical activity that is delivered in the city for the URBAN GreenUP project.

Other comments

This indicator is easy to monitor, and to feed with real data. An updated inventory can be made of all the non-technical activities carried out in the city on the occasion of URBAN GreenUP. This is easily replicable to other cities that implement non-technical interventions.

1.1.32 CH0703 Citizen perception

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0703	CITIZEN PERCEPTION	VAL
CITY	*RELATED NBS*	
VALLADOLID	All technical NbS implemented (Vertical and horizontal green infrastructure; Electro wetland; Green corridor (green cycle lane, resting areas, cycle-pedestrian green paths); Rain gardens; Green Parking Pavements;)	

Results and Discussion

Table of results (summary, from Task 5.4)

This KPI measures identified green space characteristics by the two following well-being variables and one geolocation variable: a) Green space visitors' level of satisfaction, that is directly related with the urban green space (UGS) quality. b) Self-reported quality of life (QoL). c) Frequency of green space visitors' crowd-sourced geo-tagged data in NBS sites. The result is expressed in a Likert scale (1-5).

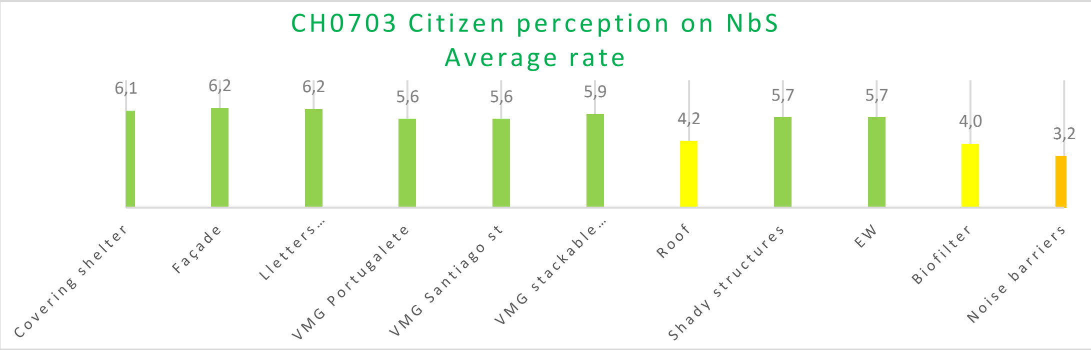
EX ANTE (BASELINE)				
2017	2018	2019	2020	? Baseline
n/a	n/a	n/a	2,93 score	2,93 score

EX POST			
2020	2021	2022 (until 14th March)	? Expost
3,03 score	2,45 score	1,62 score	2,37 score

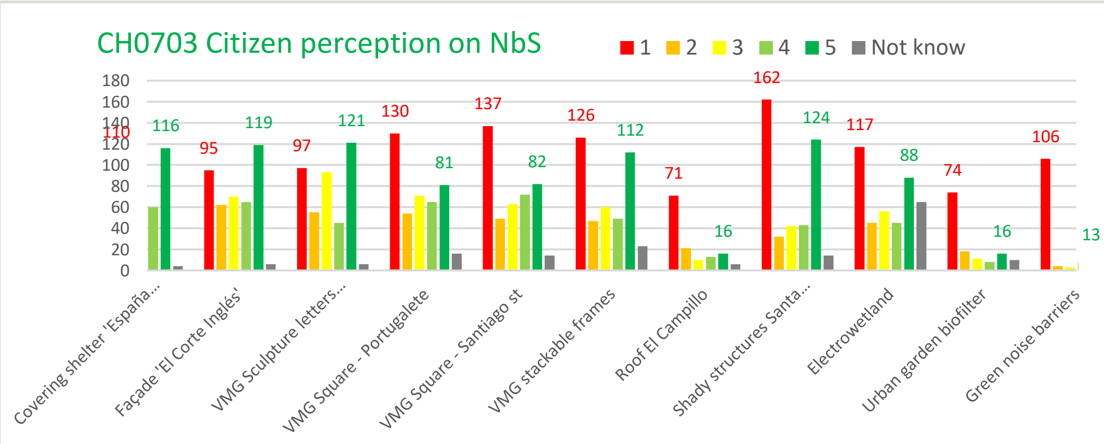
Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Data for this KPI is captured by a citizen's participation survey launched by Valladolid City Council https://forms.gle/iS3EXtAHADygmMzR7 , and the mini-surveys launched by the URBAN GreenUP mobile application (GMV-S). Scoring for this KPI is calculated on the average basis from 1-5 (Average rate). However, the Citizen perception can also be identified for every NbS independently.

The following graph shows the score of the citizens of Valladolid to the NbS of URBAN GreenUP (updated to March 2022, with a total of >400 responses).



On the other hand, this graph includes the number of people who vote for each value (1-5). It is appreciated that most of the citizens vote 1 (red) or vote 5 (dark green). This means that opinions are extreme.



Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
Not all citizens answer a digital survey (for example, older people).	A street-level paper survey has not been launched.
Only data until 14th March 2022, due to technical problems	More robust server for the survey

Economical barriers	How they have been addressed
Not identified.	

Social barriers	How they have been addressed
The degree of participation in the survey is medium. Although it has exceeded expectations.	In a few months we will again relaunch a participation campaign focused on getting more responses.

Environmental (including COVID)	How they have been addressed
Not identified.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes. The KPI CH0703 is part of the CHALLENGE 7: Participatory Planning and Governance.

The best way to know the citizen's perception is to ask, through a participation survey. We have shown that the longer an NbS has been installed, the better its rating (better citizen perception).

What was the impact? (positive/negative, significant/non-significant)?

Positive and Significant. The calculation of the KPI is positive. However, not all the results obtained from citizen perception are positive. Some NbS get low ratings (poor perception).

1.1.33 CH0801 Crime reduction (N)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0801	CRIME REDUCTION (N)	CAR

CITY	*RELATED NBS*
VAL	ALL

Results and Discussion

Table of results (summary, from Task 5.4)

	2017	2018	2019	2020
Total number of crimes	**1218**	**1195**	**1155**	**893**
Variation	**-**	**-23**	**-40**	**-262***

*Baseline data from years 2017, 2018, 2019 and (partially) 2020

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Data provided by Policía Municipal de Valladolid.

- Numb. crimes by street
- Crimes reported are civil faults.
- Baseline data from years 2017, 2018, 2019 and (partially) 2020.
- Performance reports of the municipal police

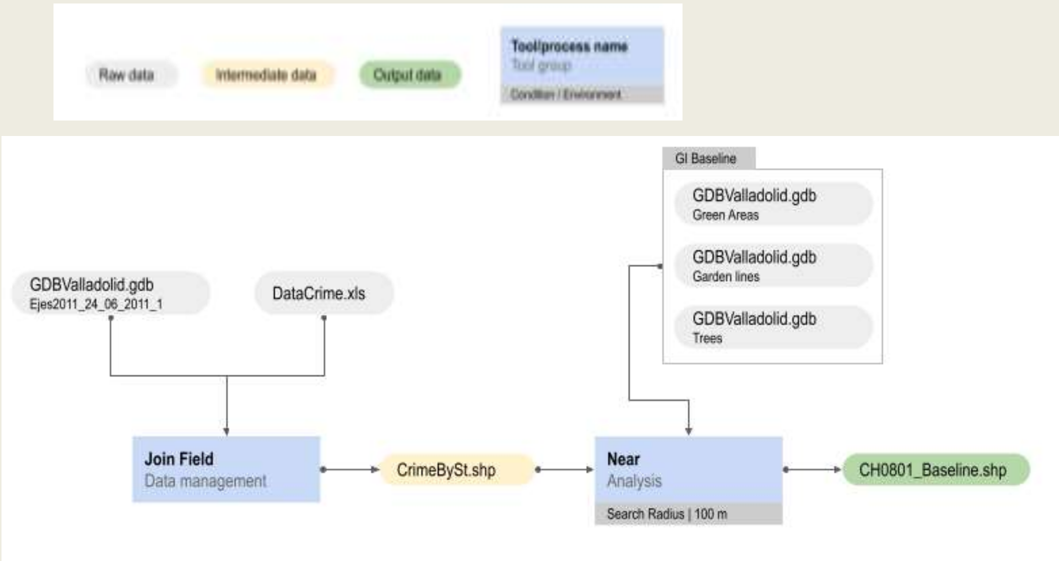


Figure 1.5: KPI algorithim dataflow scheme

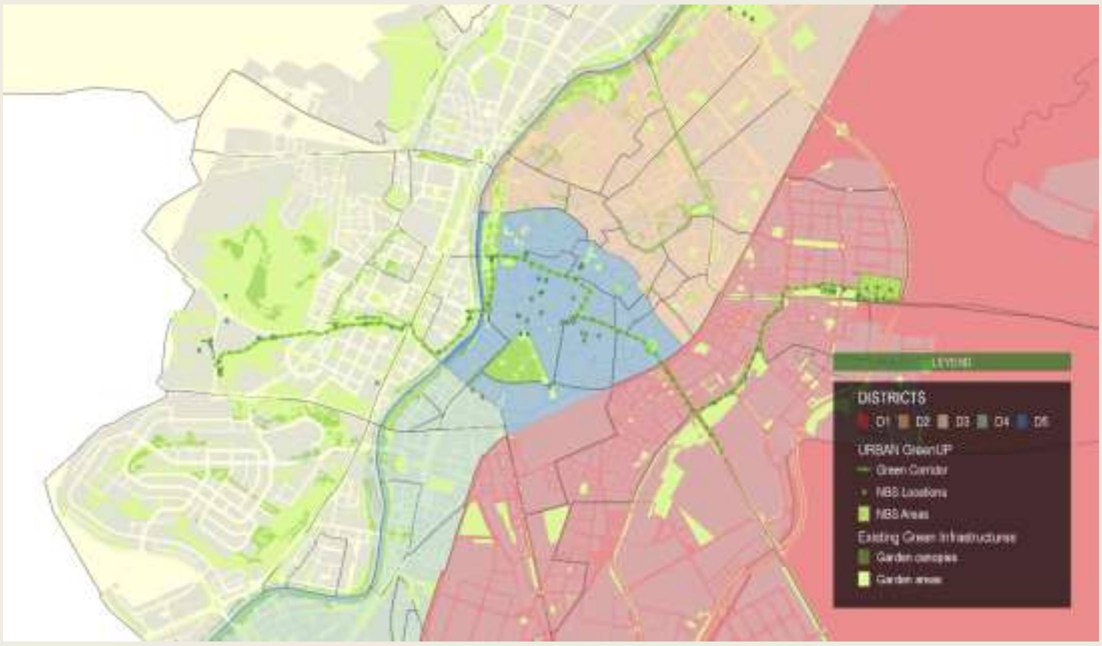
According to the data analysed, the number of crimes has been decreasing since the beginning of the study. However, this KPI has only been measured at Baseline level as the data provided includes the full years 2017 to 2019, and 2020 partially (until March). Considering also that during subsequent years there have been lockdown due to COVID, it is estimated that the post-intervention results may not reflect a natural trend, but disturbances due to this exceptional situation.

For this KPI, the approximate distance from each street where the crime occurred to a green infrastructure has also been calculated. The graphs shown on the left show for each year, the % of streets where crimes have occurred grouped by the distance of each street to a green infrastructure (within 50, 100 and more than 100 m distance to a GI). In addition, for each group of distances, the intensity (number of crimes) occurred is distinguished (>10, 5-10, 1-4 and no crimes).

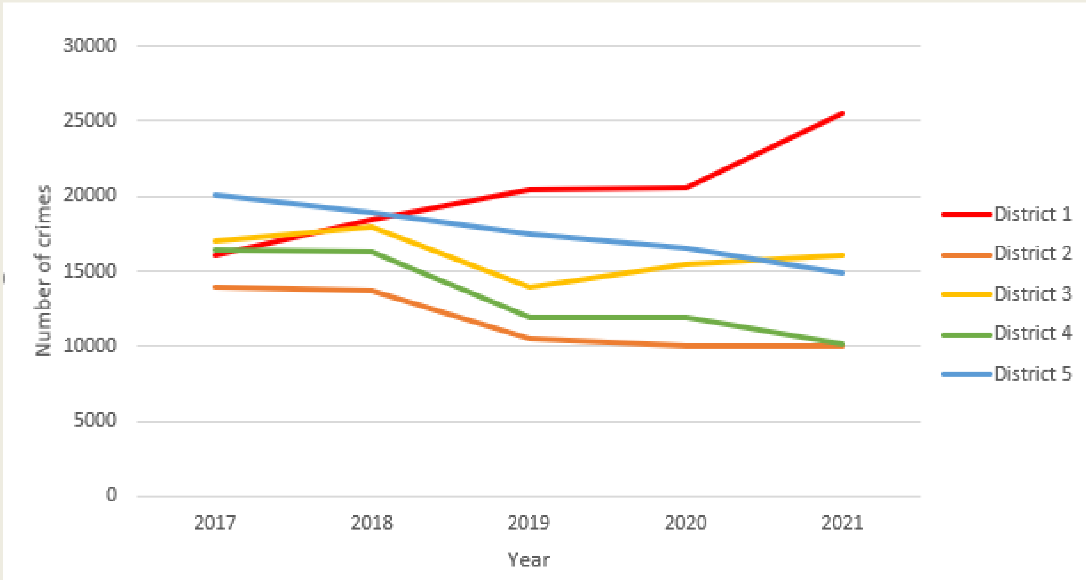
It has been found that more crime occurs near the GIs. This is mainly due to the type of crimes that the local police have referred for this study. Although very detailed, the report only includes crimes classified as "minor crimes" and does not include more serious crimes. The type of crimes reported include damage to litter bins, trees, street furniture, etc., which makes these types of incidents more frequent in parks.

The following image shows the distribution of the districts of action of the municipal police. To complete the study, we have taken the data that the local police show in their annual reports. At the time of writing this document, information is available up to 2021. The crimes are evaluated at District level, and include more varied typologies than in the case of the data provided at the request of the project team.

The NBS of the URBAN GreenUP project are mainly located in district 5 (city centre), and in districts 3 (west of the city) and 1 (east).



As can be seen in the graph below, in general crimes show a decreasing trend since 2017 with the exception of districts 1 and 3, where they have increased from 2017 to 2021, especially in district 1. In the centre district, where a higher number of project actions are concentrated, the incidence of crimes has progressively decreased from 2017 to 2021.



Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The data provided by the authorities are at street level and without associated code or coordinates. This means, apart from the arduous task of address recoding, that on long streets the data are not valid for the analysis of proximity to green areas as we cannot know where the crime has been committed. In addition, the authorities only provided data concerning vandalism or similar crimes, which makes the analysis incomplete and even penalizes proximity to green spaces (as categories include damage to trees, theft of plants, etc.).	Data analysis and cleaning has been carried out, addresses have been coded.
Economical barriers	How they have been addressed
-	
Social barriers	How they have been addressed
Since the necessary data are not in publicly available and accessible information, access to them requires an institutional data request process. Incomplete data.	A meeting was held with the authorities to explain the destination and use of the data. KPI calculated only at baseline level.
Environmental (including COVID)	How they have been addressed
Lockdown situation during the COVID may affect the results of the KPI.	This has been taken into account in the data analysis.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The number of crimes has been reduced. However, the number of crimes is higher in areas near to GI than other areas. It cannot be established whether the impact of NBS on crime reduction is significant or not, as the level of geolocation of the data provided by the authorities does not allow estimating the actual distance from the scene to the green infrastructure, being only estimable for small streets.

What was the impact? (positive/negative, significant/non-significant)?

The bias produced by the type of crimes analyzed, which only include civic behavior, vandalism, etc., means that the number of incidents in green infrastructures is higher. Incidents such as broken branches, material damage to parks or theft of plants are inherent to green areas. On the other hand, other crimes such as personal assaults or theft of personal belongings have not been reported. Therefore, based on the initial data, the number of incidents is higher in or near green areas, but as indicated above, a more detailed evaluation would be required in terms of geolocation of the actions and types of crimes analysed.

1.1.34 CH0802 Green intelligence awareness (Educational activities)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0802	GREEN INTELLIGENCE AWARENESS (Educational activities)	VAL

CITY	*RELATED NBS*
VALLADOLID	VAc39 Ecological reasoning and intelligence (only Educational activities, for recreational/cultural, see *CH0406 Recreational value*)

Results and Discussion

Table of results

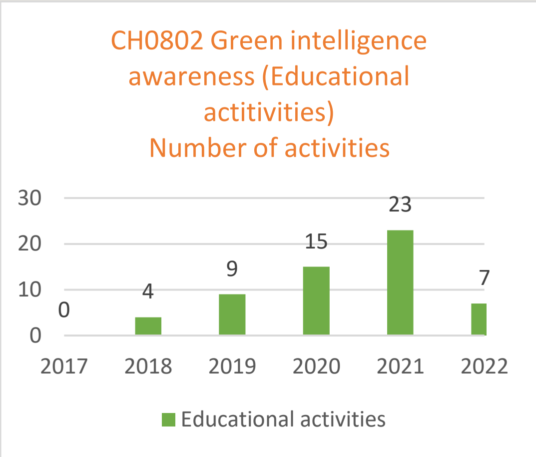
Quantify the number of activities, publications or campaigns focused on the enhancement of green intelligence awareness per year, related to a NbS. Expressed as the number or people that attends to the educational activities (nº attendee/year) and the sum of the educational activities per year (nº activities/year).

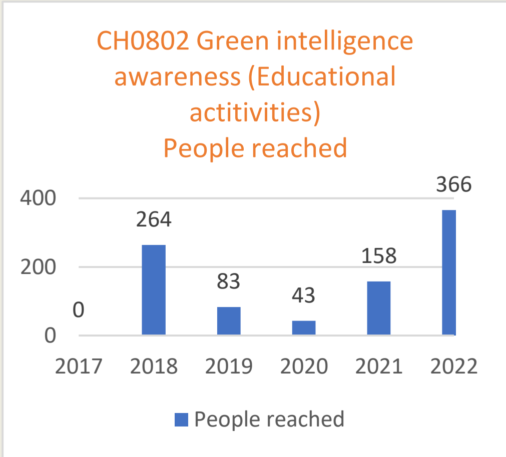
EX ANTE (BASELINE)				
2017	2018	2019	2020	⍰ Baseline
0 people	264 people	83 people	22 people	369 people

	EX POST		
2020	2021	2022	⍰ Expost
21 people	158 people	366 people	550 people

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The following graphs show the comparison between the two units that can express this KPI CH0802: people reached as well as number of activities. In terms of the number of people, there was a clear decrease in 2020, due to the Covid-19 crisis. However, the nº activities launched by the City Council has been clearly increasing yearly since the beginning of the URBAN GreenUP project.





On the other hand, the results expressed for CH0802 do not include the number of participants in the Entrepreneurship Route (ES.- *Ruta del Emprendimiento & VallaCreActivos*). These routes were carried out in until 2019. Secondary school students from many institutes in Valladolid came to the City Hall to learn about the municipal activities. European projects were explained to them at the Innovation Agency, including URBAN GreenUP. So for 2018 and 2019 the number of people that attended these activities increase considerably the results for CH0802, as it is shown in the following table. For 2020, 2021 and 2022 the Entrepreneurship Route, so the differences between years would not be comparable. For this reason, the attendees to the Entrepreneurship Route have not been considered.

EX ANTE (BASELINE) – With *Entrepreneurship Routes*				
2017	2018	2019	2020	⍰ Baseline
0 people	2.409 people	2.059 people	43 people	2.234 people

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
The quantification of the number of people who attend a non-technical activity is sometimes estimated.	Estimated number of participants, for those events in which there is no attendance list.

Economical barriers	How they have been addressed

There is no European funding for local communication actions.	The entire budget for non-technical actions at the local level comes from municipal funds (Valladolid City Council).
Social barriers	How they have been addressed
In some non-technical activities there is low citizen participation.	▪Reinforcement of the dissemination of the event. ▪Invitation campaigns to specific groups of stakeholders.
Environmental (including COVID)	How they have been addressed
▪The Covid-19 pandemic forced the cancellation of several non-technical events for 2020.	▪Non-technical actions recovered early but virtual, starting in fall 2020. The activities of 2020 and 2021 have been mostly virtual.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Yes. The KPI CH0802 is part of the CHALLENGE 8: Social Justice and Social Cohesion. This KPI clearly shows the number of citizens who have been reached with non-technical actions, though the Educational activities (Vac39). The results show that the scope of the actions has been increasing, despite the pandemic.
What was the impact? (positive/negative, significant/non-significant)?
Positive and Significant.

Other comments

This indicator is easy to monitor, and to feed with real data. An updated inventory can be made of all the non-technical activities carried out in the city on the occasion of URBAN GreenUP, and the number of people participating can be recorded.

1.1.35 CH0803 Green intelligence awareness (Communication activities)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0803	GREEN INTELLIGENCE AWARENESS (Communication activities)	VAL
CITY	*RELATED NBS*	
VALLADOLID	VAc38-Sponsoring activities, VAc39-Promotion of ecological reasoning intelligence, VAc41-Support to citizen project of NBS, VAc42-City mentoring strategy (Staff Exchange activities)	

Results and Discussion

Table of results (summary, from Task 5.4)

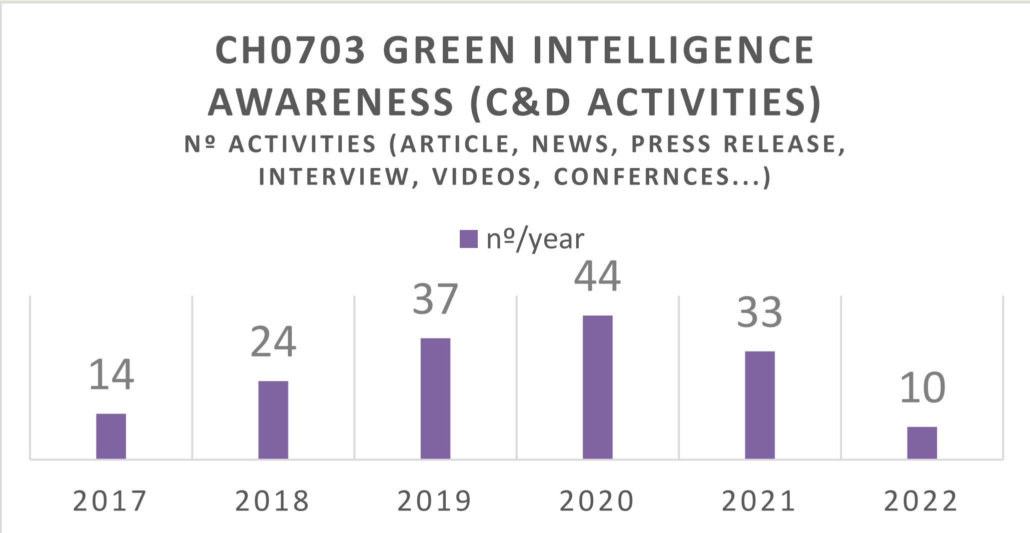
Quantify the number of publications in different communication means such as written press (newspaper, magazines, articles, brouchers), television, radio and social media. This KPI includes the Communication activities: Editorial + Communication actions.

EX ANTE (BASELINE)				
2017	2018	2019	2020 (Jan-May)	Σ Baseline
14 publications	24 public.	37 public.	35 public.	110 publications

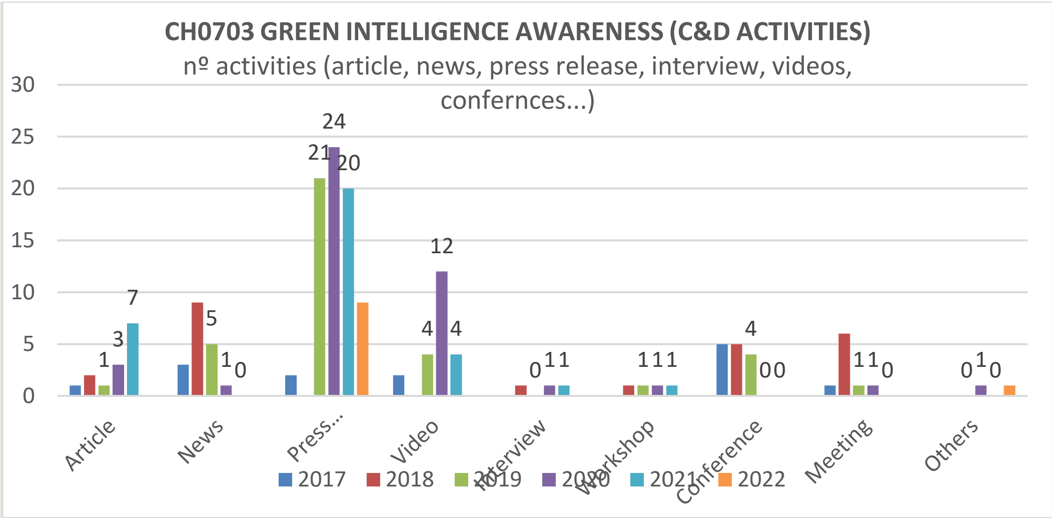
EX POST			
2020 (Jan-May)	2021	2022	Σ Expost
9 public.	33 public.	10 public.	52 publications

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Trends: Despite the Covid-pandemic in 2020 the number of communication activities launched by Valladolid City Council or that the Council participated is being increasing since the beginning of the URBAN GreenUP project.



Additional results can be broken down by type of communication action.



Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
The majority of Valladolid's citizens do not speak English.	Most of the local activities launched by Valladolid City Council are in Spanish.
Economical barriers	**How they have been addressed**
There is no European funding for local communication actions.	The entire budget for non-technical actions at the local level comes from municipal funds (Valladolid City Council).
Social barriers	**How they have been addressed**
The social impact of some NbS is high in the media (social networks, complaints in the 010 municipal communication service, etc).	▪Reinforcement of local communication actions (more articles, news, social media interactions, etc.). ▪Personalized response to each complaint or question received by each citizen.
Environmental (including COVID)	**How they have been addressed**
▪The Covid-19 pandemic forced the cancellation of several non-technical events for 2020.	▪Non-technical actions recovered early but virtual, starting in fall 2020. The activities of 2020 and 2021 have been mostly virtual.

▪Paper documentation is not printed. This may prevent reaching some citizens (especially those who do not attend digital media, such as the elderly).	▪Communication actions include articles and news published in local newspapers (on paper).

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes. The KPI CH0803 is part of the CHALLENGE 8: Social Justice and Social Cohesion. This KPI clearly shows the number of communication activities launched by Valladolid City Council about the URBAN GreenUP project, including all the non-technical NbS (Vac38, Vac39, Vac41, Vac42). The results show that the scope of the actions has been increasing, despite the pandemic.

What was the impact? (positive/negative, significant/non-significant)?

Positive and Significant.

Other comments

This indicator is easy to monitor, and to feed with real data. An updated inventory can be made of all the non-technical activities carried out in the city on the occasion of URBAN GreenUP, and the type of activity can be recorded.

1.1.36 CH0901 Noise reduction

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0901	Noise reduction	CAR
CITY	*RELATED NBS*	
VAL	VAc22, VAc23	

Results and Discussion

Table of results of this KPIs for the noise barriers in the city of Valladolid.

The calculation of this KPI has been done only for this NBS because it is supposed the only able to reduce the ambient noise levels.

It is a relevant KPI to be considered at city or district scale, but the scale of intervention of the proposed NBS and this KPI are designed to assess the impact at street scale. Anyway, results can be extrapolated and can be used to propose solutions regarding the noise reduction in other streets or even at district level for citizens (or even fauna) focusing interventions adequately.

VAc22/VAc23 Green noise barriers (Ending implementation date 30/06/2020)

NBS intervention site (Paseo del Hospital Militar St., 31). Reference site (Paseo del Hospital Militar St., 34).

Noise reduction	Average	Maximum	UNITS
Ex-ante (2020/2021)			
Reference site	70,4	100,9	dB
NBS site	66,5 (-3,9)	98,9 (-2,0)	dB
Ex-post (2022)			
Reference site	66,9	100,9	dB
NBS site	65,3 (-1,6)	98,1 (-2,8)	dB
CH0108	+2,3	-0,8	dB

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

This KPI covers the impact assessment of a specific characteristic, the noise reduction that can be got with NBS. Noise reduction with this NBS is focused mainly in the effect of the traffic. So, noise monitoring is highly affected by the traffic conditions. Reference site has been selected in the same street at around 250m far from NBS intervention site. However, there is a cross street in the middle and it affects to the traffic distribution.

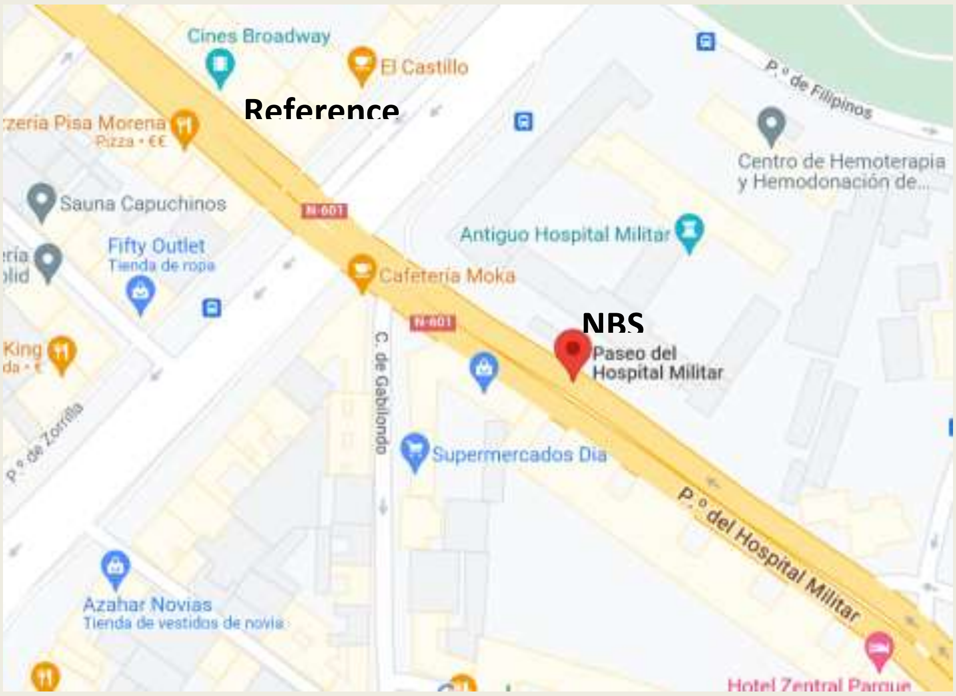
Only 3 monitoring campaigns have been carried out after the intervention. Results until now (only six months after intervention) show an increment in the average values and a slightly reduction in the peak values.

NBS Assessment. NBS site and reference site.	13/01/2022		18/03/2022		10/05/2022	
	Max.	Av.	Max.	Av.	Max.	Av.
Paseo del Hospital Militar, 34 (Ref.)	99,7	62,1	102	68,6	101	69,9

Paseo del Hospital Militar, 31 (NBS)	91,9	57,8	100,8	69,6	101,7	68,4
Difference	7,8	4,3	1,2	-1	-0,7	1,5

As it can be seen, important differences have been found in the three days monitored. The study will continue in order to explore these variations.

Vegetation is still very small but it is expected to grow within the coming months.



Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No available wifi connections in the streets. Individual gprs or other systems for each sensor is to expensive.	Install Bluetooth connection system for the sensors. However, it requires on site data collection.

Economic barriers	How they have been addressed
No barriers detected.	

Social barriers	How they have been addressed
Vandalism in sensors installed in the streets. So, it is not recommended to install and let alone noise sensors.	Monitoring campaigns are planned periodically to carry out several time limited studies.

Environmental (including COVID)	How they have been addressed
During the lockdown, no monitoring campaigns were carried out. Traffic were reduced deeply.	Hopefully, no more pandemics affect the world.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
As it has been previously introduced, current results do not show relevant impacts on noise reduction by the green noise barriers but data collected show a high variability. It is needed to continue with the monitoring campaigns in order to get more data to carry out the statistical study.

What was the impact? (positive/negative, significant/non-significant)?
Regarding noise reduction, the impact was neglectable.

1.1.37 CH0903 Cycling area increase

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0903	CYCLING AREA INCREASE	CAR, GMV
CITY	*RELATED NBS*	
VAL	Vac01	

Results and Discussion

Table of results (summary, from Task 5.4)
No data recorded (see conclusions section).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.
No data recorded (see conclusions section).

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Obtaining objective data on the use of the green corridor by citizens, discriminating between cycling and walking.	Module included within the APP to obtain geolocation and activity of the citizens.
Economical barriers	How they have been addressed
Promotion of the use of the application beyond dissemination is needed. A competitive, economic or gamification incentive is required to motivate the user to actively participate in data collection.	Not addressed within the project.
Social barriers	How they have been addressed
Activity data was to be measured through the use of the APP. However, no end user of the APP has provided data on the use of the green corridor.	The application explains quite well how the monitoring works, as shown in the attached pictures, but no one has participated in the data collection.
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

What was the impact? (positive/negative, significant/non-significant)?

1.1.38 CH0904 Walking area increase

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0904	WALKING AREA INCREASE	CAR, GMV
CITY	*RELATED NBS*	

VAL	Vac01

Results and Discussion

Table of results (summary, from Task 5.4)

No data recorded (see conclusions section).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

No data recorded (see conclusions section).

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Obtaining objective data on the use of the green corridor by citizens, discriminating between cycling and walking.	Module included within the APP to obtain geolocation and activity of the citizens.
Economical barriers	How they have been addressed
Promotion of the use of the application beyond dissemination is needed. A competitive, economic or gamification incentive is required to motivate the user to actively participate in data collection.	Not addressed within the project.
Social barriers	How they have been addressed
Activity data was to be measured through the use of the APP. However, no end user of the APP has provided data on the use of the green corridor.	The application explains quite well how the monitoring works, as shown in the attached pictures, but no one has participated in the data collection.
Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

What was the impact? (positive/negative, significant/non-significant)?

1.1.39 CH1001 Tax Reduction

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH1001	Tax Reduction	ACC
CITY	*RELATED NBS*	
VAL	VAc2, VAc4, Vac25, Vac27, Vac28	

Results and Discussion

Table of results (summary, from Task 5.4)

It is not possible to calculate the results, there is no link between the application of the NBS and the subsidies or tax reductions.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Not possible to calculate results

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
NBS implemented.	

Economical barriers	How they have been addressed
Really difficult to calculate economical barriers related to tax reductions, if there is no relationship between them.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
High environmental and economic impact, also enhancing public-private partnerships.
What was the impact? (positive/negative, significant/non-significant)?
It is true that although it has not been possible to measure, these implementations have had a very positive and significant environmental and economic impact.

1.1.40 CH1002 Job Creation

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH1002	Job Creation	ACC
CITY	*RELATED NBS*	
VAL	VAC22, VAC23, VAC25,VAC27,VAC28, VAC29	

Results and Discussion

Table of results (summary, from Task 5.4)

Data provided for the KPI calculation is related to the actions referred to: Green noise barriers, Green Roof, Green Façade, Green Covering Shelter and Green Shady Structures.

Challenge	KPI	Weight	Results
Potential of economic opportunities and green jobs	87	3,6	31,320

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

We have taken into account for each of the implementations, the workers needed per activity, compiling all of them by typology, the price per hour according to the type of work, the number of hours needed to perform such works. The results show a total of 87 workers needed to execute all the actions.

	Nº OF WORKERS	Nº HOURS	Nº DAYS (8HRS/DAY)	COST
Green noise barriers	16	1290,47124	161,308905	24.711,91 €
Green Roof	17	4170,2436	521,28045	72.911,56 €
Green Facade	10	1519,3715	189,9214375	29.210,54 €
Green Covering Shelter	22	2329,18423	280,4804038	41.882,67 €
Green shady structures	22	814,94982	92,9008525	15.811,51 €
TOTAL	87 workers	10.124,22	1.245,89	184.528,19 €

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers detected.	
Economical barriers	How they have been addressed
No economical barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	

Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The actions implemented has increased the employment ratio of Valladolid City, cresting a total of 87 works activities. This implementations has created a good economic impact for Valladolid citizens.

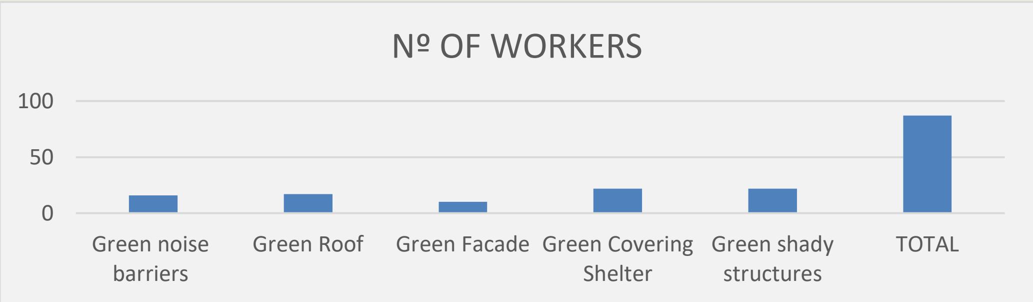
What was the impact? (positive/negative, significant/non-significant)?

The actions implemented has increased the employment ratio of Valladolid City, creating a total of 87 works activities. This implementations has created a good economic impact for Valladolid citizens.

Other comments

Optional: Any other relevant comments that you would like to include.

Regarding all the actions mentioned, the cumulative work creation has increased considerably.



1.1.41 CH1003 Business Revenue

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH1003	Business Revenue	ACC
CITY	*RELATED NBS*	
VAL	VAc27, VAc29	

Results and Discussion

Table of results (summary, from Task 5.4)

Not possible to calculate results, due to the policy of private companies not to make public their profits before and after implementations of nature-based solutions.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Not possible to calculate results, but we assume that the NBS implementations have increased the return on business rates.

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers detected.	
Economical barriers	How they have been addressed
Private companies not to make public their profits.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

This activity has caused a clear increase in the affluence of people in the areas where these implementations have been developed, being able to observe how they have increased their consumption.

What was the impact? (positive/negative, significant/non-significant)?

There is no doubt that the environmental impact has been positive, as can be seen. It has also been positive at the economic level, in which it has been possible to observe how the influx of people has increased. It is true that both indicators have not been possible to calculate as they are not tangible.

1.1.42 CH1006 Consumption Benefits

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH1006	Consumption Benefits	ACC
CITY	*RELATED NBS*	
VAL	VAc28	

Results and Discussion

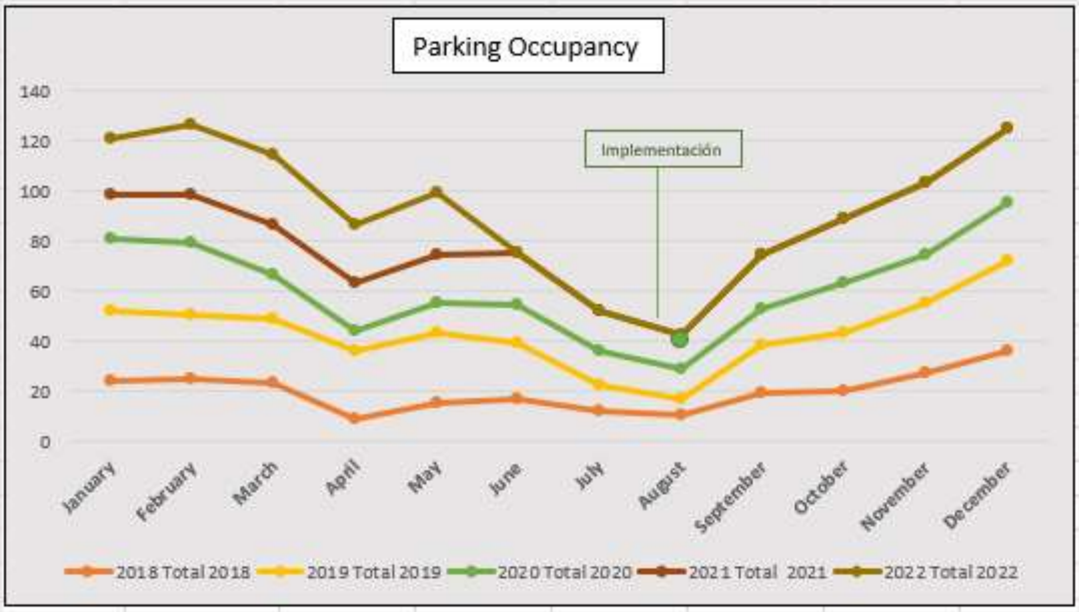
Table of results (summary, from Task 5.4)

Challenge	KPI	Weight	Results
Potential of economic opportunities and green jobs	-23,38	3,33	77,932

Data provided for the KPI calculation is only referred to Green Roof action (VaC28). The data given in the table correspond to the cumulative parking occupation.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The profits obtained in the parking have been calculated, taking into account a rate for subscribers (monthly) and another for non-subscribers (hourly).



	2018		2019		2020		2021		2022	
	Members 2018	Total 2018	Members 2019	Total 2019	Members 2020	Total 2020	Members 2021	Total 2021	Members 2022	Total 2022
January	7	24	6	28	6	29	8	17	9	23
February	7	25	8	25	7	29	6	19	9	28
March	7	23	8	26	6	17	6	20	9	28
April	2	9	6	27	8	8	7	19	7	23
May	4	15	6	28	8	12	5	19	7	25
June	6	17	5	22	6	15	8	21	0	0
July	5	12	4	10	5	14	6	16	0	0
August	5	10	3	7	5	12	5	13	0	0
September	6	19	4	19	5	15	7	21	0	0
October	4	20	5	23	7	20	7	26	0	0
November	7	27	5	28	7	19	6	29	0	0
December	6	36	4	36	7	23	3	30	0	0

	2018		2019		2020		2021		2022	
	Member	Non Members	Member	Non Members	Member	Non Members	Member	Non Members	Member	Non Members
Data Base	66	171	59	220	77	136	72	178	41	86
Totales	237		279		213		250		127	
Price for non-members Parking (2 hours*2€/hour)	4,00 €									
Precio for members monthly (60€/month)	60,00 €									

	2018		2019		2020		2021		2022	
	Member	Non Members	Member	Non Members	Member	Non Members	Member	Non Members	Member	Non Members
Benefit Parking	3.960,00 €	13.680,00 €	3.540,00 €	17.600,00 €	4.620,00 €	10.880,00 €	4.320,00 €	14.240,00 €	2.460,00 €	6.880,00 €
Benefit Total (annual)	17.640,00 €		21.140,00 €		15.500,00 €		18.560,00 €		9.340,00 €	
Benefit Total (Monthly)	1.470,00 €		1.761,67 €		1.291,67 €		1.546,67 €		3.113,33 €	

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers detected.	
Economical barriers	How they have been addressed
No economical barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The implementations in *El Campillo Market* have had an impact on the consumption/buying behavior of customers, making them aware of the need to buy quality and proximity products grown in the building's vegetable orchard.

What was the impact? (positive/negative, significant/non-significant)?

The impact has been positive, not only in the awareness of market customers and the environment due to the orchard, but also has had a positive economic impact by attracting more customers as can be seen in the data obtained by the occupancy of the parking.

1.2 Liverpool

1.2.1 CH0103 Carbon stored

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0103	CARBON STORED	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: EcoServR

EcoServR: Assumptions on habitat codes for the UGU interventions

Intervention type	**Code**	**Description**	**Notes**
Shade trees	A13	Mixed woodland	No code for trees outside woodland; assuming mixed to average out differences between coniferous and broadleaved trees
Cooling trees			
Green filter trees			
Orchard	A112o	Orchard	
Pollinator planting	J55	Brownfield/garden/park	
SuDS ponds	G1	Standing water	
Green roof	GR	Green roof	Added to EcoservR for UGU (limited evidence base)

Green wall	GW	Green wall	Added to EcoservR for UGU (limited evidence base)
Floating island	FI	Floating island	Added to EcoservR for UGU (limited evidence base)
Smart pollinator pillars	POLL	Pollinator baskets	Added to EcoservR for UGU (limited evidence base)

EcoServR results:

EcoServR: CH0103: Carbon storage (tC)	
Sub demo A	40.54
Sub demo B	2.37
Sub demo C	75.81
Overall Liverpool	138.52

NBS	**NBS name**	**EcoServR: CH0103: Carbon storage (tC)**
lac4	Urban catchment forestry	13.41
lac5	shade trees	7.10
lac6	cooling trees	9.52
lac8	SuDs & Rain Garden	0.75
lac12	Pollinator verges and spaces	8.87
lac13	Pollinator walls/vertical	0.07
lac14	Pollinator roofs	0.24
lac16	Floating gardens	0.10
lac17	Green filter area	13.41

Pollinator walls/vertical	EcoServR: CH0103: Carbon storage (tC)
L1 GW	0.04
Parr St GW	0.08
St Johns GW	0.11

Pollinator verges and spaces	EcoServR: CH0103: Carbon storage (tC)
Baltic Hub POLL	16.4
Bott SP Aig Dr POLL	5.3
Cornwallis St POLL	1.2
Lower SuDS POLL	17.2
Park Lane POLL	5.2
Pitt St POLL	0.4
Princes Av POLL	40.3
Princes roundabt POLL	3.0
Strand POLL	4.6
Top SP Aig Dr POLL	4.3
Ullet Rd POLL	3.1
Upper SuDS POLL	2.6
Wapping POLL	11.7

SuDs & Rain Garden	EcoServR: CH0103: Carbon storage (tC)
Upper Pitt St RG	0.75

Lower SuDS	0.00
Upper SuDS	0.00

Floating gardens	EcoServR: CH0103: Carbon storage (tC)
SPL FI	0.06
Wapping FI	0.15

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The EcoServR model describes the carbon sequestered annually by vegetation which accumulates in plant tissues and is incorporated into the soil to remain locked up over longer timescales (30+ years). In the model, semi-natural habitats from the natural capital baseline are assigned a carbon storage value (tonnes of carbon per hectare) representing the amount of carbon that can be stored and/or sequestered by this vegetation type and the top 30 cm of soil. These values are averages taken from the scientific literature, and do not consider habitat condition, land management, or the specific soil type at the location. Estimates were provided by grouping (inter_codes) but this leads to double-counting (as the same tree can be a shade tree and green filter tree etc). The "total" row was corrected for this (sum of carbon stored/sequestered in each physical intervention before aggregating them into their relevant group). In addition, EcoservR normally doesn't include street trees. The UGU trees were assigned woodland codes (linked to a very small intervention), so this may overestimate carbon storage.

Most carbon storage found in Sub-demo C (76 tonnes Carbon), but sub-demo B the least (2 tC). For overall Liverpool, 139 tC were calculated.

Trees within the Urban catchment forestry(13 tC) and green filter area (13tC) in particular were the most important for carbon storage, with green walls (0.1tB) and floating gardens (0.1tC) of the least importance.

From a more detailed assessment comparing the intervention types, larger areas did best for carbon storage, such as St Johns green wall (0.1tC) out of the green walls, Wapping Dock floating island (0.2tC) as compared to 0.1tC for the Sefton Park floating island; and Princes Avenue pollinator planting (40tC) and Wapping Dock planting (12tC), Baltic Hub site (16tC) and Lower SuDs planting (17tC) as compared with the other smaller pollinator sites. Upper Pitt Street rain garden scored 0.8tC as opposed to very low carbon storage scores for the other SuDs sites. This was presumably due to the bias in EcoServR for woodland habitats and no adjustment for SuDs sites. However, all interventions scored positively for carbon storage.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No EcoServR specific codes for trees outside woodland, pollinator planting, SuDs ponds, green roof, green walls, floating islands and pollinator pillars.	Codes calculated based on nearest possible code or estimated on limited evidence (see table above)
EcoServR may overestimate carbon storage due to street trees assigned woodland codes.	Awareness of limitations of tool.
EcoservR is a spatial tool designed to take into account interaction between landscape features, so some interventions may influence others	Awareness of limitations of tool.
EcoServR: Semi-natural habitats from the natural capital baseline are assigned a carbon storage value (tonnes of carbon per hectare) representing the amount of carbon that can be stored and/or sequestered by this vegetation type and the top 30 cm of soil. These values are averages taken from the scientific literature, and do not consider habitat condition, land management, or the specific soil type at the location.	Awareness of limitations of tool.

Economical barriers	How they have been addressed

n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Interventions added to the carbon storage capacity within Liverpool and within each Sub-Demo in the vegetation and soils for the long term. The larger the area of the intervention, the greater the carbon storage. For overall Liverpool, 139 tC stored were calculated.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.2 CH0104 Carbon sequestration

KPI CODE	*KPI NAME*	*PARTNER(S)*
Ch0104	CARBON SEQUESTRATION	CFT with LJMU
CITY	*RELATED NBS*	
VAL-IZM-LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL, EcoServR

EcoServR results:

EcoServR: CH0104: Carbon sequestration (tCO2e)	
sub demo A	-0.04
sub demo B	-0.03
sub demo C	-0.83
Overall Liverpool	-3.19

NBS	NBS Name	EcoServR: CH0104: Carbon sequestration (tCO2e)
lac4	Urban catchment forestry	-0.13
lac5	shade trees	-0.45
lac6	cooling trees	-0.62
lac8	SuDs & Rain Garden	-0.83
lac12	Pollinator verges and spaces	
lac13	Pollinator walls/vertical	-0.04
lac14	Pollinator roofs	-0.01
lac16	Floating gardens	
lac17	Green filter area	-0.87

Pollinator walls/vertical	EcoServR: CH0104: Carbon sequestration (tCO2e)
L1 GW	-0.02
Parr St GW	-0.04

St Johns GW	-0.05

NBS	NBS Name	EcoServR: CH0104: Carbon sequestration (tCO2e)
lac4	Urban catchment forestry	-0.13
lac5	shade trees	-0.45
lac6	cooling trees	-0.62
lac17	Green filter area	-0.87

SuDs & Rain Garden	EcoServR: CH0104: Carbon sequestration (tCO2e)
Lower SuDS	-1.45
Upper SuDS	-0.21
Upper Pitt St RG	

GI-VAL results:

CH0104: Carbon sequestration: GI-VAL BENEFITS	Sub-Demo Areas			Overall Liverpool	BENEFIT QUANTIFICATION
Tools	A	B	C		
1.7 Carbon sequestered by trees	-5.73	-22.01	-4.02	-32.82	tCO2e sequestered
1.8 Carbon sequestered through other land use change	-4.35	-4.35	-20.13	-20.13	tCO2e sequestered

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The EcoServR model describes vegetation capture of CO_2 through photosynthesis and emission of CO_2 through respiration. The net balance of these processes results in sequestration (carbon sink: uptake over time) or emission (carbon source: release over time). Creating and maintaining natural sinks of carbon is important in tackling climate change. For the model, semi-natural habitats from the natural capital baseline are assigned a carbon sequestration value (tonnes of CO_2e per hectare per year) representing the amount of carbon that can be sequestered by this vegetation type. These values are averages taken from the scientific literature, and do not consider habitat condition, land management, or the specific soil type at the location. The models do not consider emissions from built-up areas. Note that the negative values and carbon sequestration, so are a positive benefit. Estimates were provided by grouping (inter_codes) but this leads to double-counting (as the same tree can be a shade tree and green filter tree etc). The "total" row was corrected for this (sum of carbon stored/sequestered in each physical intervention before aggregating them into their relevant group).

Using the EcoServR model, sub-demo C was found to sequester the most Carbon (-0.8 tCO2e), but overall Liverpool sowed the most impact (-3.2 tCO2e). Trees and SuDs were the most important interventions for this factor. All the green walls were also important.

A more detailed breakdown of the EcoServR results showed that the green walls were similar in their effect on carbon sequestration, but St Johns green wall showed the greatest effect (-0.05 tCO2e). Out of the tree interventions, the green filter area trees sequestered the most Carbon (-0.87 tCO2e) but cooling and shade trees were also important (-0.62 and -0.45 tCO2e respectively), followed by the Strand urban catchment trees (-0.13 tCO2e). Out of the SuDs, the Lower Suds were best at -1.45 tCO2e followed by the Upper Suds at -0.21 tCO2e).

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The Gi-Val model demonstrated also that most of the carbon sequestration was by trees, (-33 tCO2e for overall Liverpool) but also by other land use changes (-20 tCO2e for overall Liverpool). The most sequestration from the interventions was for Sub-demo B trees (-22 tCO2e) and for Sub-Demo C for other land use changes (-20 tCO2e).

Carbon was sequestered in all areas by all interventions.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
EcoServR: Semi-natural habitats from the natural capital baseline are assigned a carbon sequestration value (tonnes of CO2e per hectare per year) representing the amount of carbon that can be sequestered by this vegetation type. These values are averages taken from the scientific literature, and do not consider habitat condition, land management, or the specific soil type at the location. The models do not consider emissions from built-up areas. NOTE! Negative values are sequestration; positive values are emissions. The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model Awareness of limitations of model
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

For the GI-Val model, carbon sequestration could most easily be investigated for the difference between trees and grassland; however, we did not have a value for wildflowers so we had to make an assumption that it would be classed as 'improved grassland'.

Both models showed that all the interventions helped with carbon sequestration, particularly the planted trees. For the interventions over all Liverpool, it was calculated that 3.19 tonnes CO2e would be sequestered.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.3 CH0105 Temperature decrease

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0105	TEMPERATURE DECREASE	CFT
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc4, LAc5, LAc6, LAc13, LAc14, LAc15, LAc17	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Reveal Thermal Camera

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY									
CH0105: Temperature Decrease	**Pre-Intervention**				**Post-Intervention**				**% Change**
Area	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	
Overall Liverpool	35	15	1.2	3.2	186	50	4.7	3.8	274.6
Sub-Demo A	16	6	0.8	1.8	61	17	5.7	4.4	586.7
Sub-Demo B	19	9	1.6	4.0	125	33	4.2	3.3	160.8

QUANTITATIVE DATA SUMMARY										
CH0105: Temperature Decrease		**Pre-Intervention**				**Post-Intervention**				**% Change**
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9
LAc5	Shade_TREES					24	10	5.5	2.9	
LAc6	Cooling_TREES					43	18	7.2	4.4	
LAc8	Upper Pitt St RG					5	1	6.2	3.7	
LAc12	Baltic POLL					2	2	6.3	0.7	
LAc12	Cornwallis St POLL					1	1	9.0		
LAc12	Park Lane POLL					2	1	6.4	1.4	
LAc13	L1 GW					12	3	5.8	3.5	
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0	
LAc14	Royal Court GR					22	5	2.6	2.9	
LAc17	Lime St TREES					1	1	6.5		
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

For related intervention site names, please see table below:

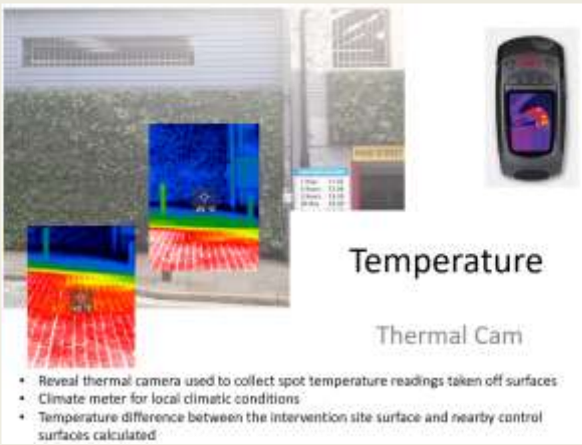
FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0105	TEMPERATURE DECREASE	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc4	Urban Catchment forestry		Strand Tree SuDS	
		LAc5	Shade trees	Shade_TREES	Shade_TREES	Shade_TREES
		LAc6	Cooling trees	Cooling_TREES	Cooling_TREES	
		LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW, L1GW	
		LAc14	Pollinator roofs		RoyaL Court GR	
		LAc15	Mobile gardens			
		LAc17	Green filter area with large urban trees		Green_Filter_TREES	

Map of monitoring locations (sub demo areas A and B): Urban catchment forestry, green filter area (Stafford Street), pollinator roof and vertical pollinator walls:

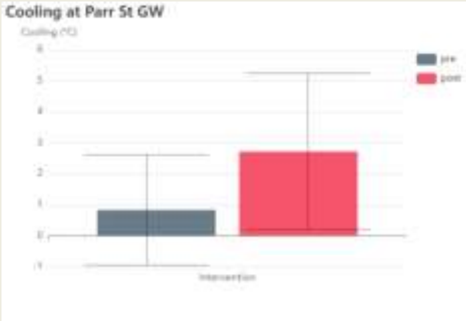
Map of monitoring locations (sub demo areas A and B): Cooling trees:

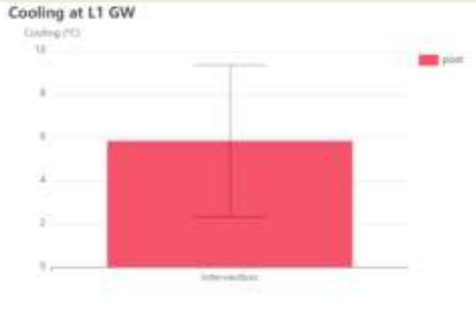
Map of monitoring locations (sub demo areas A and B): Shade trees:

Equipment and methodology:

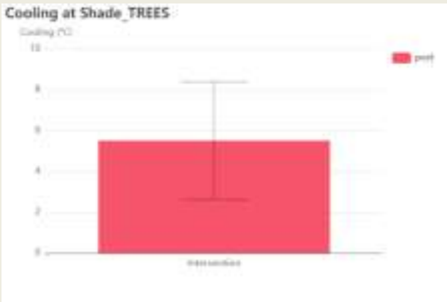


Summary plot example from Sub-Demos A and B: Pollinator vertical wall comparisons

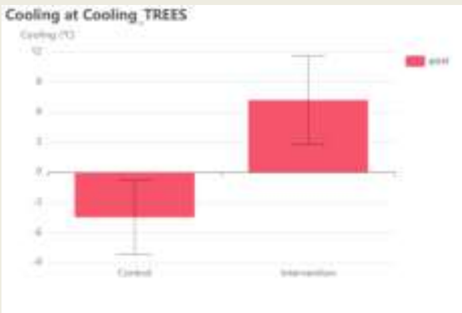




Summary plot example for intervention: Shade trees



Summary plot example for intervention: Cooling trees



The vertical pollinator or green wall comparison plots show that the Liverpool One green wall had the greatest cooling effect (approximately 6C compared to 3C for both the other green walls). Both Parr Street and St Johns's green walls face North-East and North-West respectively, so rarely get any Sun, sot this needs to be taken into account.

The comparison plot examples for shade and cooling trees show between 5.5-7.5C cooling effect. Cooling tree species seemed to show a slightly greater cooling effect. Consideration is needed for the lack of maturity of the trees and there were often difficulties getting an adequate control site and temperatures varied greatly with local climatic conditions and materials of the control site. Further comparisons would help to understand the data variability better.

The data comparison tables do not present a full picture due to the difficulties of pre-intervention monitoring, so the % Change in temperature reduction shows extremes such as for the urban catchment forest, Strand tree SuDs (a 71% increase in temperature with the intervention), bit the Parr Street green wall and Stafford Street trees (green filter area) showed a strong cooling effect. Due to the cooling effect from the many sites in the sub demo A, including the occasional monitoring of the pollinator and rain garden sites, sub demo A was found in the overall data summary to have the most important cooling effect of all the areas studied at 587%. Sub demo B was still important at 160%. Overall all the Liverpool interventions in sub demos A and B, there was found to be a 275% temperature decrease. So, a strong positive effect of the interventions.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
None	
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	

Environmental (including COVID)	How they have been addressed
None	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further future analyses investigating the influence of surface materials, sunlight, local and Liverpool climatic factors would be beneficial to fully understand the relative importance of the cooling effect.

All interventions observed created a cooling effect and hence temperature decrease. This is even although interventions such as the trees are still young immature trees without a full canopy and not all interventions face the Sun. Overall, the Liverpool sub demo A and B interventions generated a 275% temperature decrease.

What was the impact? (positive/negative, significant/non-significant)?

Positive.

1.2.4 CH0106 Temperature reduction (projected)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0106	TEMPERATURE REDUCTION (PROJECTED)	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: EcoServR, GI-VAL, Star

EcoServR results:

EcoServR: CH0106: Temperature reduction		
extent	**service**	**% Change**
Sub-demo A	Local.climate.regulation	1.7

Sub-demo B	Local.climate.regulation	10.1
Sub-demo C	Local.climate.regulation	0.5
Liverpool LA	Local.climate.regulation	0.0

EcoServR: CH0106: Temperature reduction		
NBS	**NBS Name**	**% Change**
lac4	Urban catchment forestry	24.2
lac5	shade trees	59.7
lac6	cooling trees	46.7
lac8	SuDs & Rain Garden	0.2
lac12	Pollinator verges and spaces	76.3
lac13	Pollinator walls/vertical	3.0
lac14	Pollinator roofs	
lac16	Floating gardens	0.0
lac17	Green filter area	44.7

EcoServR: CH0106: Temperature reduction			
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**
A	Baltic Hub POLL	20	
A	Baltic POLL	20	9.14
A	Cornwallis St POLL	20	
A	Pitt St POLL	20	
A	Strand POLL	20	226.44

A	Wapping POLL	20	0.02
C	Bott SP Aig Dr POLL	20	
C	Lower SuDS POLL	20	2.21
C	Park Lane POLL	20	
C	Princes Av POLL	20	
C	Princes roundabt POLL	20	
C	Top SP Aig Dr POLL	20	
C	Ullet Rd POLL	20	455.33
C	Upper SuDS POLL	20	-1.86
A	Baltic Hub POLL	100	
A	Baltic POLL	100	6.75
A	Cornwallis St POLL	100	
A	Pitt St POLL	100	
A	Strand POLL	100	21.77
A	Wapping POLL	100	0.79
C	Bott SP Aig Dr POLL	100	0.00
C	Lower SuDS POLL	100	2.15
C	Park Lane POLL	100	
C	Princes Av POLL	100	0.00
C	Princes roundabt POLL	100	0.00
C	Top SP Aig Dr POLL	100	485.13
C	Ullet Rd POLL	100	14.93
C	Upper SuDS POLL	100	-1.71

EcoServR: CH0106: Temperature reduction		
SuDs & Rain Garden	**radius (m)**	**% Change**
Upper Pitt St RG	20	
Upper SuDS	20	-1.90
Lower SuDS	20	2.28
Upper Pitt St RG	100	
Upper SuDS	100	-1.77
Lower SuDS	100	2.18

EcoServR: CH0106: Temperature reduction		
NBS Name	**radius (m)**	**% Change**
shade trees	20	109.98
cooling trees	20	
Green filter area	20	
shade trees	100	9.36
cooling trees	100	46.66
Green filter area	100	44.67

EcoServR: CH0106: Temperature reduction		
Pollinator walls/vertical	**radius (m)**	**% Change**
L1 GW	20	5.30
Parr St GW	20	

St Johns GW	20	
L1 GW	100	0.72
Parr St GW	100	
St Johns GW	100	

EcoServR: CH0106: Temperature reduction		
Floating gardens	**radius (m)**	**% Change**
SPL FI	20	0.00
Wapping FI	20	0.00
SPL FI	100	0.06
Wapping FI	100	0.01

GI-VAL results:

CH0106: Temperature reduction	**GI-VAL BENEFITS**	**Sub-Demo Areas**			**Overall Liverpool**	**BENEFIT QUANTIFICATION**
Functions	**Tools**	**A**	**B**	**C**		
Shelter from wind	1.1 Reduced building energy consumption for heating	37200.00	0.00	0.00	0.00	kWh/yr energy saved
Shelter from wind	1.2 Avoided carbon emissions from building energy saving for heating	6861.54	0.00	0.00	0.00	kgCO2/yr not emitted
Shelter from wind	1.3 Avoided damage from wind and storms	n.a.	n.a.	n.a.	n.a.	

Reduction of urban heat island effect	1.4 Reduced peak summer surface temperatures	0.02	0.15	0.01	0.00	°C in surf. temperature reduction
Cooling through shading and evapo-transpiration	1.5 Reduced building energy consumption for cooling	326.70	1035.42	0.00	1362.12	kWh/yr energy saved
Cooling through shading and evapo-transpiration	1.6 Avoided carbon emissions from building energy saving for cooling	163.46	518.07	0.00	681.53	kgCO2 not emitted

Star tool results:

Maximum surface temperatures (°C) under Temperature scenario: 2050s High temperature - 50% probability level	
Average decrease across all interventions	**STAR calculation**
Overall Liverpool	0.49
Sub Demo A	0.43
Sub Demo B	0.63
Sub Demo C	0.28

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

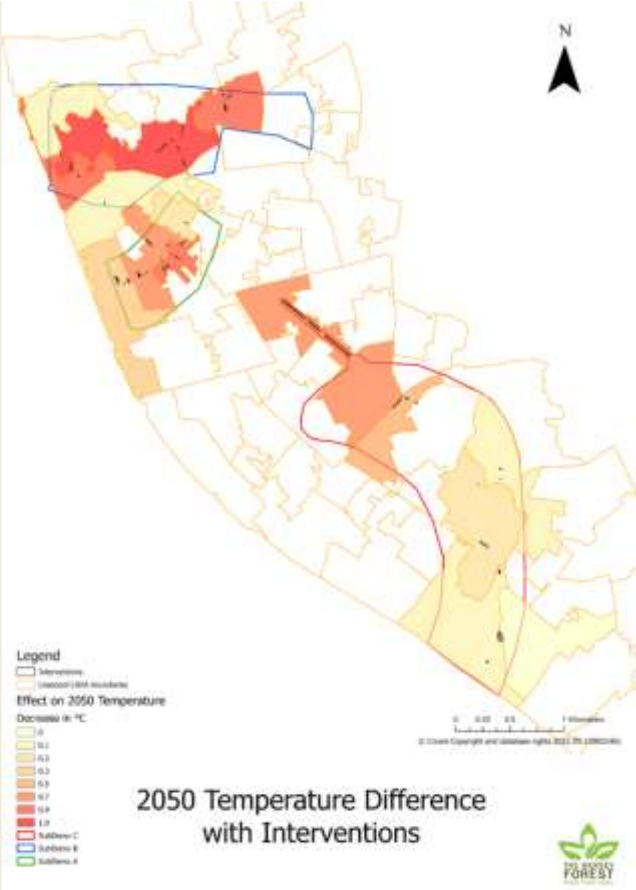
The various models assessed the interventions in various ways.

The EcoServR model described landscape features which provide shade or can absorb heat to help in local climate regulation. Relative scores (0-100) were assigned to habitat types from the natural capital baseline based on their relative capacity to cool down their surroundings. Areas with trees (shade) and bodies of water are especially good at this. Because the benefits that a habitat provides may be felt a certain distance away from the habitat itself, focal statistics sum the scores at a local (300 m) range. Because smaller patches will have less of an impact on their surroundings than large patches, a series of buffers are then used as masks to constrain the cooling scores around the features that provide them (< 2 ha: 20 m | 2-5 ha: 40 m | 5-10 ha: 80 m | > 10 ha: 100 m). Raw units do not represent a biophysical value. A rescaled (0-100) version is provided where 100 is the highest capacity in the area mapped.

The GI-VAL model assessed this factor by analysing the vegetation in various ways. These included shelter from the wind and the associated reduced energy consumption and emissions from heating needs, reduction of the urban heat island effect on surface temperatures and cooling through shade and evapotranspiration (with the associated reduced energy consumption and emissions with respect to the cooling needs). The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

STAR tools allow users to assess the potential of green infrastructure in adapting their areas to climate change. Within the Star too, The surface temperature tool will give the average maximum surface temperature for the study area(s) of interest. Depending on the temperature scenarios selected and whether the tool is run for different land cover scenarios there will be a number of maximum surface temperatures provided. STAR tools can be used at a neighbourhood scale to test the impact of different land cover scenarios of greening and development on surface temperatures, under different temperature scenarios.

In the figure generated by the Star tool, the darker colours correspond with the greatest decrease in degrees Celsius.



The EcoServR model demonstrated that all interventions had a cooling effect, with those in sub-demo B at 10% the most important overall, but negligible for overall Liverpool. Pollinator verges and spaces (76%) were most important, together with trees, but green walls and the SuDs were not shown to be so important. EcoServR, though, does not take SuDs and drainage systems into account and heavily penalises loss of woodland, so scored the Upper SuDs site as negative*.

From a more detailed breakdown of the interventions in terms of pollinator verges, EcoServR showed the pollinator planting on the Strand (Strand POLL) had a very important cooling effect particularly at 20m rather than 100m radius (226% and 22% respectively). Also, the pollinator pillars (Baltic POLL) had a greater cooling effect at a 20m radius than at 100m radius (9 and 7% cooling respectively). The majority of the pollinator verge sites had a better cooling effect in close proximity (20m) than at 100m, as demonstrated by the Ullet road site (Ullet Rd POLL) (455% and 15% at 20m and 100m respectively), except for the Wapping pollinator site which had a greater effect at 100m (0.02% at 20m and 0.79% at 100m radius). The top of Aigburth Drive at the top of Sefton Park (Top SP Aig Dr POLL showed a large change in cooling at 100m, so the combined effect on the nearby Ullet Rd site may have caused this beneficial joint effect.

Other comparisons between interventions at different radii for EcoServR showed the lower SuDs to have a more cooling effect than the Upper Suds. This is due to the bias by the model*. In addition, shade trees had an important cooling effect of 110% at 20m in contrast to 9% at 100m. Cooling trees and green filter trees provided a cooling effect at 100m (47% and 45% respectively). So, trees had an important cooling effect. The Liverpool One green wall (L1 GW) had a better cooling effect at close range too (5% at 20m to 1% at 100m). Although, the floating gardens had a better cooling effect at 100m (0.06% for Sefton Park and 0.01% for Wapping Dock)

From the GI-VAL results, the sub-demo A interventions were found to be most important in reducing building energy consumption for heating (e.g. 37200 KWh/yr energy saved), but those in sub demo B were the best at reducing the building costs for cooling (e.g. 1035KWh/yr energy saved). Sub demo B interventions were also found the best in reducing the urban heat island effect (0.25C temperature reduction) in comparison to sub demos A and C (0.02 and 0.01C respectively). Overall Liverpool showed negligible results for this factor.

The Star tool analyses showed that Sub-demo B interventions would have the most important future effect on temperature reduction (a Star value of 0.63% as compared to the average value overall of 0.49), followed by sub demo A (0.43%), then sub demo C (0.28%). The overall Liverpool calculation was for 0.49% temperature reduction.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
EcoservR: Relative scores (0-100) are assigned to habitat types from the natural capital baseline based on their relative capacity to cool down their surroundings. Areas with trees (shade) and bodies of water are especially good at this. Because the benefits that a habitat provides may be felt a certain distance away from the habitat itself, focal statistics sum the scores at a local (300	Awareness of limitations of model

m) range. Because smaller patches will have less of an impact on their surroundings than large patches, a series of buffers are then used as masks to constrain the cooling scores around the features that provide them (< 2 ha: 20 m | 2-5 ha: 40 m | 5-10 ha: 80 m | > 10 ha: 100 m). Raw units do not represent a biophysical value. A rescaled (0-100) version is provided where 100 is the highest capacity in the area mapped. *EcoServR does not take drainage systems or SuDs into account. The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes, all interventions scored well for cooling (except for SuDs drainage* in EcoServR). Sub-demo B interventions were the best at reducing the urban heat island effect and future probable temperature reduction scenarios. Pollinator verges and trees were found to be the most effective at temperature reduction particularly within 20m radius.

What was the impact? (positive/negative, significant/non-significant)?

Positive for all models

1.2.5 CH0108 Heatwave risk

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0108	HEATWAVE RISK	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

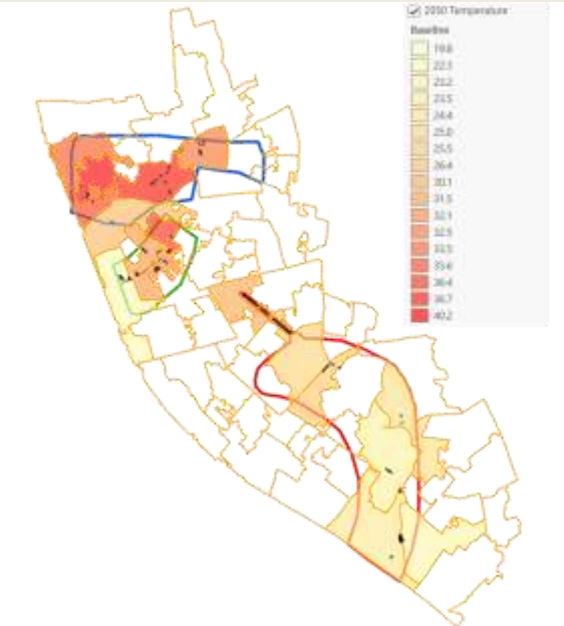
Table of results (summary, from Task 5.4)

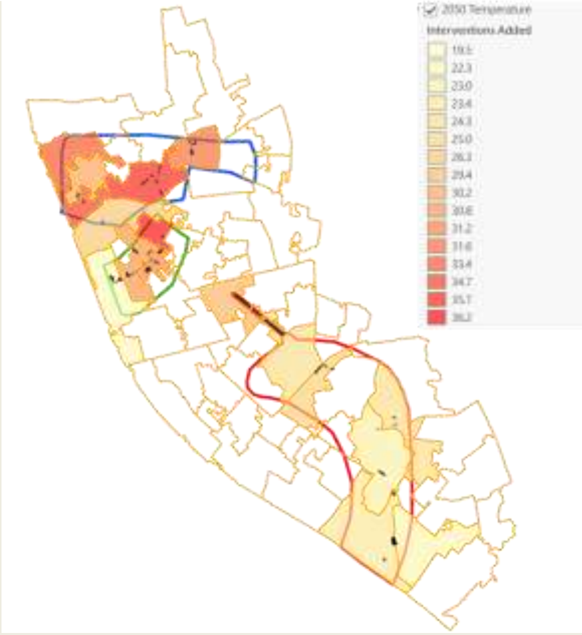
MODELLING: Star

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

STAR tools can be used at a neighbourhood scale to test the impact of different land cover scenarios of greening and development on surface temperatures and runoff, under different temperature and precipitation scenarios.

2050 Maximum Surface Temperature Results from STAR Tools: Pre and post interventions effects are shown together with the sub demo areas and intervention locations:





For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The Star tool could not include actual numbers of days with an associated heatwave risk, so the results are only per neighbourhood and not on a fine scale.	Awareness of limitations of model.
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	

Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Areas with less GI are at a greater risk of heatwave; thus, it is essential to add GI interventions to areas of impervious (non-GI) surfaces. This is shown form the figures for the most urban area in Liverpool studied (sub demo B) when the interventions are added to the model analyses. So, a slight positive impact was viewed even at this coarse scale.

What was the impact? (positive/negative, significant/non-significant)?
Positive

1.2.6 CH0111 Species movement

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0111	SPECIES MOVEMENT	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

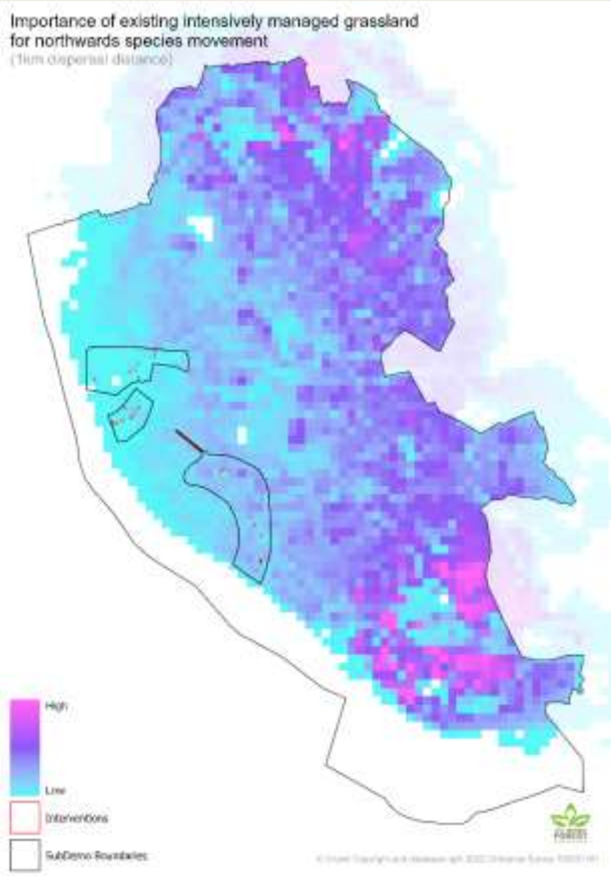
Table of results (summary, from Task 5.4)
MODELLING: Condatis Ecological Networks: Attempted but inconclusive (see notes 'UGU model notes') No data downloads except for raster images were possible for the Condatis model.

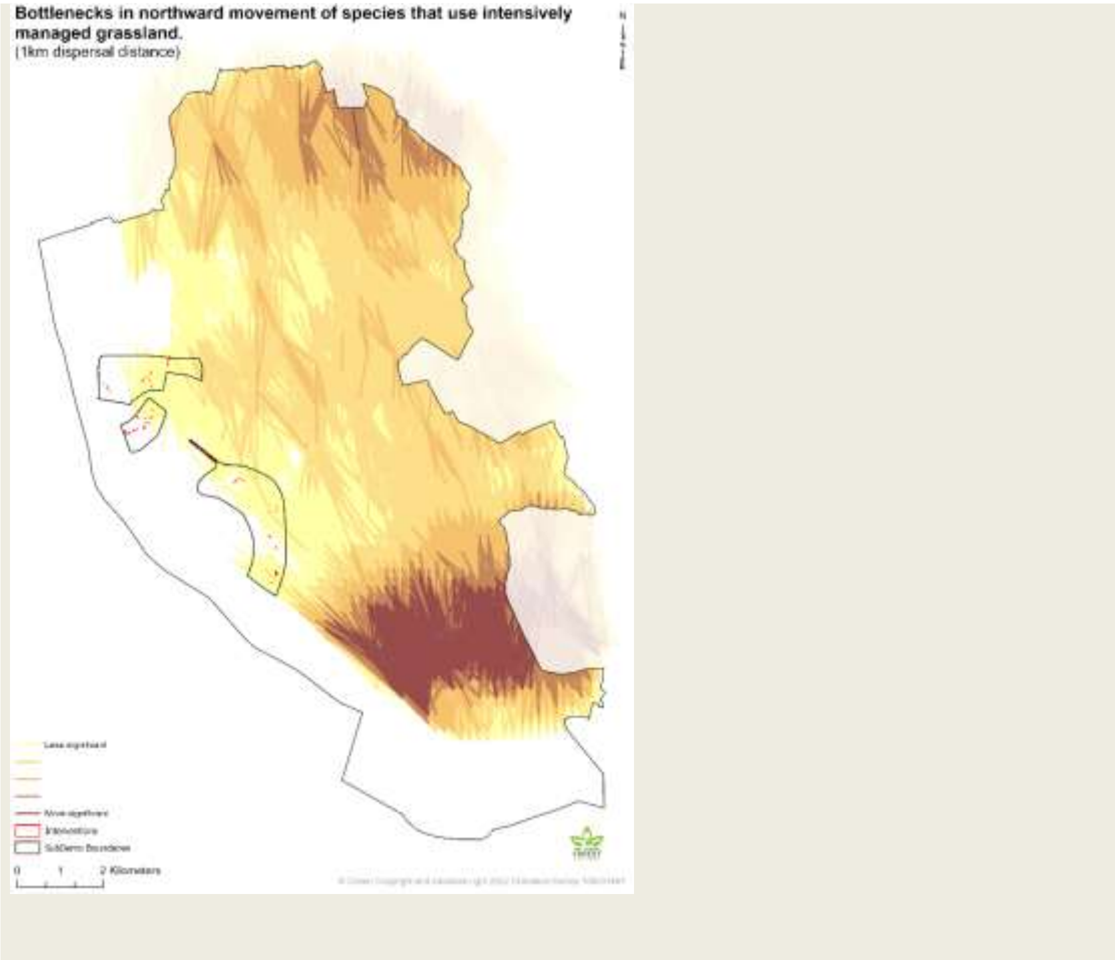
Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

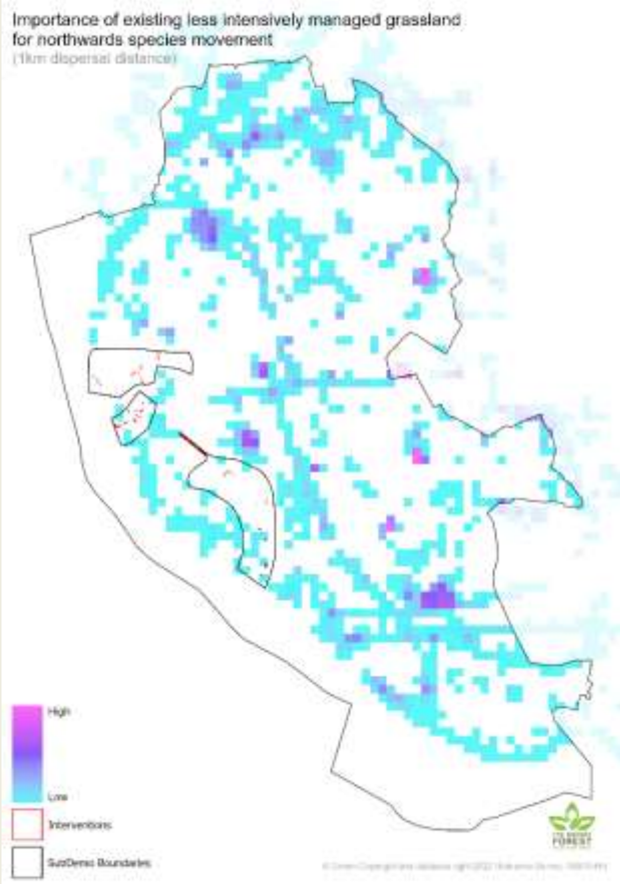
Condatis considers a landscape as analogous to a circuit board, with a source population of species being considered the voltage, the links between habitat useable by these species being the resistors, and the flow of species colonising the available habitat across those links being considered the current.

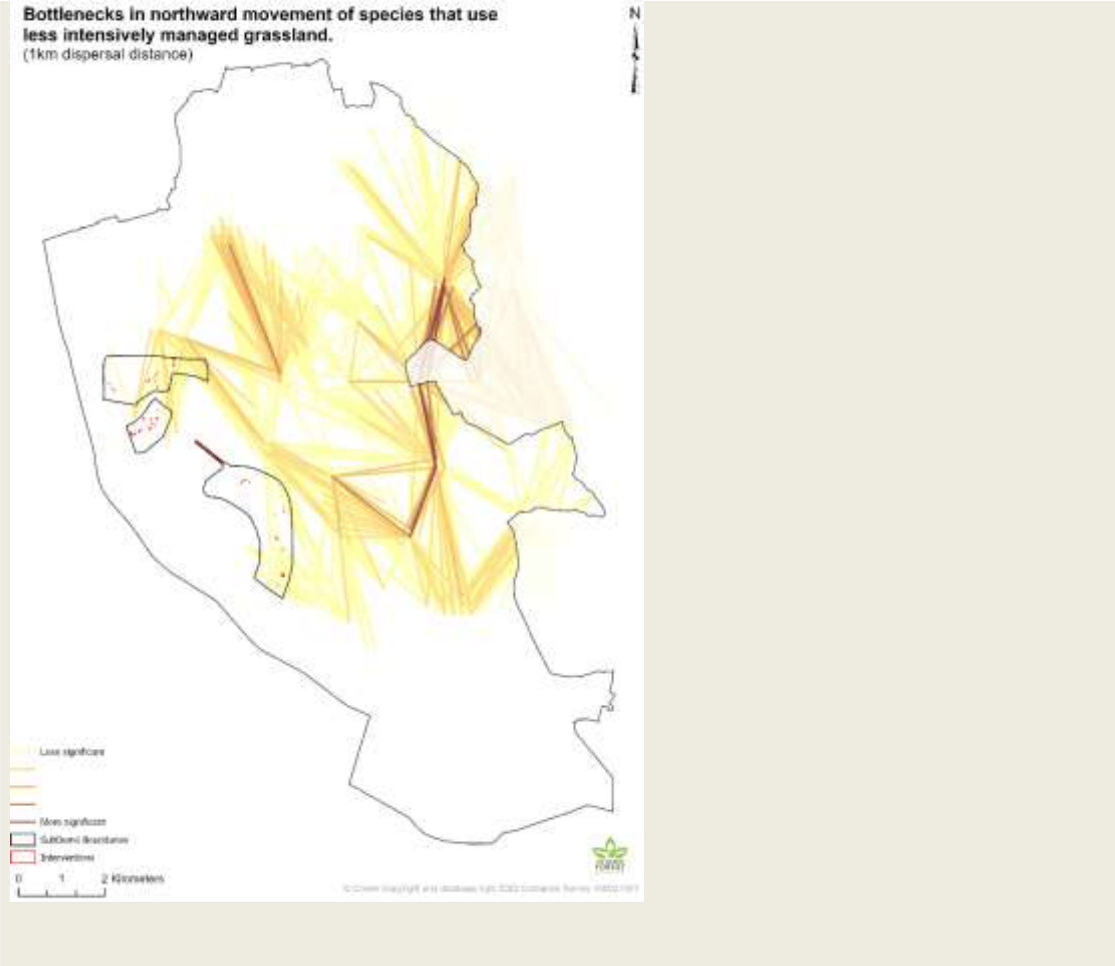
Thus, the bottlenecks and flow maps around Liverpool represent areas where habitat is suitable for the source population of species. This will tell us how species move around the city centre and which habitats are of high importance.

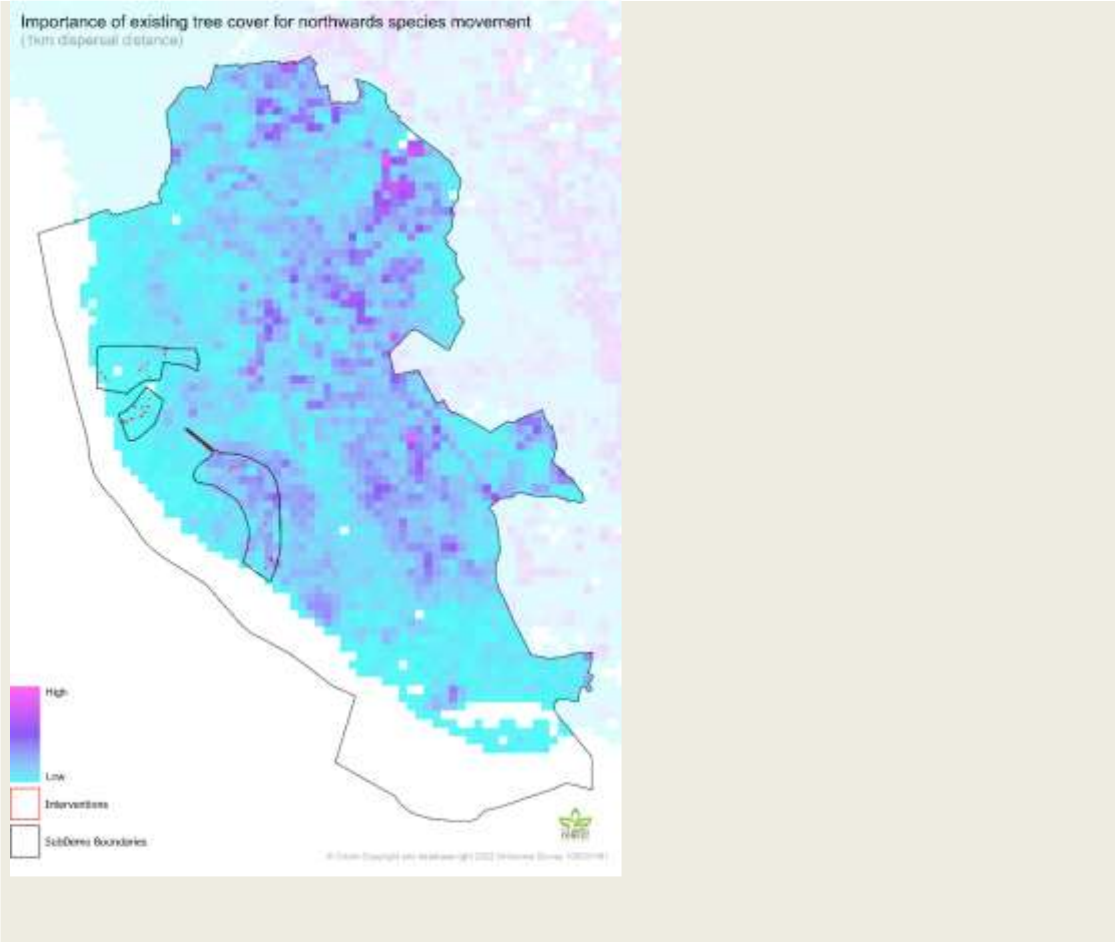
Summary figures shown for intensively managed grassland, less intensively managed grassland and species requiring tree cover:

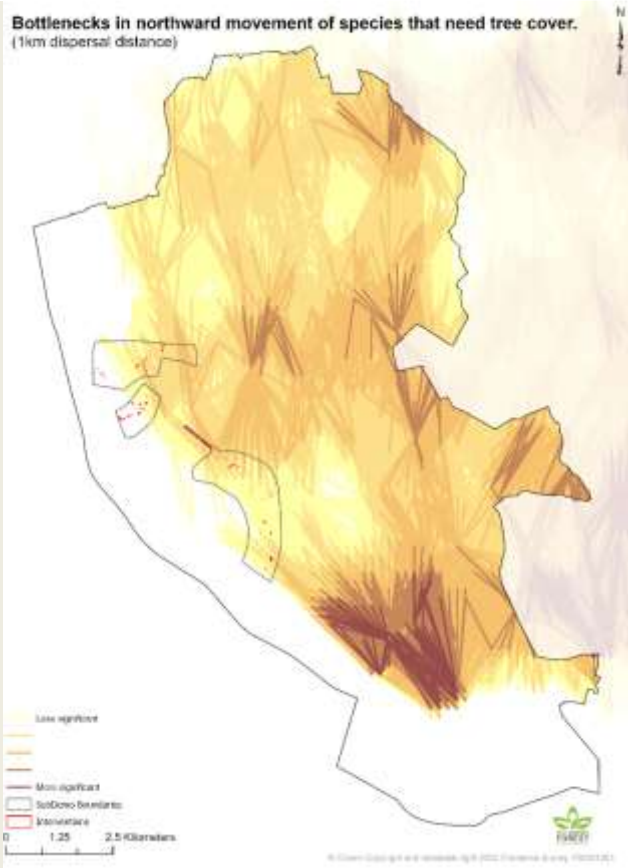



Bottlenecks in northward movement of species that use intensively managed grassland.
(1km dispersal distance)
0 1 2 Kilometers


Importance of existing less intensively managed grassland for northwards species movement
(1km dispersal distance)
High
Low
Interventions
SubDemo Boundaries


Bottlenecks in northward movement of species that use less intensively managed grassland.
(1km dispersal distance)
N
0
1
2


Importance of existing tree cover for northwards species movement
(1km dispersal distance)
High
Low
Interventions



From the figures above, it is impossible to decipher at this scale if the introduction of the interventions would be able to influence species movement. So, the effect was found to be inconclusive.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Ecological Network modelling software was found to produce inconclusive results for the scale of interventions. The models use a minimum patch source size (typically 0.1ha) and a functional threshold (size below which a portion of network is considered	Awareness of limitations of models

ineffective). Even when the latter was reduced from 1ha to 0.001 ha, the results were still inconclusive. Condatis is a coarse landscape tool so was not detailed enough for the interventions.	
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Due the scale at which the model operated, it was impossible to tell if any species movement opportunities were created by the introduction of the interventions.
What was the impact? (positive/negative, significant/non-significant)?
Inconclusive

1.2.7 CH0201 Run-off coefficient

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0201	RUN-OFF COEFFICIENT	CFT
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

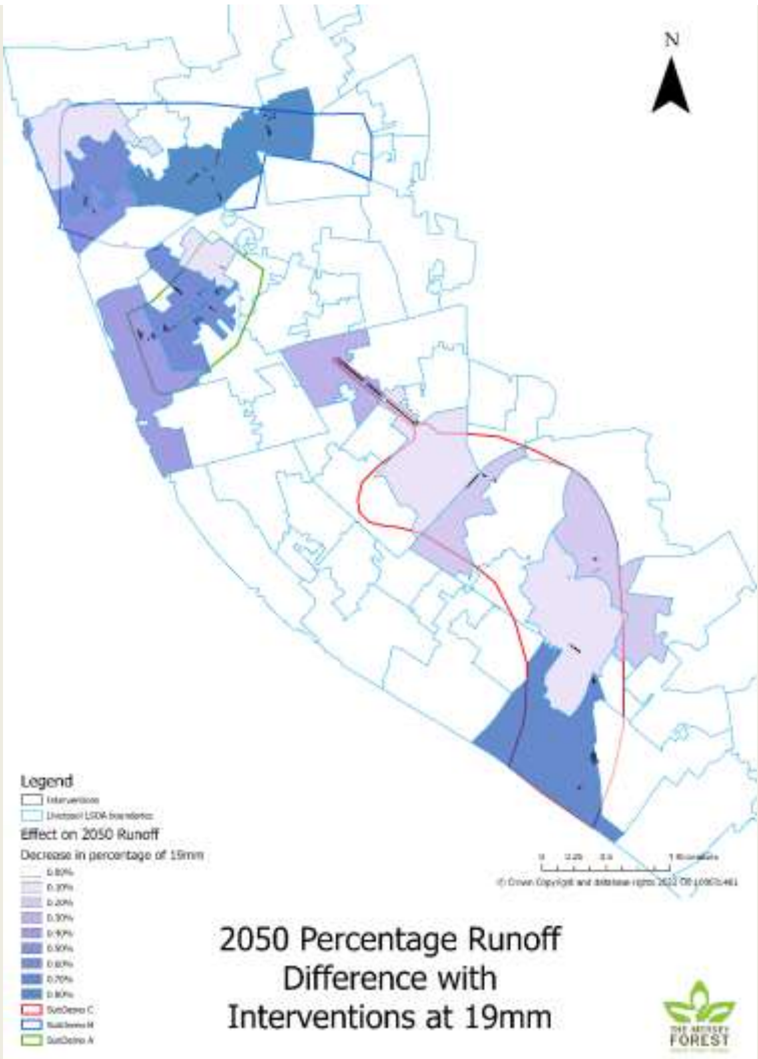
MODELLING: Star

Star tool results:

Surface runoff percentages under the precipitation scenario: 2050s High precipitation - 50% probability level	
Average decrease across all interventions	**STAR calculation**
Overall Liverpool	0.36
Sub Demo A	0.43
Sub Demo B	0.56
Sub Demo C	0.27

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

STAR tools allow users to assess the potential of green infrastructure in adapting their areas to climate change. The surface runoff tool will give the percentage and volume of surface runoff for the study area(s) of interest. This output is available for daily precipitation depths of 0-100mm. You can choose to highlight selected precipitation scenarios and to run the tool for different land cover scenarios. STAR tools can be used at a neighbourhood scale to test the impact of different land cover scenarios of greening and development on surface runoff, under different precipitation scenarios. For these analyses, the study areas were set as the LSOAs as the smallest area possible to represent the interventions. The mm in STAR tools is set to 19mm and then the percentage is representing the amount of decrease in runoff for 19mm. So, the darker colours in the maps represent the greatest decrease in runoff at 19mm.



From the figure, greater decreases in surface water runoff can be found at the Otterspool Woods end of Sub demo C, throughout sub demos A and B. For sub demo B, it can be assumed that the percentage run off was changed particularly with the addition of trees, permeable paving, and tree SuDs. In sub demo A, the rain garden and planting areas were important. Then in sub demo C, the Upper and Lower SuDs water retention ponds were most important. A more detailed breakdown for each intervention is not possible for this tool.

From the data summary, the highest reduction in surface runoff was achieved under the Star scenarios in sub demo B (0.56%), followed by sub demo A (0.36%) then sub demo C (0.27%). The overall average reduction for Liverpool was calculated at 0.36%. So overall positive effects of the interventions were observed.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
n/a	
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The Star tool analyses demonstrated overall slight decreases in surface runoff for all areas, in particular in sub demo B. It was assumed that the interventions specifically designed for this had the most impact, but other interventions may have had an added effect.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.8 CH0204 Water slowed down from sewer system

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	CFT

CITY	*RELATED NBS*
LIV	LAc4, LAc8

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: EcoServR

QUANTITATIVE: Detectronic flow meter data (see in CH0211). Also refer to soilmania sensor data

EcoServR: Assumptions on habitat codes for the UGU interventions

Intervention type	**Code**	**Description**	**Notes**
Shade trees Cooling trees Green filter trees	A13	Mixed woodland	No code for trees outside woodland; assuming mixed to average out differences between coniferous and broadleaved trees
Orchard	A112o	Orchard	
Pollinator planting	J55	Brownfield/garden/park	
SuDS ponds	G1	Standing water	
Green roof	GR	Green roof	Added to EcoservR for UGU (limited evidence base)
Green wall	GW	Green wall	Added to EcoservR for UGU (limited evidence base)
Floating island	FI	Floating island	Added to EcoservR for UGU (limited evidence base)
Smart pollinator pillars	POLL	Pollinator baskets	Added to EcoservR for UGU (limited evidence base)

EcoServR results:

EcoServR: CH0204: Water slowed down		% Change
sub demo A	Flood.risk.mitigation	0.10
sub demo B	Flood.risk.mitigation	0.08
sub demo C	Flood.risk.mitigation	-0.07
Overall Liverpool	Flood.risk.mitigation	0.01

EcoServR: CH0204: Water slowed down		
NBS	**NBS Name**	**% Change**
lac4	Urban catchment forestry	0.0
lac5	shade trees	1.0
lac6	cooling trees	2.3
lac8	SuDs & Rain Garden	-10.2
lac12	Pollinator verges and spaces	11.2
lac13	Pollinator walls/vertical	-1.0
lac14	Pollinator roofs	0.0
lac16	Floating gardens	7.3
lac17	Green filter area	1.5

EcoServR: CH0204: Water slowed down		
Floating gardens	**radius (m)**	**% Change**
SPL FI	20	0.0
Wapping FI	20	
SPL FI	100	0.0
Wapping FI	100	22.0

EcoServR: CH0204: Water slowed down		
SuDs & Rain Garden	**radius (m)**	**% Change**
Upper Pitt St RG	20	0.0
Upper SuDS	20	-31.0
Lower SuDS	20	-24.3

Upper Pitt St RG	100	0.0
Upper SuDS	100	-2.7
Lower SuDS	100	-3.1

	EcoServR: CH0204: Water slowed down		
NBS	**NBS Name**	**radius (m)**	**% Change**
lac4	Urban catchment forestry	20	
lac5	shade trees	20	1.7
lac6	cooling trees	20	4.4
lac17	Green filter area	20	2.6
lac4	Urban catchment forestry	100	0
lac5	shade trees	100	0.2
lac6	cooling trees	100	0.1
lac17	Green filter area	100	0.4

EcoServR: CH0204: Water slowed down		
Pollinator walls/vertical	**radius (m)**	**% Change**
L1 GW	20	-2.6
Parr St GW	20	
St Johns GW	20	
L1 GW	100	-0.4
Parr St GW	100	0.0
St Johns GW	100	

	EcoServR: CH0204: Water slowed down		
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**
A	Baltic Hub POLL	20	-11.5
A	Baltic POLL	20	-2.2
A	Cornwallis St POLL	20	6.9
A	Park Lane POLL	20	-3.8
A	Pitt St POLL	20	-0.4

A	Strand POLL	20	-4.5
A	Wapping POLL	20	67.1
C	Bott SP Aig Dr POLL	20	5.6
C	Lower SuDS POLL	20	-15.6
C	Princes Av POLL	20	156.2
C	Princes roundabt POLL	20	100.0
C	Top SP Aig Dr POLL	20	0.0
C	Ullet Rd POLL	20	17.4
C	Upper SuDS POLL	20	-24.5
A	Baltic Hub POLL	100	-3.6
A	Baltic POLL	100	0.5
A	Cornwallis St POLL	100	2.7
A	Park Lane POLL	100	-0.5
A	Pitt St POLL	100	0.6
A	Strand POLL	100	-2.1
A	Wapping POLL	100	10.7
C	Bott SP Aig Dr POLL	100	0.7
C	Lower SuDS POLL	100	-2.7
C	Princes Av POLL	100	11.5
C	Princes roundabt POLL	100	4.4
C	Top SP Aig Dr POLL	100	0.9
C	Ullet Rd POLL	100	1.0
C	Upper SuDS POLL	100	-2.4

Quantitative monitoring data results:

Ongoing discussion with water experts so expected soon.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The EcoServR model described the flood risk mitigation in the following way to assess the effect of natural habitats to slow the flow of water and alleviate the risk of flooding downstream. The capacity of the landscape to slow down water flow was measured by considering two indicators. First, vegetation roughness was mapped by assigning Manning's Roughness Coefficient to habitats in the baseline. Denser, more complex vegetation structures were better at retaining water. Second, slopes were calculated from a digital elevation model and assigned relative scores, with flatter profiles scoring higher and steeper slopes scoring lower in their ability to slow water. The two indicators were combined (multiplied) to produce the final supply map. Patches smaller than 500 m2 were removed as they are unlikely to provide the service to any meaningful extent. The model does not consider urban drainage systems or built defences. Raw units do not represent a biophysical value. A rescaled (0-100) version was provided where 100 is the highest capacity in the area mapped. The map is a bird's eye view and doesn't allow for features to pile up. For instance the L1 green wall is linked to a loss of amenity grassland and therefore shows a loss in flood mitigation.

The EcoServR model showed a positive impact overall for the impact of the interventions for all areas, except a slight decrease for sub demo C* (-0.07%). Sub demo A showed the best mitigation (0.10%), followed by sub demo B (0.08%). Overall, for the extent of Liverpool, the flood risk reduction due to Urban GreenUP was calculated as 0.01%.

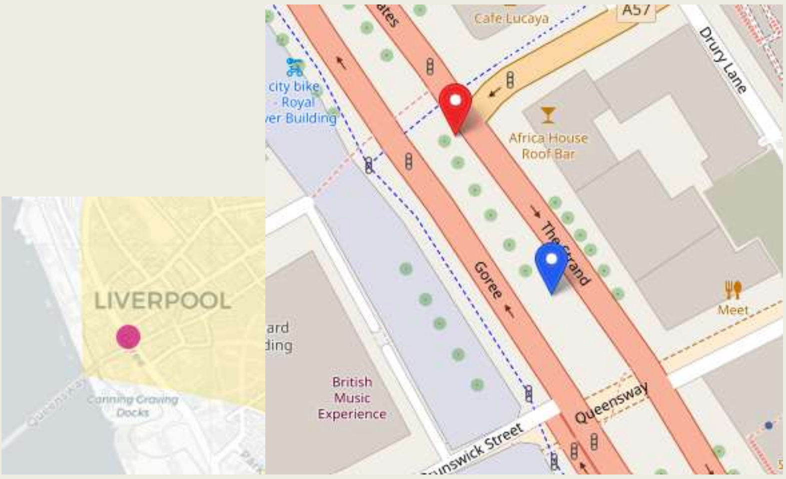
From the breakdown of the interventions, pollinator verges and spaces were the most important at 11.2% reduction, followed by floating gardens (7.3%), then the tree-based interventions, cooling trees, shade trees and green filter area (2.3%, 1.0% and 1.5% respectively); the urban catchment forestry and pollinator roofs showed a negligible change. The pollinator walls (-1.0%) and Suds and rain garden (-10.2%) showed a negative change, possibly due to the constrictions of the model*.

A further detailed look at the interventions demonstrated the following EcoServR generated results at a 20m and 100m radius of influence. The Wapping Dock floating island showed a high influence of 22% at 100m radius, but the Sefton Park island showed negligible results. For the SuDs and rain garden category, the rain garden showed negligible results with both the Suds showing negative effects. These results are all possibly due to the model limitations*. For the tree-based interventions, the cooling tree species had the best impact at close proximity (4.4% at 20m, 0.1% at 100m), followed by the green filter trees (2.6% at 20m, 0.4% at 100m) and shade trees (1.7% at 20m, 0.2% at 100m). The green walls could not always be calculated, but the Liverpool One green wall showed a negative change, but this would be due to the model limitations, as explained*. From the pollinator verge site breakdown, some negative changes were within the output*, but the best reductions in flood mitigation were for the larger sites, such as Princes Av POLL (156% at 20m, 12% at 100m), Princes roundabout POLL (100% at 20m, 4% at 100m), Wapping POLL (67% at 20m, 11% at 100m). The pollinator verge sites also generally showed better flood risk mitigation at closer proximities.

For related intervention site names used in the quantitative data, please see table below:

FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	LAc4	Urban Catchment forestry		Strand Tree SuDS	
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		

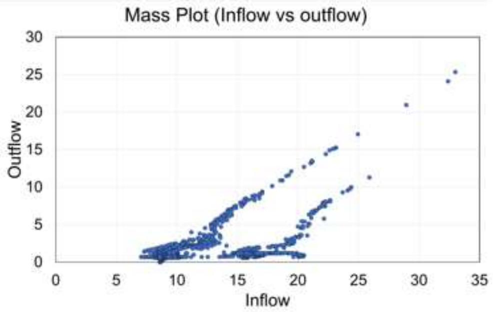
Map of monitoring locations: Sub Demo B: Strand tree SuDS (Urban Catchment Forestry)



Map of monitoring locations: Sub demo A Baltic Rain Garden

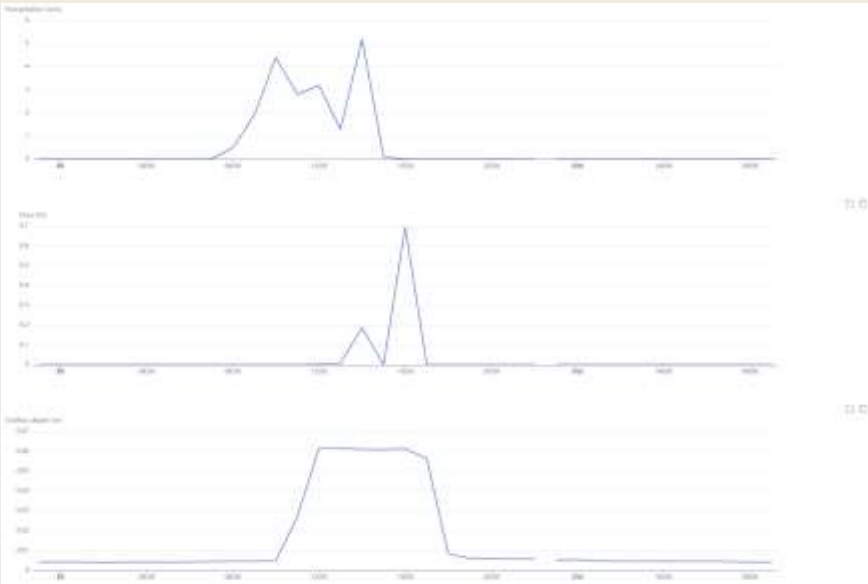
Equipment and methodology: Detectronic flow meter sensors

Summary plot example: Strand: inflow vs outflow



Summary plot example: Strand: example of rainfall event (2/11/22 at 15:00): Precipitation data are from the University of Liverpool campus a short distance away; the Level data are from the flow meter data at the inflow entry point for the tree SuDs or urban catchment forestry on the Strand; the Depth data are from the outflow exit point of the line of tree SuDs. Soil moisture data were from both the first and last trees in the line.

Summary plot example: Baltic rain garden: example of rainfall event (29/09/22 at 10:00): Precipitation data are from the University of Liverpool campus a short distance away; all the flow meter points (flow, depth and velocity) are taken at a point at the outflow section of the rain garden; the soil moisture data are from bed 1 (uppermost part), bed 2 (middle section) and bed 3 (lowest section).



For the quantitative data, data from the flow meters on the Strand were intermittent due to problems caused by silt build-up, so rainfall events were targeted for data analysis and an idea of the performance of the SuDs. The Baltic rain garden had a flow meter only at one point, so a calculation of water slowed may be impossible at this site. Ongoing discussions with water experts may provide further insights.

From the figures above, the Strand inflow vs outflow chart indicates a slowing of the water speed throughout the tree SuDs line. In addition, hydrograph plots (see plot example above) of the rainfall events, the level inflow and depth outflow indicate the water slowing through the SuDs system due to the later peaks of water depth showing a time lag.

The Baltic rain garden (Upper Pitt St RG) demonstrated that after a certain amount of water entering the system, that a discharge with a peak flow and velocity occurred (see example above).

For both the Strand and Baltic systems, the soil moisture meters (provided by Soil Mania and Myerscough College) provided information on the saturation of the soil. This would be expected to highlight where the trees or rain garden reach the limit of water absorption and start to release the water from the system. From the rain garden example plot above, it can be see that bed 3 (the lowermost bed in the rain garden) showed a peak in soil moisture at the time of the discharge of water from the raingarden, when the flow and velocity were also measured by the Detectronic flow meter.

Overall from the indications from the quantitative data and the modelled data, reduction in flood risk and water speeds were observed, so a positive change is seen for this KPI.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Sensor issues due to silt buildup	Being resolved
*EcoServR is a spatial landscape tool, so doesn't allow for features to pile up. For instance, the L1 green wall is linked to a loss of amenity grassland and therefore shows a loss in flood mitigation. In addition, the models cannot consider SuDs and drainage systems and will penalize loss of woodland excessively.	Awareness of limitations of tool.
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of tool.

Economical barriers	How they have been addressed

None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
None	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The data were compared with other data such as precipitation and soil moisture data (see Hydrographs). Further analyses investigating the influence of these factors would be beneficial to fully understand the relative importance of the effect on slowing of the water.

Water Flow: NBS & Comparative Data Sources

KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS	OTHER COMPARATIVE DATA SOURCES		
WATER SLOWED DOWN FROM SEWER SYSTEM	LAc4	Urban Catchment forestry	Strand Tree SuDS	Detectronic Flow meter	Soilmania	Precipitation
WATER REMOVED FROM THE WATER TREATMENT	LAc4	Urban Catchment forestry	Strand Tree SuDS	Detectronic Flow meter	Soilmania	Precipitation

Ongoing discussions with water experts are hoped to determine more precise results for this KPI.

EcoServR model results are limited due to lack of consideration of drainage systems and SuDs, so not very meaningful in this instance, but overall, there were positive benefits show for flood risk mitigation.

Overall from the indications from the quantitative data and the modelled data, reduction in flood risk and water speeds were observed, so a positive change is seen for this KPI.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.9 CH0207 Nutrient abatement (COD)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0207	NUTRIENT ABATEMENT (COD)	CFT
CITY	*RELATED NBS*	
LIV	LAc4, LAc8, LAc16	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: DSS YSI Water Probe, Nutrient analyses, Metal analyses, Water quality assessments of Wapping Dock

Also refer to soilmania sensor data in CH0211

Quantitative monitoring data results (selection):

QUANTITATIVE DATA SUMMARY					
CH0207 Water % Change	**Specific conductivity**	**Dissolved Oxygen**	**Combined Nitrogen**	**Phosphate**	**all metals**
Overall Liverpool	15.7	6.8	21.8	217.8	984.3
Sub-Demo A		-17.6			
Sub-Demo B	57.8	26.2	90.0	510.0	-16.5
Sub-Demo C	7.9	-8.1	-18.0	93.6	7353.5

QUANTITATIVE DATA SUMMARY					
Nutrients in solution					
CH0207 Water % Change	**Overall Liverpool**	**Sub-Demo A**	**Sub-Demo B**	**Sub-Demo C**	
Ammonium (N-NH4)	-7.2		19.2	-8.3	
Nitrite (N-NO2)	-49.2		-64.7	-23.2	
Nitrate (N-NO3)	51		251.5	-36.2	
Phosphate (SRP)	217.8		510	93.6	

QUANTITATIVE DATA SUMMARY
Metals in solution

CH0207 Water % Change	Overall Liverpool	Sub-Demo A	Sub-Demo B	Sub-Demo C
Arsenic	4709.2		118.8	55830.7
Cadmium	0		0	0
Chromium	-29		-40.5	-26.3
Cobalt	3252.5		-7.7	0
Copper	148.4		-17.4	851.1
Iron	62.1		-48.8	686.3
Lead	492.8		-40.8	946.3
Manganese	7.4		-60.5	64.5
Nickel	240.4		-17.1	478
Zinc	-25.2		-34.7	-2.4

QUANTITATIVE DATA SUMMARY						
CH0207 Water		**% Change**				
NBS	**NBS name**	**Specific Conductivity**	**Dissolved Oxygen**	**Combined Nitrogen**	**Phosphate**	**All metals**
LAc4	Urban catchment forestry	57.8	26.2	90.0	510.0	-16.5
LAc8	SuDs & Rain Garden	-15.1	-4.6	-13.2	76.9	39.8
LAc16	Floating gardens	13.8	-5.2	-43.1	48.9	0.2

QUANTITATIVE DATA SUMMARY					
CH0207 Water % Change Nutrients in Solution					
NBS	**NBS Name**	**Ammonium (N-NH4)**	**Nitrite (N-NO2)**	**Nitrate (N-NO3)**	**Phosphate (SRP)**
LAc4	**Strand Tree SuDS**	19.2	-64.7	251.5	510.0
LAc8	**Lower SuDS**	-59.9	-6.3	214.7	94.8
LAc8	**Upper Pitt St RG**				
LAc8	**Upper SuDS**	-23.8	16.6	0.1	59.0
LAc16	**SPL FI**	-20.6	-56.9	-69.4	48.9

QUANTITATIVE DATA SUMMARY
CH0207 Water % Change Metals in Solution

NBS	NBS Name	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Manganese	Nickel	Lead	Zinc
LAc 4	Strand Tree SuDS	119		-41	-8	-17	-49	-61	-17	-41	-35
LAc 8	Lower SuDS			-89		489	186	66	38		-68
LAc 8	Upper Pitt St RG										
LAc 8	Upper SuDS			-92		10	18	10	-55	-8	12
LAc 16	SPL FI			-99		0	35	23	-16	48	11

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

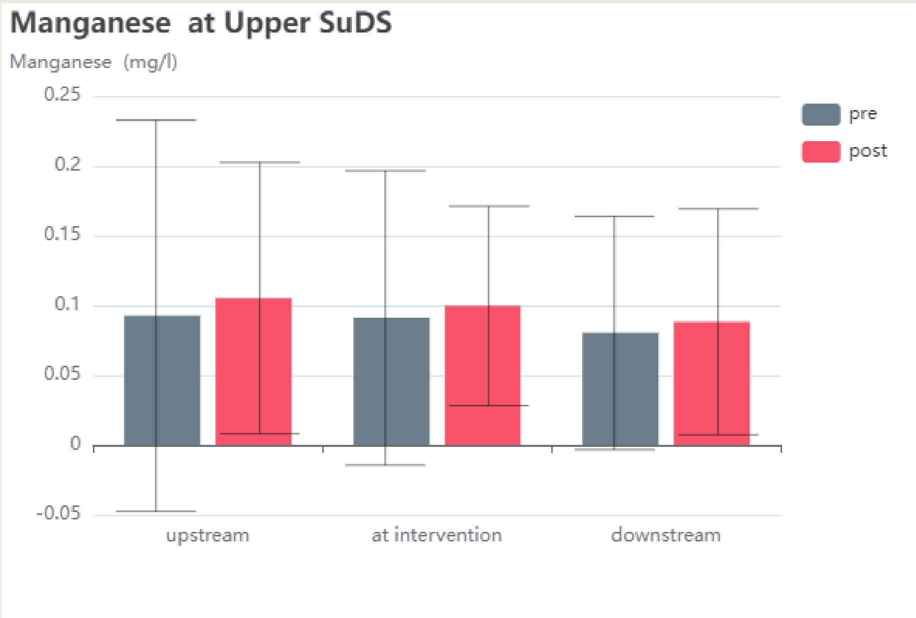
For related intervention site names, please see table below:

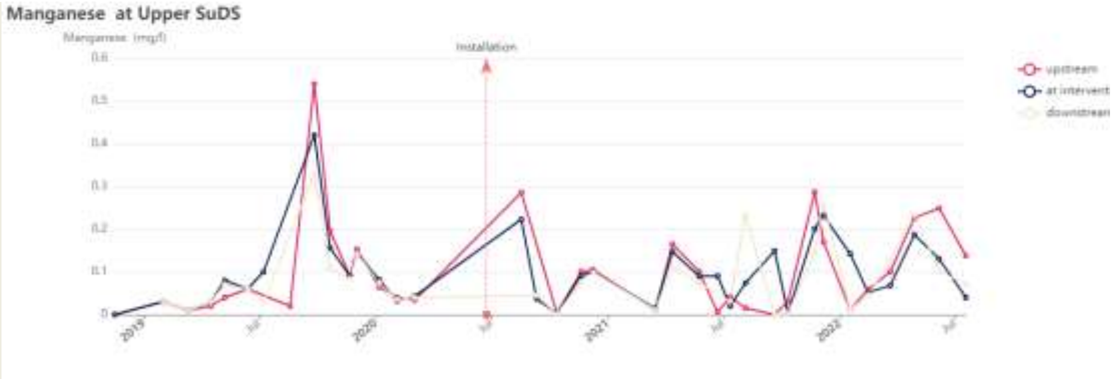
FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0207	NUTRIENT ABATEMENT (COD)	LAc4	Urban Catchment forestry		Strand Tree SuDS	
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		Upper SuDS, Lower SuDS
		LAc16	Floating gardens	Wapping FI		SPL FI
			LeakyDam			LeakyDam

Map of monitoring locations

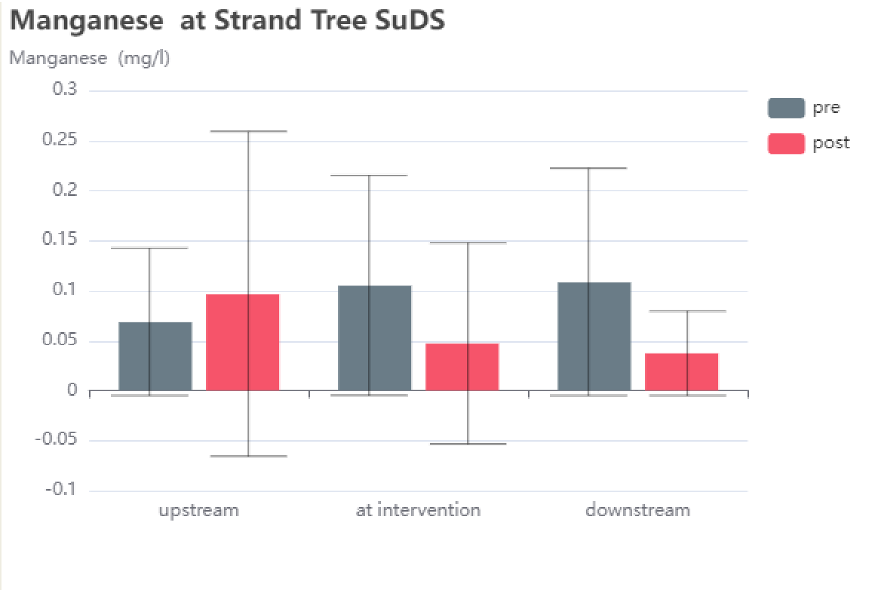
Equipment and methodology:

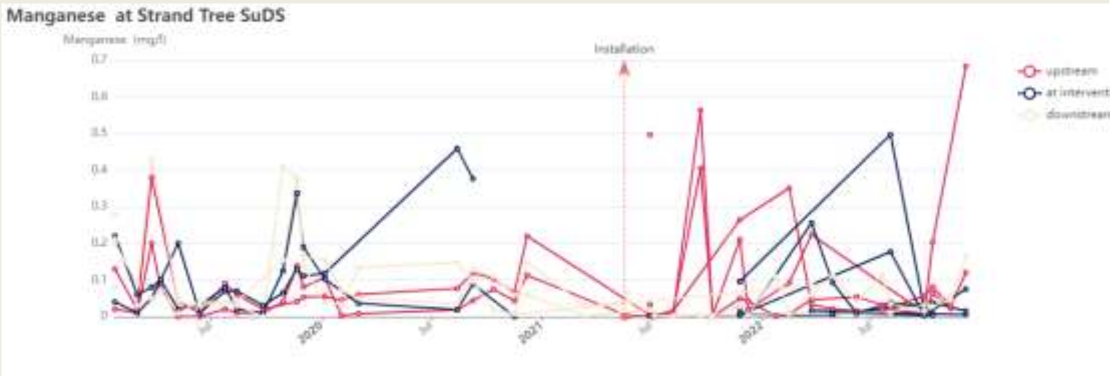
Summary plot example: Manganese at Water retention pond: Upper SuDs: Box plot showing upstream, at intervention and downstream; Time-line plot showing installation date.



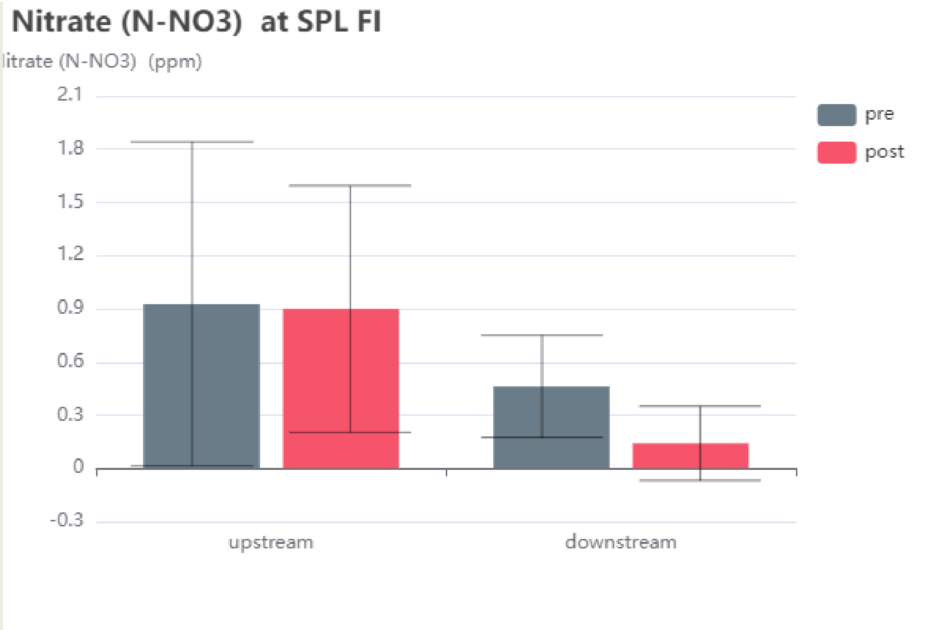


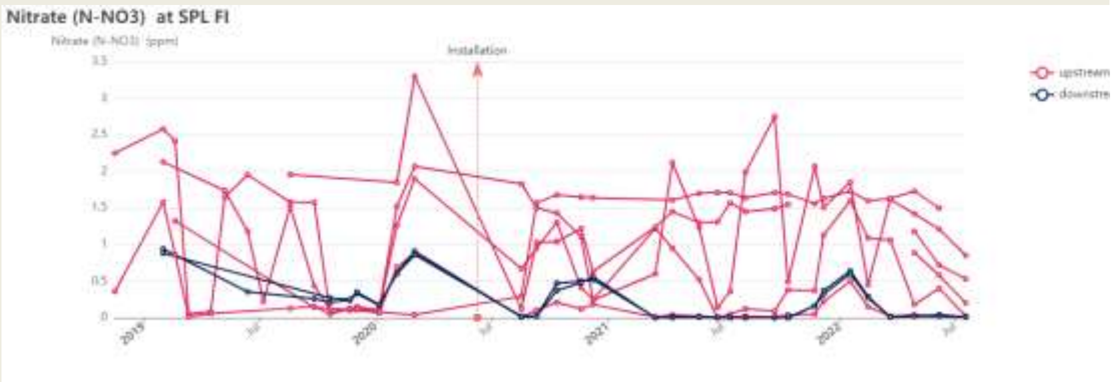
<u>Summary plot example: Manganese at Urban Catchment Forestry: Strand Tree</u> SuDs: Box plot showing upstream, at intervention and downstream; Time-line plot showing installation date.





<u>Summary plot example: Floating island data so far: Sefton Park Floating island: Nitrate (N-NO3):</u> Box plot showing upstream and downstream data pre and post intervention; Time-line plot showing the time of installation.





The water monitoring of the abiotic measures and metal and nutrients in solution demonstrated variable results. The rain garden in sub demo A could not be assessed for any change with installation due to no pre-installation monitoring.

From the summary data table it can be seen that the conductivity (or amount of ions present) increased in all areas, particularly for sub demo B at 58% in contrast to sub demo C at 8%. Overall Liverpool this increased by 16%. Dissolved Oxygen levels decreased adversely in sub demos A and C (-18% and -8% respectively), but increased in Sub demo B (26%) and overall Liverpool at 7%. The combined Nitrogen factor (a combination of Ammonium, Nitrate and Nitrite) showed an increase for all areas (overall Liverpool 22% and sub demo B 90%), but reduced in sub demo C (-18%). Phosphate levels increased for all (overall Liverpool 217% and sub demo B 510%), but was the lowest increase in sub demo C (at 94%). If all the metals were combined a decrease was observed in sub demo B (-17%) but increased dramatically in sub demo C(7353%) and overall Liverpool (984%). So variable results with the best results showing for sub demo C except for decrease in dissolved Oxygen and increase in all metals. Sub demo B seemed to show a positive effect on reducing all the metals.

From an assessment of the nutrients, Nitrite showed the most reduction and reduced over all areas (sub demo B -65%, sub demo C -23% and overall Liverpool -49%). Please see example plot for sub demo C Sefton Park Island. Ammonium decreased over all Liverpool (-7%) and in sub demo C (-8%) but increased in sub demo B (19%). Nitrate increased dramatically in sub demo B (252%) and showed an increase overall Liverpool (51%), but decreased in sub demo C (-36%). Phosphate, as mentioned above increased in all areas.

Within the metals in solutions, Chromium showed the best decrease for overall Liverpool (-29%) and a decrease for sub demos B and C (-41% and -26% respectively). Zinc also showed a reduction overall at -25% for Liverpool, -34% for sub demo B and -2% for sub demo C. Other metals showed variable results. Arsenic increased for all, but all other metals increased over Liverpool as a whole and sub demo C. However, sub demo B showed a reduction for the other metals, particularly for Manganese at -61% (inc contrast to 65% for sub demo C and 7% for Liverpool. Please see the example summary plots for Manganese.

A more detailed look at the effect of individual interventions showed that the Suds and rain garden combined had a beneficial effect on reducing the number of ions (Specific conductivity) with -15% as contrast to the floating gardens at 14% and urban catchment forestry at 58%. Dissolved Oxygen levels dropped slightly except for the urban catchment forestry (Strand SuDs) at 26%. The combined Nitrogen factor, though increased on the Strand (90%), but decreased for the SuDs & rain garden and floating gardens (-13% and -43% respectively). Phosphate increased for all sites. The combined 'all metals' showed a reduction for sub demo B, urban catchment forestry (-17%) but an increase for the Suds & rain garden (40%), with a negligible change for the floating gardens.

For the specific nutrients, reduction were observed for Ammonium for all sites except the Strand SuDs, with the highest reduction for the Lower SuDs site (-60%) followed by the Upper SuDS and Sefton Park floating island (-24% and -21% respectively). For Nitrite, a reduction was observed for all sites, except the Upper SuDs site (17% in contrast to -57% and -65% for the floating island and Strand SuDs respectively). Nitrate increased for all except a negligible result for the Upper SuDs and a decrease of -70% seen for the Sefton Park floating island. Phosphate, as mentioned above, increased for all sites.

For the metals assessment, results were very variable. Chromium was reduced at all sites, particular at the Lower SuDs, Upper SuDs and floating island (at approx. -90% for all and -41% for the Strand SuDs). Nickel also mainly showed a reduction, except for an increase at the Lower SuDs site. Other metals were variable between each site. Overall the Strand tree SuDs appeared to do better in reducing the meals than the other sites, except for an increase in Arsenic.

Therefore, these water results showed variable results at different sites and for the various nutrients and metals investigated. For metal reduction the urban catchment forestry or Strand Tree SuDs sites demonstrated the most reductions. Overall, though the results were too inconclusive to state if the interventions had helped throughout.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The last metal analyses did not include Zinc analyses so Zinc has not got the same sample size as the other metal samples	Awareness that the Zinc calculations may be incorrect for the time period studied.
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Some delays and interruptions due to university lab shutdowns in lockdowns and technical staff retirement/changes	Flexibility and resilience; technical issues being resolved

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data analyses using comparative data sources (as shown in table below) will further the understanding of the importance of the interventions in the nutrient and metal abatement.

KPI NAME	NBS Ref No.	NBS NAME	OTHER POSSIBLE COMPARATIVE DATA SOURCES			OTHER VARIABLES
NUTRIENT ABATEMENT (COD)	LAc4	Urban Catchment forestry	Detectronic Flow meter	Soilmania	Precipitation	COVID lockdown; Road salting
	LAc8	Rain Garden (SUDs)	Detectronic Flow meter		Precipitation	COVID lockdown; Leaky dams; Borehole use; Salting
	LAc16	Floating gardens		Biobank/ iNaturalist records	Precipitation	COVID lockdown; Leaky dams; Borehole use; Salting

These water results showed variable results at different sites and for the various nutrients and metals investigated. For metal reduction the urban catchment forestry or Strand Tree

SuDs sites demonstrated the most reductions. Overall, though the results were too inconclusive to state if the interventions had helped throughout.

What was the impact? (positive/negative, significant/non-significant)?

Inconclusive

1.2.10 CH0209 Nutrient abatement (SST)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0209	NUTRIENT ABATEMENT (SST)	CFT
CITY	*RELATED NBS*	
LIV	LAc4, LAc8, LAc16	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Measuring equipment results (Muffle furnace and XRF)

No data for Baltic sub demo A rain garden as intervention added in 2022.

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY			
CH0209 % Change	**Organic matter**	**Suspended sediment**	**All Suspended metals**
Overall Liverpool	407.7	-60.0	-8.2
Sub-Demo A			
Sub-Demo B	118.4	-74.6	8.4
Sub-Demo C	417.2	-19.1	10.4

QUANTITATIVE DATA SUMMARY
Metals in Suspended Sediment

CH0209 % Change	Overall Liverpool	Sub-Demo B	Sub-Demo C
Arsenic	2.8	11.9	10.7
Cadmium	157.9	160.1	178.2
Chromium	-59.4	-63.5	24.1
Copper	-85.9	-78.3	-36.8
Iron	-45.1	-26.8	-18.4
Lead	-28.7	-26.4	-1.3
Manganese	0.9	26.1	-28.1
Nickel	15.2	50.9	17.9
Zinc	8.2	31.3	4.6

QUANTITATIVE DATA SUMMARY				
CH0209 Suspended Sediment Water		% Change		
NBS	NBS name	Organic Matter	Suspended Sediment	All Suspended Metals
LAc4	Urban catchment forestry	118.4	-74.6	8.4
LAc8	SuDs & Rain Garden	296.3	-53.8	59.8
LAc16	Floating gardens	1095.1	47.0	-6.9

QUANTITATIVE DATA SUMMARY										
CH0209 Suspended Sediment Water % Change Metals										
NBS	NBS name	Arsenic	Cadmium	Chromium	Copper	Iron	Manganese	Nickel	Lead	Zinc
LAc4	Strand Tree SuDS	12	160	-64	-78	-27	26	51	-26	31
LAc8	Upper SuDS	185	224	23	-16	34	29	48	41	51
LAc16	SPL FI	-59	207	51	-41	-43	-48	-5	-31	-29

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

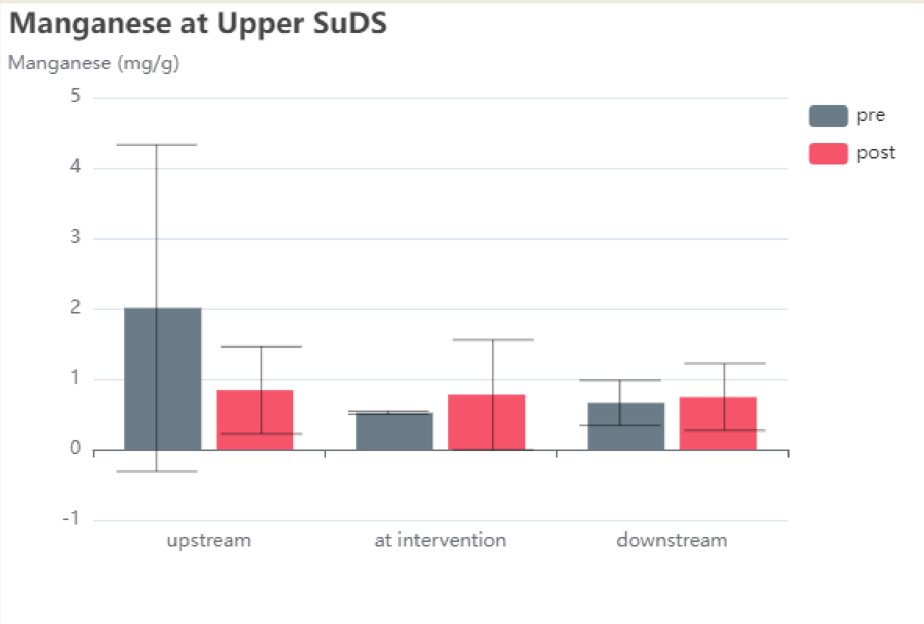
For related intervention site names, please see table below:

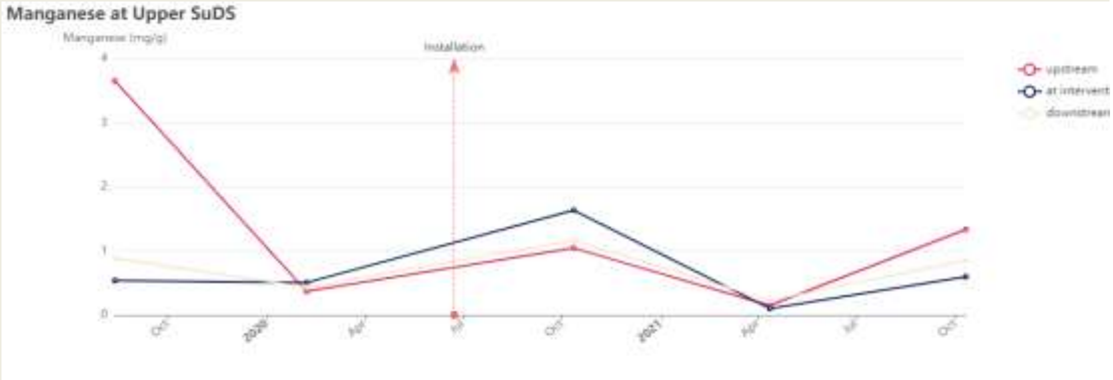
FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0209	NUTRIENT ABATEMENT (SST)	LAc4	Urban Catchment forestry		Strand Tree SuDS	
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		Upper SuDS, Lower SuDS
		LAc16	Floating gardens			SPL FI

Map of monitoring locations: See CH0207

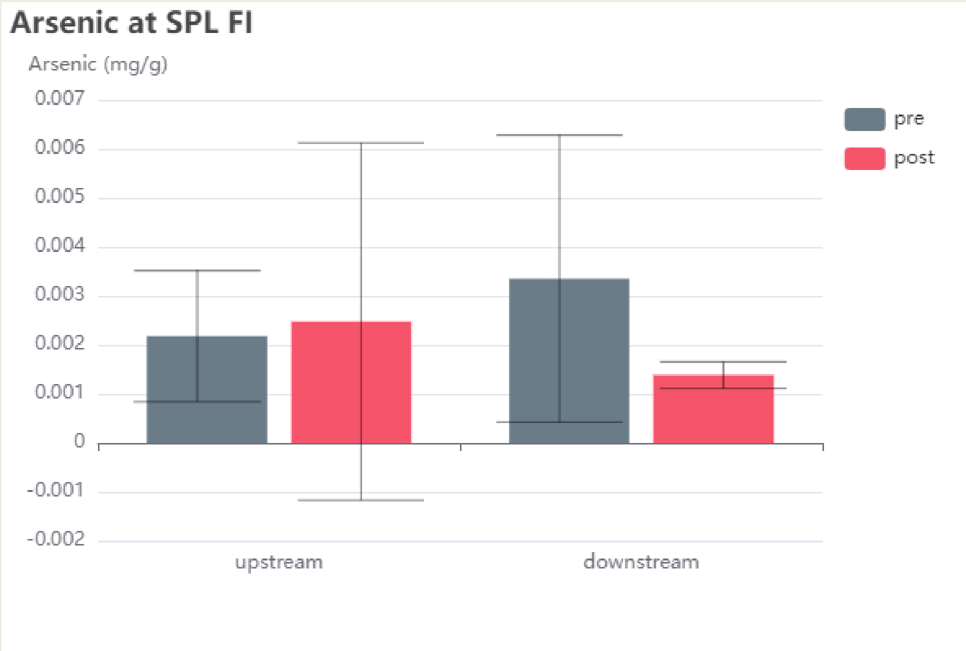
Equipment and methodology: Muffle furnace (photo) and X-ray- fluorescence

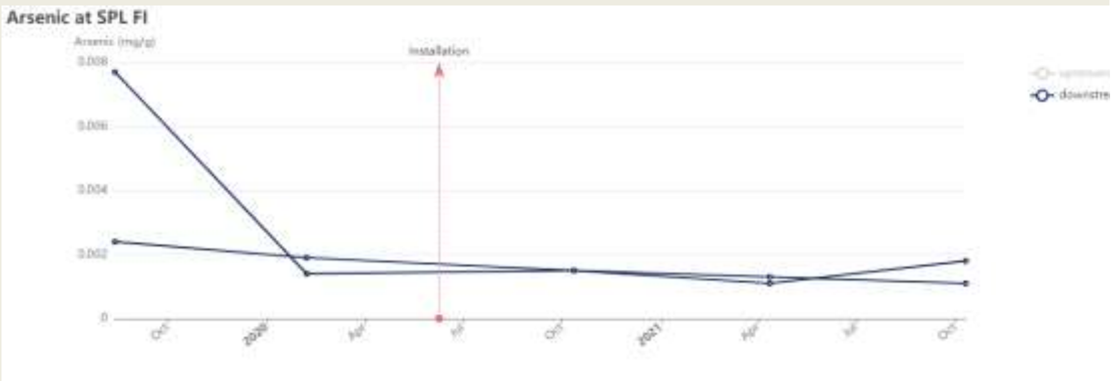
Summary plot example: Manganese in suspended sediment at Water retention pond (see also plot in CH0207): Box plot showing upstream, at intervention and downstream; Time-line plot showing installation date.





Summary plot example: Arsenic in suspended sediment for Sefton Park Floating Island: Box plot showing upstream and downstream; Time-line plot showing installation date and downstream data:





The water monitoring of the metals suspended in sediment demonstrated variable results. The rain garden in sub demo A could not be assessed for any change with installation due to no pre-installation monitoring.

The summary table shows that the metals in suspension increased for sub demos B and C (8% and 10% respectively), but decreased for Liverpool as a whole (-8%).

For individual metals in suspension, Copper decreased most for Liverpool (-86%, together with sub demo B at -78% and C at –37%). In contrast, Cadmium, Nickel, Zinc and Arsenic all increased for all areas. The other metals varied according to the area but decreased overall for Liverpool and all areas for Chromium, Iron and Lead (except for an increase for Chromium for Sub demo C).

From the detailed assessment of the intervention sites, it can be seen in the summary that only the floating islands intervention reduced the suspended metals (-7%) when the urban catchment forestry showed a slight increase at 8% and the Suds & rain garden showed a 60% increase.

The individual metal detail showed variable results. The floating island at Sefton Park demonstrated reductions for all metals, particularly Arsenic at -60% (see example plot), but except for Cadmium and Chromium levels. However, the Upper SuDs site tended to show an increase for all metals, except Copper (-16%). Strand tree Suds or the Urban Catchment Forestry site was very variable with some reductions (particularly for Chromium at -64%, Copper at -78%, Iron at -27% and Lead at -26%) and some increases in metals (including Manganese at 26%). Please see plot examples.

Although, the floating island generally showed a decrease for metals, the results overall were highly variable, so proved inconclusive in determining if the interventions has a positive effect.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
None	

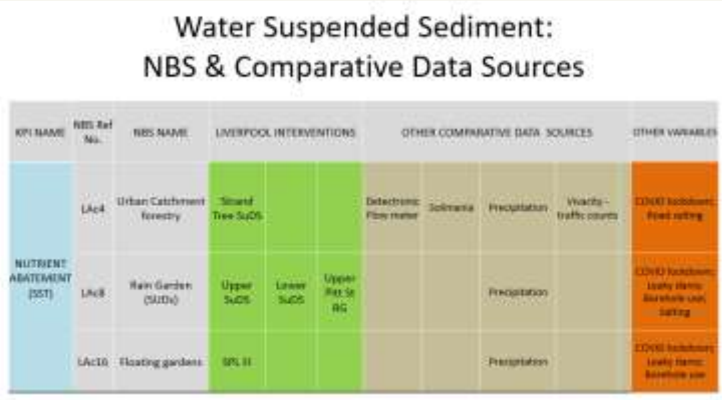
Economical barriers	How they have been addressed

None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Some due to university lab shutdowns in lockdowns and technical staff retirement/changes	Flexibility and resilience; technical issues being resolved

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data comparations yet to be made with comparative data sources to increase the understanding of the impact of the interventions.



Reduction in all suspended metal for overall Liverpool, so assumed to have a positive impact but other results inconclusive.

What was the impact? (positive/negative, significant/non-significant)?

Inconclusive

1.2.11 CH0211 Water removed from the water treatment

KPI CODE	*KPI NAME*	*PARTNER(S)*

CH0211	WATER REMOVED FROM THE WATER TREATMENT	CFT with LJMU
CITY	*RELATED NBS*	
LIV	LAc4, LAc8	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL,

QUANTITATIVE: Detectronic Flow meter

Soilmania sensor data: Soil moisture, Soil Oxygen index, Soil pH, Soil conductivity, Soil temperature

See CH0204

GI-VAL results:

CH0211: Water removed from water treatment	**GI-VAL BENEFITS**	**Sub-Demo Areas**			**Overall Liverpool**	**BENEFIT QUANTIFICATION**
Functions	**Tools**	**A**	**B**	**C**		
Interception, storage and infiltration of rainwater	2.1 Energy and carbon emissions savings from reduced stormwater volume entering combined sewers	461323	9624052	625635	5205062	L/yr water diverted from sewers

Quantitative monitoring data results:

Ongoing discussion with water experts so calculations on these data are expected in the near future.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL model analysis output showed the addition of the interventions resulted in water diverted from the water treatment systems for all areas, in particular for sub demo B (9,624,052 l/yr). Overall in Liverpool the amount of water diverted was 5,205,062 l/yr.

For the related intervention site names for the quantitative data, please see table below:

FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0211	WATER REMOVED FROM THE WATER TREATMENT	LAc4	Urban Catchment forestry		Strand Tree SuDS	
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		

Map of monitoring locations See CH0204

Equipment and methodology: See CH0204

Summary hydrograph examples: See CH0204

With an emphasis on the GI-VAL data, overall positive influenced of the interventions were found.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Sensor issues due to silt buildup for the water flow sensors	Being resolved
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed

None	
Environmental (including COVID)	How they have been addressed
None	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The data were compared with other data such as precipitation and soil moisture data (see Hydrographs). Further analyses investigating the influence of these factors would be beneficial to fully understand the relative importance of the effect on removal of the water.

Water Flow: NBS & Comparative Data Sources

KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS	OTHER COMPARATIVE DATA SOURCES		
WATER SLOWED DOWN FROM SEWER SYSTEM	LAc4	Urban Catchment forestry	Strand Tree SuDS	Detectronic Flow meter	Soilmania	Precipitation
WATER REMOVED FROM THE WATER TREATMENT	LAc4	Urban Catchment forestry	Strand Tree SuDS	Detectronic Flow meter	Soilmania	Precipitation

Ongoing discussions with water experts are hoped to determine more precise results for this KPI.

The Gi-VAL data showed a positive effect of the interventions on the amount of water removed from water treatment, so this a positive change.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.12 CH0212 Savings in treatment of stormwater

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0212	SAVINGS IN TREATMENT OF STORMWATER	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

GI-VAL results:

CH0212: Savings in treatment of stormwater	**GI-VAL BENEFITS**		**Sub-Demo Areas**			**Overall Liverpool**	
Functions	**Tools**	**GVA value**	**A**	**B**	**C**		**BENEFIT MONETISATION**
Interception, storage and infiltration of rainwater	2.1 Energy and carbon emissions savings from reduced stormwater volume entering combined sewers	**GVA value**	425.4	8874.3	576.9	4799.6	£
Interception, storage and infiltration of rainwater	2.2 Reduced wastewater treatment costs for domestic and commercial water customers	**GVA value**	0.0	0.0	0.0	0.0	£
Interception, storage and infiltration of rainwater	2.3 Avoided costs of traditional water drainage infrastructure	**GVA value**	n.a.	n.a.	n.a.	n.a.	£
		Total Water Management & Flood Alleviation benefit monetisation:	425.4	8874.3	576.9	**4799.6**	£

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL output showed positive savings in stormwater treatment for all factors investigated. The major positive benefits were from the energy and carbon emission savings from the reduced stormwater volume entering the combined sewers. These savings were greatest for sub demo B (£8874), followed by sub demo C (£577) and sub demo A (£425). Overall, for the extent of Liverpool, the savings were £4800.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

GI-Val showed a positive impact of the Urban GreenUP interventions for savings from the reduced stormwater entering the water treatment drainage system.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.13 CH0403 Green Space accessibility

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0403	GREEN SPACE ACCESSIBILITY	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL, EcoServR

SOCIO-ECONOMIC: Data in CH0904. Also refer to report 'Analysis of NBS in Liverpool' which assesses CH0403-Green Space Accessibility, CH0702 Citizen Participation, CH0703 Social Learning, CH0705 Engagement with NBS and CH0904 Health Quality Perception.

EcoServR: Assumptions on habitat codes for the UGU interventions

Intervention type	**Code**	**Description**	**Notes**
Shade trees Cooling trees Green filter trees	A13	Mixed woodland	No code for trees outside woodland; assuming mixed to average out differences between coniferous and broadleaved trees
Orchard	A112o	Orchard	
Pollinator planting	J55	Brownfield/garden/park	

SuDS ponds	G1	Standing water	
Green roof	GR	Green roof	Added to EcoservR for UGU (limited evidence base)
Green wall	GW	Green wall	Added to EcoservR for UGU (limited evidence base)
Floating island	FI	Floating island	Added to EcoservR for UGU (limited evidence base)
Smart pollinator pillars	POLL	Pollinator baskets	Added to EcoservR for UGU (limited evidence base)

EcoServR results:

EcoServR: CH0403: Green Space Accessibility		
Mean	**households**	**population**
sub demo A	929	1679
sub demo B	641	1025
sub demo C	1189	2530
Overall Liverpool	11702	23449

	EcoServR: CH0403: Green Space Accessibility		
NBS	**NBS Name**	**households**	**population**
lac4	Urban catchment forestry	454	670
lac5	shade trees	3413	5817
lac6	cooling trees	2910	5031
lac8	SuDs & Rain Garden	1161	2491
lac12	Pollinator verges and spaces	1314	2651
lac13	Pollinator walls/vertical	922	1580
lac14	Pollinator roofs	764	1247
lac16	Floating gardens	306	545
lac17	Green filter area	2538	4409

EcoServR: CH0403: Green Space Accessibility		
Pollinator walls/vertical	**households**	**population**
L1 GW	538	877
Parr St GW	1422	2557
St Johns GW	806	1307

	EcoServR: CH0403: Green Space Accessibility		
NBS	**Site**	**households**	**population**
lac4	Urban catchment forestry	454	670
lac5	shade trees	3413	5817
lac6	cooling trees	2910	5031
lac17	Green filter area	2538	4409

EcoServR: CH0403: Green Space Accessibility		
Floating gardens	**households**	**population**
SPL FI	360	658
Wapping FI	252	431

GI-VAL results:

CH0403: Greenspace accessibility: GI-VAL BENEFITS		Sub-Demo Areas			Overall Liverpool	BENEFIT QUANTIFICATION
Functions	**Tools**	**A**	**B**	**C**		
Catalyst for community cohesion and pride	3.1 Willingness to pay for a view of urban green space	340	1003	1108	817	more households with a view of green space
Catalyst for community cohesion and pride	3.2 Increase in volunteering	10	10	10	10	new volunteers

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The EcoServR model access output was produced in the following way. Domestic buildings were extracted from the natural capital baseline. The average population per home was extracted from census data. The interventions were buffered by 500 m, and this catchment was intersected with the household layer to get an estimate of the catchment population. The EcoServR output then described households and populations with a view of green space. The overall Liverpool calculation was over the footprint of all interventions and was smaller than the sum of the sub-demo area to avoid double-counting due to some locations counting towards several inter code categories. These totals of 11702 households and 23449 residents are therefore the overall UGU program impact and possibly the most useful metric.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

Green space accessibility worked really well in GI-Val as we could update the number of people and households that were within 300m and 1200m of the interventions. The benefit output shows an increase in the number of households with a view of green space (817) and the economic value associated with the willingness to pay for this and an increase in volunteering (10).

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final)

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Model: Domestic buildings were extracted from the natural capital baseline. The average population per home is extracted from census data. The interventions were buffered by 500 m, and this catchment was	Awareness of limitations of model

intersected with the household layer to get an estimate of the catchment population. The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
Impacts on number of face-to-face surveys due to Covid restrictions	Online interviews and postal surveys became the focus of the Socio-economic investigations

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

EcoServR produced an output of a total of 11702 households and 23449 residents within Liverpool having better access to green space as a result of the Urban GreenUP interventions.

The GI-VAL analyses also showed a positive increase in the number of households (817) with a view of green space.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final) and CH404.

All data indicated a positive benefit.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.14 CH0404 Green infrastructure connectivity

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	UOL/UOM with CFT
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

SOCIO-ECONOMIC: No data directly but linked to other KPIs so refer to other socio-economic KPIs such as CH0403-Green Space Accessibility MODELS: modelling not possible as mapping not carried out as planned. Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final) *For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic*

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Model development not progressed as planned in terms of mapping	Focus of KPI assessment on Socio-economic data with reference to other KPIs

Economical barriers	How they have been addressed
n/a	

Social barriers	How they have been addressed
n/a	

Environmental (including COVID)	How they have been addressed
Impacts on number of face-to-face surveys due to Covid restrictions	Online interviews and postal surveys became the focus of the Socio-economic investigations

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final): Overall, responses to the social, economic, and environmental impacts of greenspace/NBS were predominantly positive in both sites, suggesting that local people are aware of the multifaceted and interconnected benefits greenspace/NBS can offer.

Hence the outcome was indicated as positive.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.15 CH0410 Pollinator species increase

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0410	POLLINATOR SPECIES INCREASE	CFT
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc8, LAc12, LAc13, LAc14, LAc16	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELS: EcoServR

QUANTITATIVE: Observational Flower-Insect Timed counts

EcoServR: Assumptions on habitat codes for the UGU interventions

Intervention type	**Code**	**Description**	**Notes**
Shade trees	A13	Mixed woodland	No code for trees outside woodland; assuming mixed to average out differences between coniferous and broadleaved trees
Cooling trees			
Green filter trees			
Orchard	A112o	Orchard	
Pollinator planting	J55	Brownfield/garden/park	
SuDS ponds	G1	Standing water	
Green roof	GR	Green roof	Added to EcoservR for UGU (limited evidence base)
Green wall	GW	Green wall	Added to EcoservR for UGU (limited evidence base)
Floating island	FI	Floating island	Added to EcoservR for UGU (limited evidence base)
Smart pollinator pillars	POLL	Pollinator baskets	Added to EcoservR for UGU (limited evidence base)

EcoServR results:

EcoServR: CH0410: Pollinator increase		% Change
sub demo A	Pollination	0.77
sub demo B	Pollination	1.20
sub demo C	Pollination	0.06
Overall Liverpool	Pollination	0.04

EcoServR: CH0410: Pollinator increase		
NBS	**NBS Name**	**% Change**
lac4	Urban catchment forestry	0.70
lac5	shade trees	0.22
lac6	cooling trees	1.74
lac8	SuDs & Rain Garden	1.17
lac12	Pollinator verges and spaces	1.73
lac13	Pollinator walls/vertical	12.78
lac14	Pollinator roofs	23.13
lac16	Floating gardens	7.08
lac17	Green filter area	1.78

EcoServR: CH0410: Pollinator increase		
Pollinator walls/vertical	**radius (m)**	**% Change**
L1 GW	20	19.95
Parr St GW	20	0.78
St Johns GW	20	24.43
L1 GW	100	13.71
Parr St GW	100	0.15
St Johns GW	100	17.66

EcoServR: CH0410: Pollinator increase

SuDs & Rain Garden	radius (m)	% Change
Upper Pitt St RG	20	0.60
Upper SuDS	20	0.03
Lower SuDS	20	3.95
Upper Pitt St RG	100	0.15
Upper SuDS	100	0.01
Lower SuDS	100	2.31

	EcoServR: CH0410: Pollinator increase		
NBS	**NBS Name**	**radius (m)**	**% Change**
lac4	Urban catchment forestry	20	0.16
lac5	shade trees	20	0.21
lac6	cooling trees	20	1.71
lac17	Green filter area	20	1.65
lac4	Urban catchment forestry	100	1.23
lac5	shade trees	100	0.22
lac6	cooling trees	100	1.76
lac17	Green filter area	100	1.91

EcoServR: CH0410: Pollinator increase		
Floating gardens	**radius (m)**	**% Change**
SPL FI	20	0.00
Wapping FI	20	15.35
SPL FI	100	0.00
Wapping FI	100	12.98

	EcoServR: CH0410: Pollinator increase		
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**

A	Baltic Hub POLL	20	4.09
A	Baltic POLL	20	4.79
A	Cornwallis St POLL	20	0.78
A	Park Lane POLL	20	0.16
A	Pitt St POLL	20	0.00
A	Strand POLL	20	0.55
A	Wapping POLL	20	14.42
C	Bott SP Aig Dr POLL	20	0.15
C	Lower SuDS POLL	20	3.98
C	Princes Av POLL	20	0.17
C	Princes roundabt POLL	20	0.13
C	Top SP Aig Dr POLL	20	0.12
C	Ullet Rd POLL	20	0.01
C	Upper SuDS POLL	20	0.06
A	Baltic Hub POLL	100	2.44
A	Baltic POLL	100	3.55
A	Cornwallis St POLL	100	0.18
A	Park Lane POLL	100	0.02
A	Pitt St POLL	100	0.11
A	Strand POLL	100	0.56
A	Wapping POLL	100	9.69
C	Bott SP Aig Dr POLL	100	0.02
C	Lower SuDS POLL	100	2.39
C	Princes Av POLL	100	0.04
C	Princes roundabt POLL	100	0.06
C	Top SP Aig Dr POLL	100	0.01
C	Ullet Rd POLL	100	0.01
C	Upper SuDS POLL	100	0.01

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY
CH0410: Pollinator Count

Pre-Intervention				Post-Intervention				% Change	Area
n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd		
60	15	4.2	5.8	91	15	10.1	13.7	141.1	**Overall Liverpool**
34	8	4.3	6.5	35	7	13.0	16.2	205.5	**Sub-Demo A**
				12	2	3.6	6.6		**Sub-Demo B**
26	7	4.1	4.9	44	6	9.5	12.5	133.6	**Sub-Demo C**

QUANTITATIVE DATA SUMMARY									
CH0410: Pollinator diversity									
Pre-Intervention				**Post-Intervention**				**% Change**	**Area**
n_obs	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**		
60	15	1.6	1.7	91	15	1.8	1.6	17.8	**Overall Liverpool**
34	8	1.5	1.9	35	7	2.0	1.9	35.2	**Sub-Demo A**
				12	2	1.3	1.4		**Sub-Demo B**
26	7	1.7	1.5	44	6	1.9	1.5	12.7	**Sub-Demo C**

QUANTITATIVE DATA SUMMARY		
CH0410: Pollinator Count		
NBS	**NBS Name**	**% Change**
LAc8	SuDs & Rain Garden	448.6
LAc12	Pollinator verges and spaces	286.6
LAc13	Pollinator walls/vertical	
LAc16	Floating gardens	-60.0

QUANTITATIVE DATA SUMMARY		
CH0410: Pollinator Diversity		
NBS	**NBS Name**	**% Change**
LAc8	SuDs & Rain Garden	41.8
LAc12	Pollinator verges and spaces	77.7
LAc13	Pollinator walls/vertical	
LAc16	Floating gardens	-60.0

QUANTITATIVE DATA SUMMARY										
CH0410: Pollinator Count		Pre-Intervention				Post-Intervention				% Change
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	
LAc8	Lower SuDS	4	1	6.8	5.4	11	1	9.5	11.7	40.1
LAc8	Upper Pitt St RG	6	1	2.3	2.1	3	1	22.3	19.3	857.1
LAc12	Baltic Hub POLL	4	1	11.0	7.7	2	1	20.0	15.6	81.8
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	3.4	2.2	928.6
LAc12	Cornwallis St POLL	10	1	5.2	9.0	3	1	3.0	5.2	-42.3
LAc12	Lower SuDS POLL	4	1	6.8	5.4	11	1	9.5	11.7	40.1
LAc12	Park Lane POLL	3	1	2.0	3.5	7	1	12.4	11.6	521.4
LAc12	Princes Av POLL					7	1	14.9	21.2	
LAc12	Princes roundabt POLL	5	1	2.8	5.7					
LAc12	Strand POLL	4	1	3.3	2.9	6	1	29.3	24.3	802.6
LAc12	Top SP Aig Dr POLL	4	1	3.8	2.2	2	1	10.5	0.7	180.0
LAc12	Top SP roundabt POLL	1	1	1.0						
LAc12	Ullet Rd POLL	3	1	5.3	8.4	5	1	12.2	13.2	128.8
LAc12	Wapping POLL	5	1	2.6	5.8	2	1	1.0	1.4	-61.5
LAc13	L1 GW					2	1	12.0	15.6	
LAc13	Parr St GW	1	1	0.0		12	1	6.3	9.7	
LAc13	St Johns GW					10	1	1.9	2.7	
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0
LAc16	Wapping FI	1	1	3.0						

QUANTITATIVE DATA SUMMARY										
CH0410: Pollinator Diversity		Pre-Intervention				Post-Intervention				% Change
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	
LAc8	Lower SuDS	4	1	2.5	2.1	11	1	2.1	1.7	-16.4

LAc8	Upper Pitt St RG	6	1	1.2	1.0	3	1	2.3	2.1	100.0
LAc12	Baltic Hub POLL	4	1	3.8	1.0	2	1	4.5	0.7	20.0
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	1.7	0.8	414.3
LAc12	Cornwallis St POLL	10	1	1.7	2.6	3	1	1.0	1.7	-41.2
LAc12	Lower SuDS POLL	4	1	2.5	2.1	11	1	2.1	1.7	-16.4
LAc12	Park Lane POLL	3	1	1.0	1.7	7	1	2.9	2.5	185.7
LAc12	Princes Av POLL					7	1	1.6	1.6	
LAc12	Princes roundabt POLL	5	1	0.8	1.3					
LAc12	Strand POLL	4	1	1.3	1.0	6	1	2.5	2.2	100.0
LAc12	Top SP Aig Dr POLL	4	1	2.3	0.5	2	1	3.0	0.0	33.3
LAc12	Top SP roundabt POLL	1	1	1.0						
LAc12	Ullet Rd POLL	3	1	1.0	1.0	5	1	1.2	1.3	20.0
LAc12	Wapping POLL	5	1	0.6	1.3	2	1	0.5	0.7	-16.7
LAc13	L1 GW					2	1	2.0	1.4	
LAc13	Parr St GW	1	1	0.0		12	1	1.3	1.2	
LAc13	St Johns GW					10	1	1.1	1.4	
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0
LAc16	Wapping FI	1	1	1.0						

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The EcoServR model assessed pollinator habitats in the following way. This model provided a probability of pollinators visiting based on the proximity of suitable habitats. Core habitats (semi-natural grasslands, heathlands, scrub, hedgerows, gardens, as well as green roofs, walls and pollinator planting) and edge habitats (woodlands; suitable for nesting when within 20m of core habitats) were selected from the natural capital basemap. Distances to habitats were calculated (up to 668m which is considered the maximum flight distance) and converted to a visitation probability score (which decreases with increasing distance to habitats). An elevation mask (250m) was applied as areas above this are likely to be too exposed to support pollinators in great numbers. Raw units represented the probability (0-1) of visitation by pollinators. A rescaled (0-100) version was provided where 100 is the highest demand in the area mapped.

The EcoServR model results demonstrated an increase in pollinator habitats for all sub demo areas (A was 0.77% and C was 0.06%), particularly for sub demo B at 1.20%, as well as overall Liverpool (0.04%).

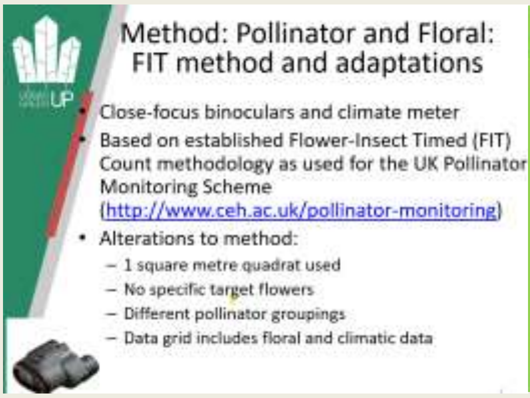
A more detailed breakdown per intervention showed that the pollinator roof had the greatest effect at 23% followed by Vertical pollinator planting(13%) and floating gardens (7%). The tree interventions, Suds, rain garden and pollinator verges also had important positive effects. At a closer radius, the interventions tended to show a greater positive importance. Of the green walls, Parr Street had less of an effect (0.8% at 20m and 0.2% at 100m) than the Liverpool One green wall (20% at 20m and 14% at 100m) and St Johns green wall (24% at 20m and 18% at 100m). The Lower SuDs site had a better positive effect (4% at 20m and 2% at 100m) than the lower SuDs and rain garden sites. The tree-based interventions had much the same effect over both radii, but the Strand trees (urban catchment forestry) had more effect over the 100m radius (0.2% at 20m, 1.2% at 100m). The Wapping dock floating island (15% at 20m, 13% at 100m) had more of an effect than the Sefton park island (negligible). Out of the pollinator planting sites, Wapping POLL had a greater effect than the other sites (14% at 20m, 10% at 100m), but the other larger sites were also important.

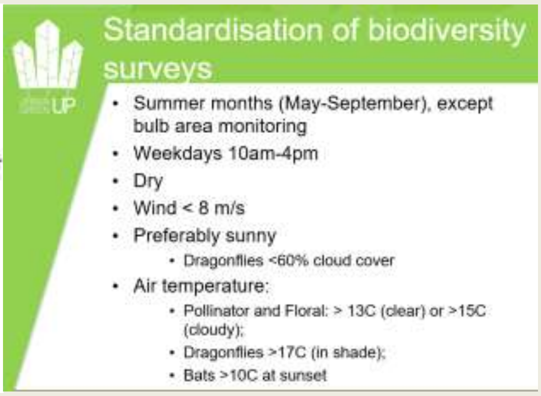
The Quantitative monitoring included many interventions. For the intervention site names, please see table below:

FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0410	POLLINATOR SPECIES INCREASE	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		Upper SuDS, Lower SuDS
		LAc12	Pollinator Planting Spaces and Verges	Baltic Green Route POLL, Cornwallis St POLL, Pitt St POLL, Park Lane POLL, Baltic Hub POLL, Strand POLL, Wapping POLL		Princes Av POLL, Princes roundabt POLL, Ullet Rd POLL, Top SP Aig Dr POLL, Top SP roundabt POLL, Bott SP Aig Dr POLL, Upper SuDS POLL, Lower SuDS POLL
		LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW, L1GW	
		LAc14	Pollinator roofs		RoyaL Court GR	
		LAc16	Floating gardens	Wapping FI		SPL FI

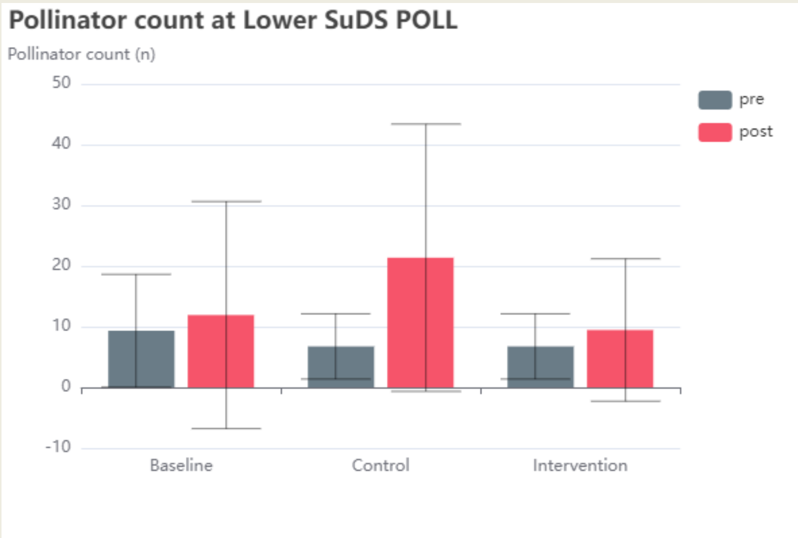
Map of monitoring locations

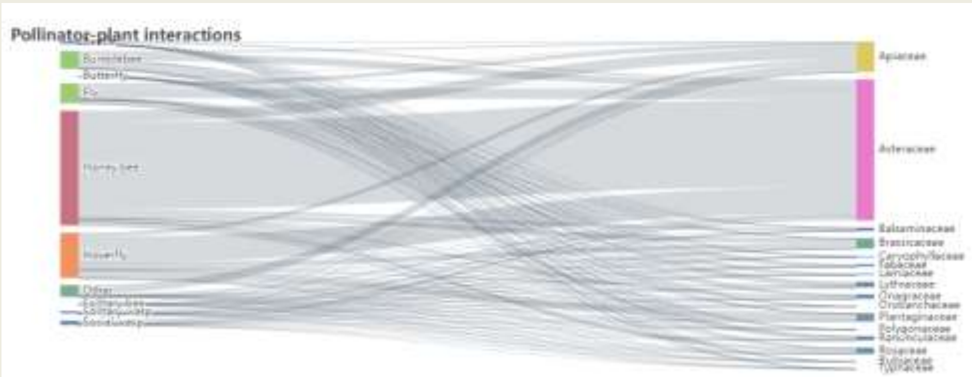
Equipment and methodology:

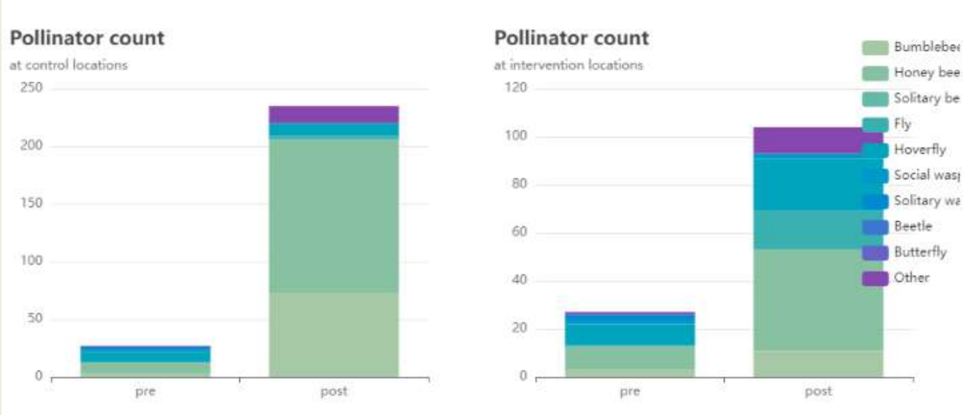


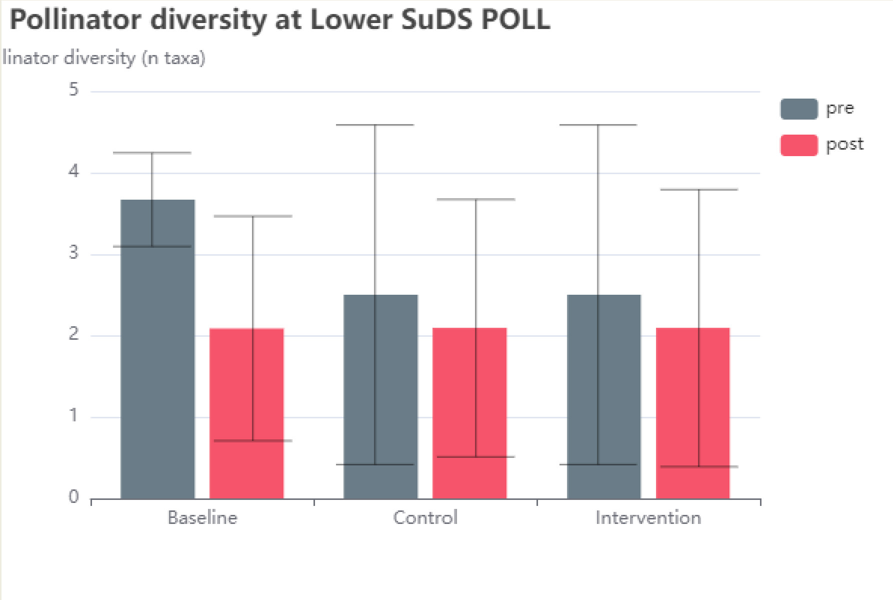


Summary plot example for pollinator verge: Sub-Demo C: Lower SuDs POLL

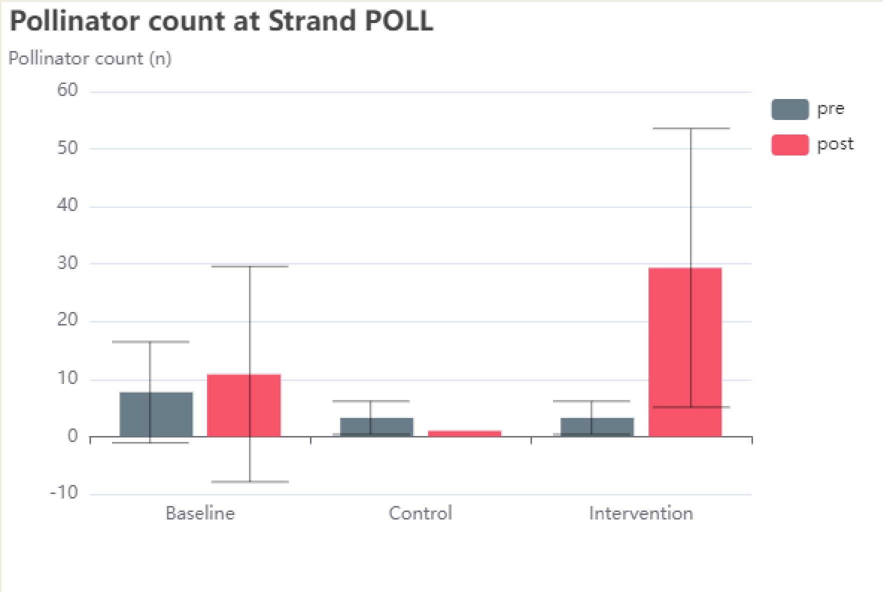


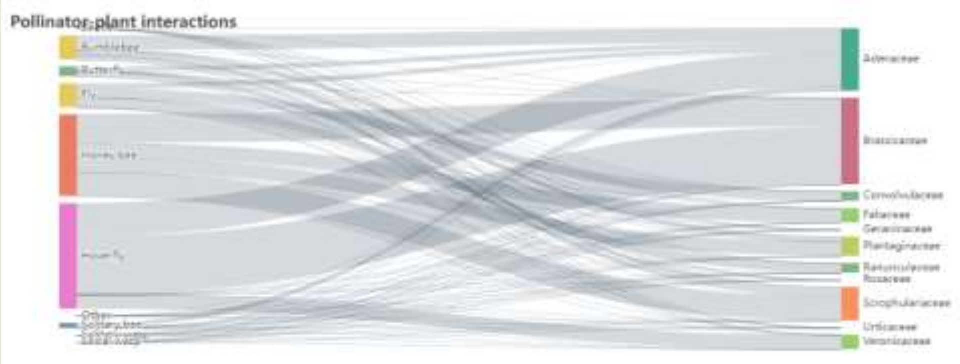


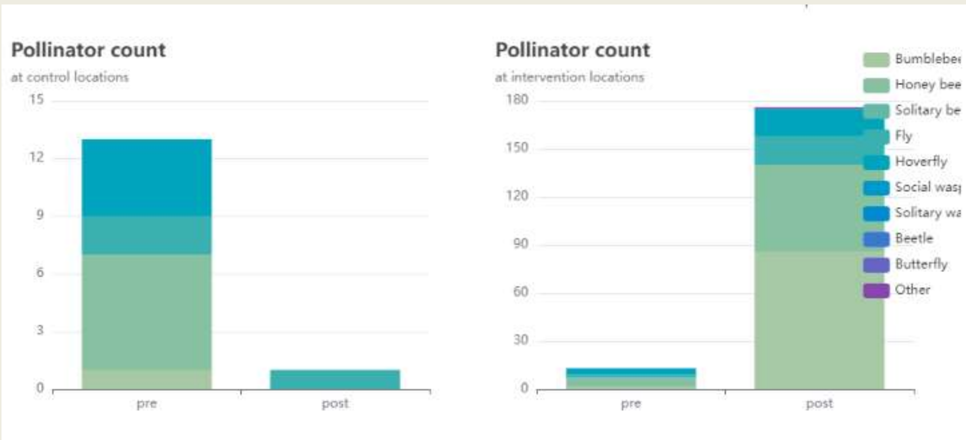


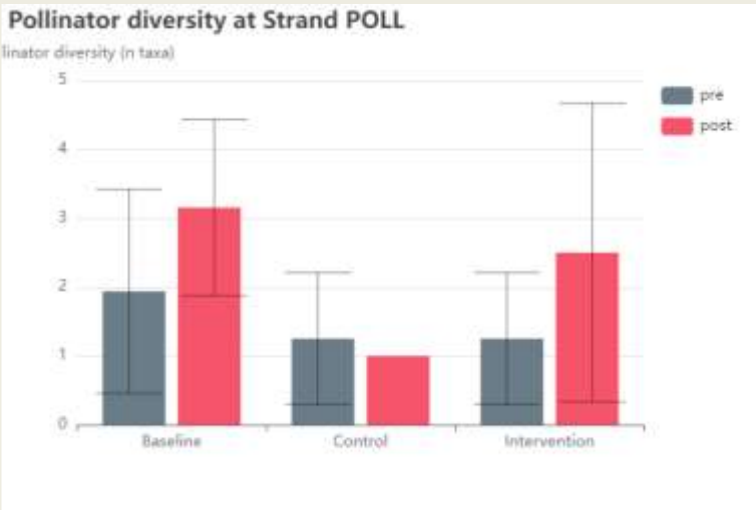


Summary plot example for pollinator verge: Sub-Demo A: Strand POLL

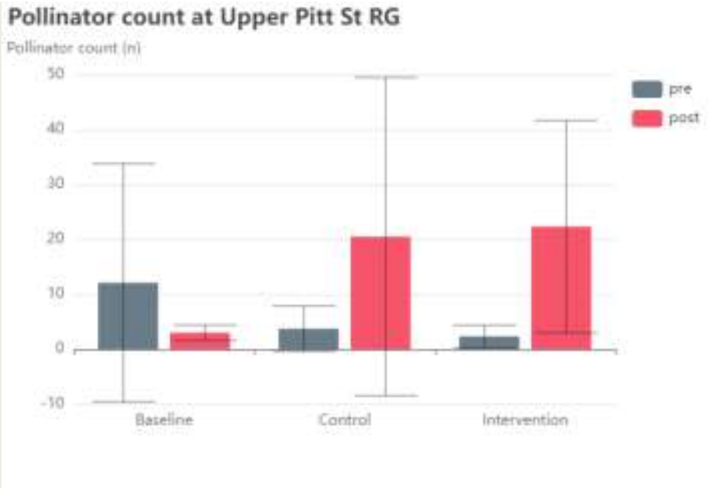


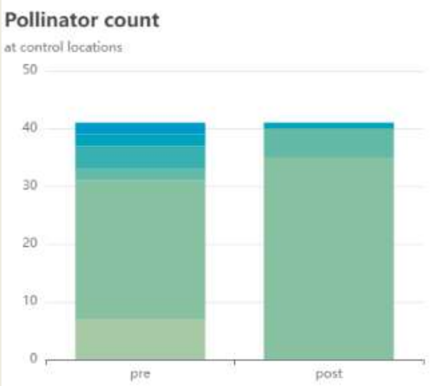


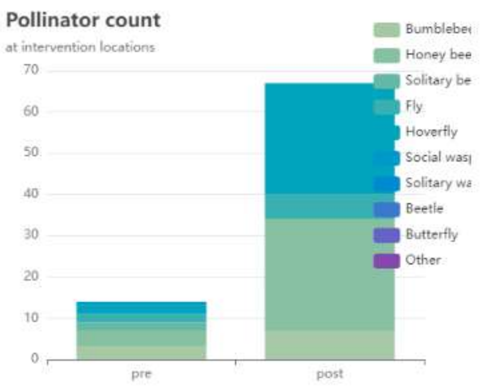


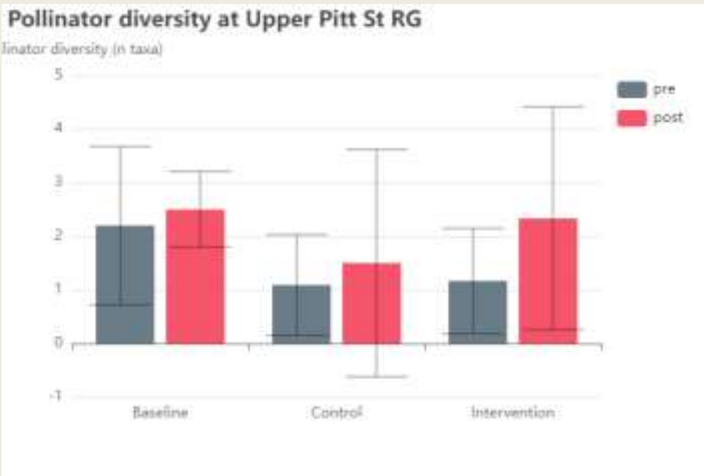


Summary plot example for sub demo A Rain garden:









The quantitative data summaries for both the pollinator count and diversities demonstrated a positive change for all areas (although sub demo B could not be calculated overall), particularly for sub demo A (206% and 35% respectively for pollinator abundance and pollinator diversity), with sub demo C (134% and 13% respectively) and overall Liverpool (141% and 18% respectively) also very important.

From the detailed look at the interventions, the SuDs and rain garden (449% and 42% respectively) were extremely important, followed by the pollinator verge sites (287% and 78% respectively). The pollinator verges showed the most increase in pollinator group diversity though. The floating gardens, though, showed a decreased change (-60%), but with a low number of observations.

The rain garden was particularly important with an 857% positive change in pollinator abundance and 100% increase in pollinator diversity (see also the plot examples). Of the green walls, no % changes could be calculated, but all had a positive effect, with Liverpool One green wall showing the most pollinator abundance (16 pollinators), followed by Parr Street, then St Johns (10 and 3 pollinators respectively). The pollinator verges were really important, particularly the Aigburth Drive (Top SP Aig Dr POLL at 180% and Bott SP Aig Dr POLL at 928%), Ullet road (Ullet Rd POLL at 129%) sites in sub demo C, and the Baltic sites Strand POLL and Park Lane POLL (803% and 521% increase in pollinator abundance respectively). Please also see example plots. The pollinator diversities tended to reflect the pollinator abundance figures accordingly.

Overall, all areas showed a positive change with the introduction of the interventions, particularly the central Liverpool sub demos A and B. Larger planted areas and interventions added into sterile environments (such as the Baltic rain garden) had the most important effects.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
EcoServR: This model provides a probability of pollinators visiting based on the proximity of suitable habitats. Core habitats (semi-natural grasslands, heathlands, scrub, hedgerows, gardens, as well as green roofs, walls and pollinator planting) and edge habitats (woodlands; suitable for nesting when within 20m of core habitats) are selected from the natural capital basemap. Distances to habitats are calculated (up to 668m which is considered the maximum flight distance) and converted to a visitation probability score (which decreases with	Awareness of limitation of model

increasing distance to habitats). An elevation mask (250m) is applied as areas above this are likely to be too exposed to support pollinators in great numbers. Raw units represent the probability (0-1) of visitation by pollinators. A rescaled (0-100) version is provided where 100 is the highest demand in the area mapped.	
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
None	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data analyses with comparative data sources such as local climate and shading, as shown in the table below, would increase understanding of the impact of the interventions on pollinator levels.

KPI NAME	NBS Ref No.	NBS NAME	OTHER POSSIBLE COMPARATIVE DATA SOURCES		
POLLINATOR SPECIES INCREASE	LAc1	New green cycle route	Local climate	Liverpool climate	
	LAc2	Green travel route	Local climate	Liverpool climate	
	LAc8	Rain Garden (SUDs)	Local climate	Liverpool climate	Detectronic Flow meter
	LAc12	Pollinator Planting Spaces and Verges	Local climate	Liverpool climate	
	LAc13	Pollinator walls/vertical	Local climate	Liverpool climate	
	LAc14	Pollinator roofs	Local climate	Liverpool climate	
	LAc16	Floating gardens	Local climate	Liverpool climate	

The EcoServR data showed a positive benefit of all the interventions, particularly for sub demo B.

These overall positive changes were also reflected in the quantitative data, especially where interventions were larger and introduced into a sterile urban environment.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.16 CH0412 Floral resources increase

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0412	FLORAL RESOURCES INCREASE	CFT
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc8, LAc12 ,LAc13, LAc14, LAc16	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Observational Flower-Insect Timed counts

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY									
CH0412: Flower Count									
Pre-Intervention				Post-Intervention				% Change	Area
n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd		
60	15	2.5	1.6	91	15	3.9	3.0	55.2	**Overall Liverpool**
34	8	3.5	1.5	35	7	6.1	2.4	73.2	**Sub-Demo A**
				12	2	6.5	2.6		**Sub-Demo B**
26	7	1.2	0.4	44	6	1.4	0.5	20.2	**Sub-Demo C**

QUANTITATIVE DATA SUMMARY		
CH0412: Flower Count		
NBS	NBS Name	% Change
LAc8	SuDs & Rain Garden	328.7
LAc12	Pollinator verges and spaces	510.8
LAc13	Pollinator walls/vertical	228.8
LAc16	Floating gardens	-10.8

QUANTITATIVE DATA SUMMARY										
CH0412: Flower Count		Pre-Intervention				Post-Intervention				% Change
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	
LAc8	Lower SuDS	4	1	37.0	23.9	11	1	267.5	205.8	623.1
LAc8	Upper Pitt St RG	6	1	94.8	58.7	3	1	127.3	42.1	34.3
LAc12	Baltic Hub POLL	4	1	326.0	178.6	2	1	483.0	521.8	48.2
LAc12	Bott SP Aig Dr POLL	3	1	28.0	14.8	7	1	528.1	935.8	1786.2
LAc12	Cornwallis St POLL	10	1	84.8	124.6	3	1	233.3	182.4	175.2

LAc12	Lower SuDS POLL	4	1	37.0	23.9	11	1	267.5	205.8	623.1
LAc12	Park Lane POLL	3	1	37.3	24.9	7	1	401.3	470.9	974.9
LAc12	Princes Av POLL					7	1	402.3	563.9	
LAc12	Princes roundabt POLL	5	1	98.2	144.5					
LAc12	Strand POLL	4	1	67.0	23.6	6	1	565.3	411.1	743.8
LAc12	Top SP Aig Dr POLL	4	1	660.3	1043.5	2	1	1487.5	1594.5	125.3
LAc12	Top SP roundabt POLL	1	1	135.0						
LAc12	Ullet Rd POLL	3	1	170.7	246.3	5	1	269.4	92.6	57.9
LAc12	Wapping POLL	5	1	196.6	293.5	2	1	319.0	161.2	62.3
LAc13	L1 GW					2	1	206.0	217.8	
LAc13	Parr St GW	1	1	50.0		12	1	164.4	190.8	228.8
LAc13	St Johns GW					10	1	378.2	368.5	
LAc16	SPL FI	2	1	115.5	92.6	1	1	103.0		-10.8
LAc16	Wapping FI	1	1	162.0						

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

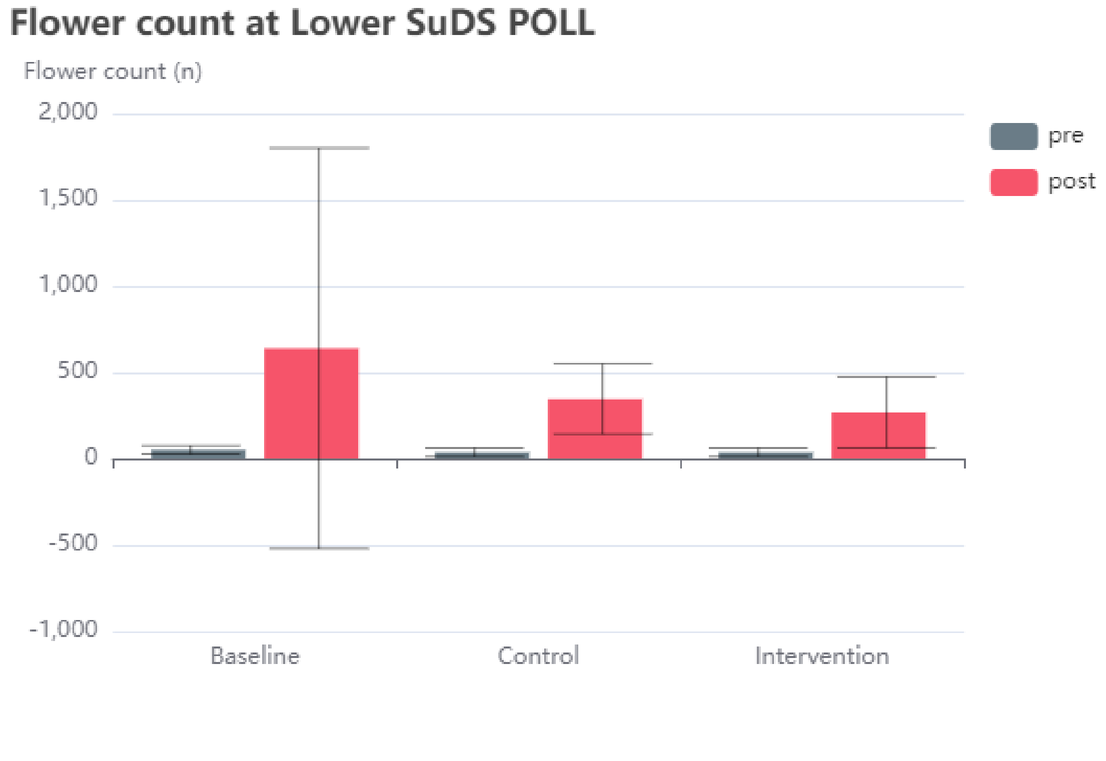
For related intervention site names, please see table below:

FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0412	FLORAL RESOURCES INCREASE	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		Upper SuDS, Lower SuDS
		LAc12	Pollinator Planting Spaces and Verges	Baltic Green Route POLL, Cornwallis St POLL, Pitt St POLL, Park Lane POLL, Baltic Hub POLL, Strand POLL, Wapping POLL		Princes Av POLL, Princes roundabt POLL, Ullet Rd POLL, Top SP Aig Dr POLL, Top SP roundabt POLL, Bott SP Aig Dr POLL, Upper SuDS POLL, Lower SuDS POLL
		LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW, L1GW	
		LAc14	Pollinator roofs		RoyaL Court GR	
		LAc16	Floating gardens	Wapping FI		SPL FI

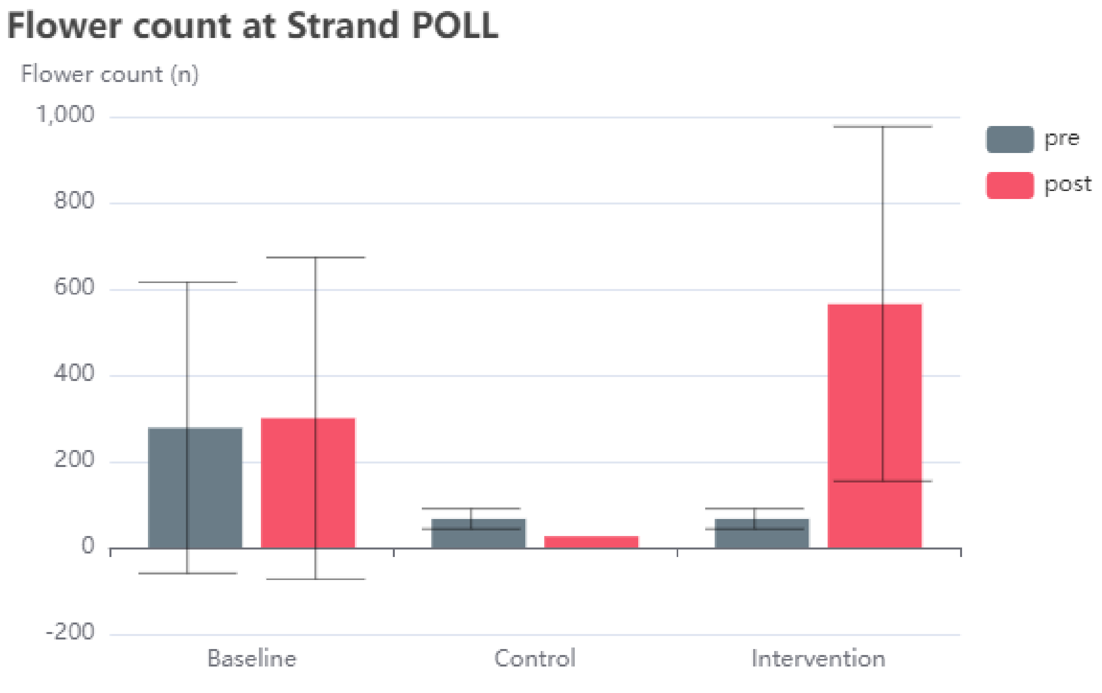
Map of monitoring locations: See CH0410

Equipment and methodology: See CH0410

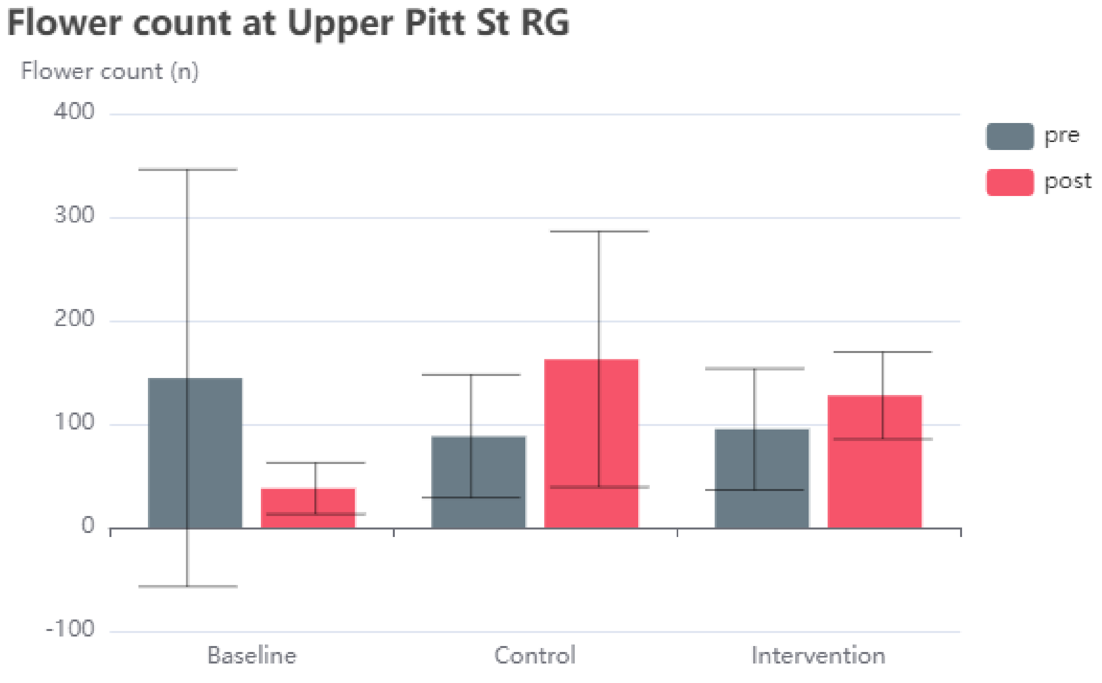
Summary plot example for pollinator verge: Sub-Demo C: Lower SuDs POLL



Summary plot example for pollinator verge: Sub-Demo A: Strand POLL



Summary plot example for sub demo A Rain garden:



The data tended to follow the pattern of the pollinator abundances and diversity results (as in CH0410). Overall, positive changes were observed for all areas, particularly for sub demo A (73% increase in floral abundance) with sub demo C at 20% and overall Liverpool at 55% increase.

From a more detailed assessment of the data, the pollinator verges were shown to have the most increase in flower numbers (511%), followed by the Suds and rain garden (329%) and pollinator vertical walls (229%). The floating gardens showed a slight decreased change, but on a low number of observations.

The rain garden was important with a 34% increase in flowers, with the lower SuDs area as a whole showing a 623% increase in flowers. For the green walls, although the % change could not be calculated for all, these interventions were shown to be important with high number of flowers post-interventions. Parr Street showed a 229% increase. Of the pollinator planting sites, the lower Aigburth Drive site (Bott SP Aig Dr POLL), Park Lane POLL and Strand POLL were the most important (1786%, 975% and 744% increases respectively).

Overall, all sites and areas showed generally positive increases in floral abundances (see summary plots).

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
None	
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed

None	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data comparisons with comparative data sources such as local BioBank and iNaturalist records would be useful to understand the impact of the interventions on the floral diversity and abundances.

Overall, all sites and areas showed generally positive increases in floral abundances (see summary plots). These changes mainly reflected the pollinator abundances, although some influence of factors such as shade and local climate should be taken into account.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.17 CH0411 Plant species increas

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0411	PLANT SPECIES INCREASE	CFT
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc8, LAc12, LAc13, LAc14, LAc16	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Observational Flower-Insect Timed counts

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY
CH0411: Plant Count

Pre-Intervention				Post-Intervention				% Change	Area
n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd		
60	15	3.3	2.5	91	15	6.3	5.4	90.2	**Overall Liverpool**
34	8	4.8	2.4	35	7	10.4	4.5	117.5	**Sub-Demo A**
				12	2	10.7	5.0		**Sub-Demo B**
26	7	1.4	0.5	44	6	1.9	0.4	34.2	**Sub-Demo C**

QUANTITATIVE DATA SUMMARY									
CH0411: Plant diversity									
Pre-Intervention				**Post-Intervention**				**% Change**	**Area**
n_obs	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**		
60	15	2.5	1.6	91	15	3.9	3.0	55.2	**Overall Liverpool**
34	8	3.5	1.5	35	7	6.1	2.4	73.2	**Sub-Demo A**
				12	2	6.5	2.6		**Sub-Demo B**
26	7	1.2	0.4	44	6	1.4	0.5	20.2	**Sub-Demo C**

QUANTITATIVE DATA SUMMARY		
CH0411: Plant Count		
NBS	**NBS Name**	**% Change**
LAc8	SuDs & Rain Garden	68.4
LAc12	Pollinator verges and spaces	77.4
LAc13	Pollinator walls/vertical	1108.3
LAc16	Floating gardens	33.3

QUANTITATIVE DATA SUMMARY										
CH0411: Plant Count		**Pre-Intervention**				**Post-Intervention**				**% Change**
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	
LAc8	Lower SuDS	4	1	1.3	0.5	11	1	1.9	0.5	52.7
LAc8	Upper Pitt St RG	6	1	4.2	2.6	3	1	7.7	2.3	84.0

LAc12	Baltic Hub POLL	4	1	7.3	2.5	2	1	11.5	0.7	58.6
LAc12	Bott SP Aig Dr POLL	3	1	1.3	0.6	7	1	2.0	0.0	50.0
LAc12	Cornwallis St POLL	10	1	5.6	2.3	3	1	5.0	1.0	-10.7
LAc12	Lower SuDS POLL	4	1	1.3	0.5	11	1	1.9	0.5	52.7
LAc12	Park Lane POLL	3	1	4.3	2.3	7	1	9.6	5.5	120.9
LAc12	Princes Av POLL					7	1	1.9	0.4	
LAc12	Princes roundabt POLL	5	1	1.4	0.5					
LAc12	Strand POLL	4	1	3.3	0.5	6	1	12.3	3.7	279.5
LAc12	Top SP Aig Dr POLL	4	1	1.5	0.6	2	1	2.0	0.0	33.3
LAc12	Top SP roundabt POLL	1	1	2.0						
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.8	0.4	8.0
LAc12	Wapping POLL	5	1	4.4	2.3	2	1	9.0	4.2	104.5
LAc13	L1 GW					2	1	2.0	0.0	
LAc13	Parr St GW	1	1	1.0		12	1	12.1	4.7	1108.3
LAc13	St Johns GW					10	1	12.4	3.2	
LAc16	SPL FI	2	1	1.5	0.7	1	1	2.0		33.3
LAc16	Wapping FI	1	1	4.0						

QUANTITATIVE DATA SUMMARY		
CH0411: Plant diversity		
NBS	**NBS Name**	**% Change**
LAc8	SuDs & Rain Garden	52.4
LAc12	Pollinator verges and spaces	55.0
LAc13	Pollinator walls/vertical	541.7
LAc16	Floating gardens	0.0

QUANTITATIVE DATA SUMMARY			
CH0411: Plant diversity	**Pre-Intervention**	**Post-Intervention**	**% Change**

NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	
LAc8	Lower SuDS	4	1	1.0	0.0	11	1	1.4	0.5	36.4
LAc8	Upper Pitt St RG	6	1	3.2	1.6	3	1	5.3	1.2	68.4
LAc12	Baltic Hub POLL	4	1	3.8	1.5	2	1	5.5	0.7	46.7
LAc12	Bott SP Aig Dr POLL	3	1	1.0	0.0	7	1	1.7	0.5	71.4
LAc12	Cornwallis St POLL	10	1	4.7	1.3	3	1	3.3	0.6	-29.1
LAc12	Lower SuDS POLL	4	1	1.0	0.0	11	1	1.4	0.5	36.4
LAc12	Park Lane POLL	3	1	2.7	0.6	7	1	6.3	3.5	135.7
LAc12	Princes Av POLL					7	1	1.3	0.5	
LAc12	Princes roundabt POLL	5	1	1.2	0.4					
LAc12	Strand POLL	4	1	3.3	0.5	6	1	7.5	2.1	130.8
LAc12	Top SP Aig Dr POLL	4	1	1.3	0.5	2	1	2.0	0.0	60.0
LAc12	Top SP roundabt POLL	1	1	1.0						
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.0	0.0	-40.0
LAc12	Wapping POLL	5	1	3.0	1.6	2	1	5.5	0.7	83.3
LAc13	L1 GW					2	1	2.0	0.0	
LAc13	Parr St GW	1	1	1.0		12	1	6.4	2.4	541.7
LAc13	St Johns GW					10	1	7.4	1.8	
LAc16	SPL FI	2	1	1.0	0.0	1	1	1.0		0.0
LAc16	Wapping FI	1	1	2.0						

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

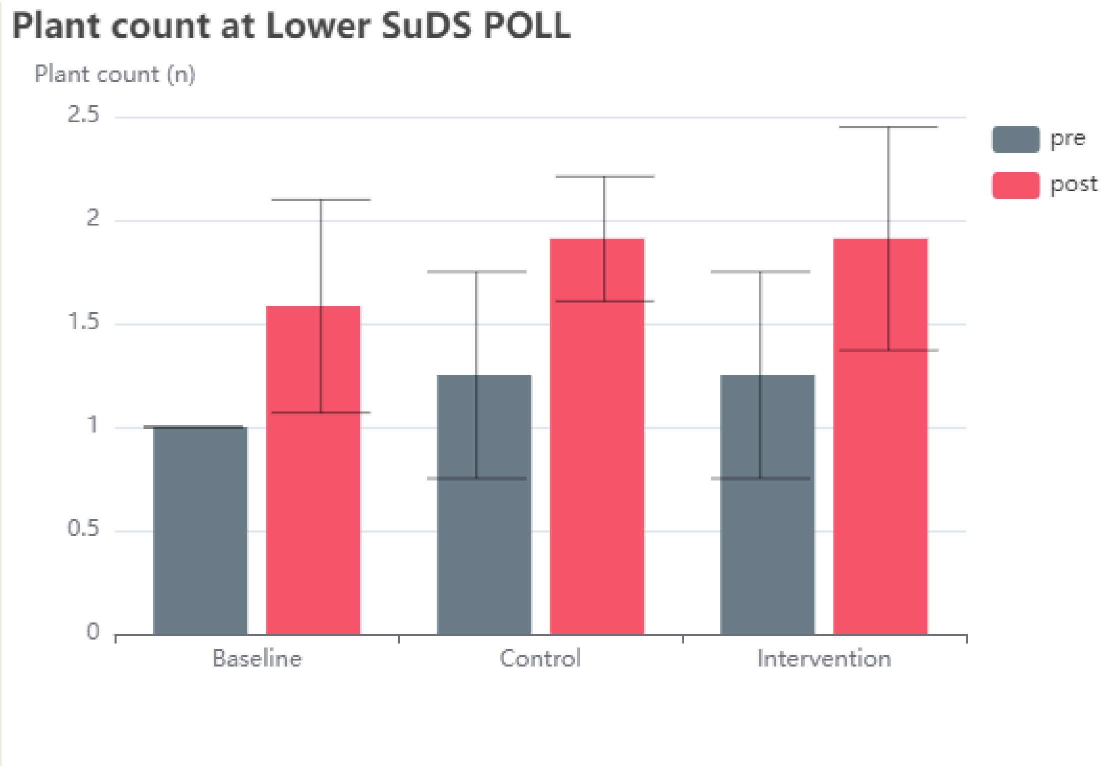
For related intervention site names, please see table below:

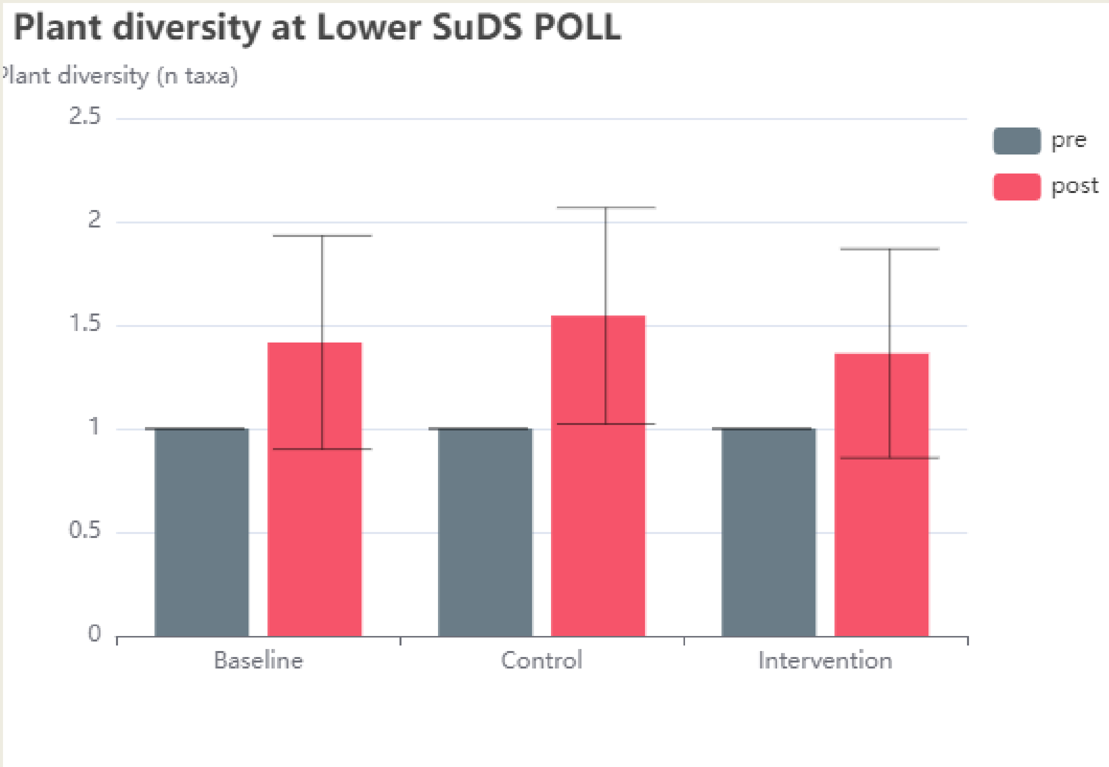
FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0411	PLANT SPECIES INCREASE	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		Upper SuDS, Lower SuDS
		LAc12	Pollinator Planting Spaces and Verges	Baltic Green Route POLL, Cornwallis St POLL, Pitt St POLL, Park Lane POLL, Baltic Hub POLL, Strand POLL, Wapping POLL		Princes Av POLL, Princes roundabt POLL, Ullet Rd POLL, Top SP Aig Dr POLL, Top SP roundabt POLL, Bott SP Aig Dr POLL, Upper SuDS POLL, Lower SuDS POLL
		LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW, L1GW	
		LAc14	Pollinator roofs	RoyaL Court GR		
		LAc16	Floating gardens	Wapping FI		SPL FI

Map of monitoring locations: See CH0410

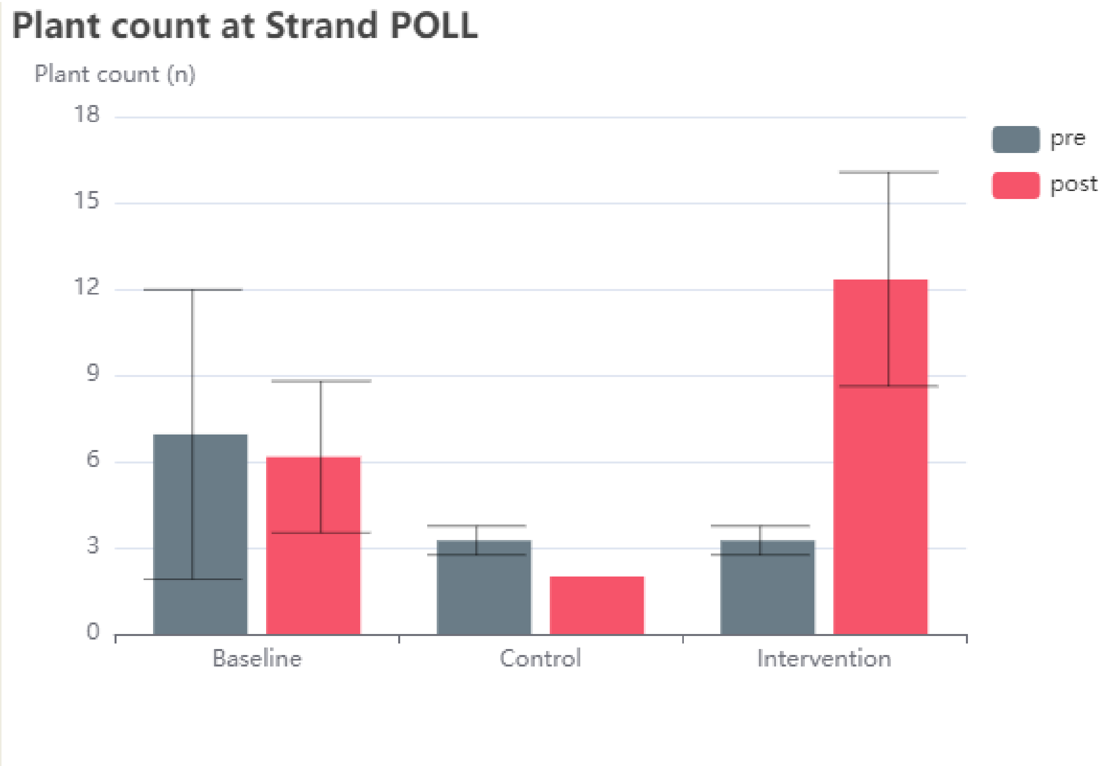
Equipment and methodology: See CH0410

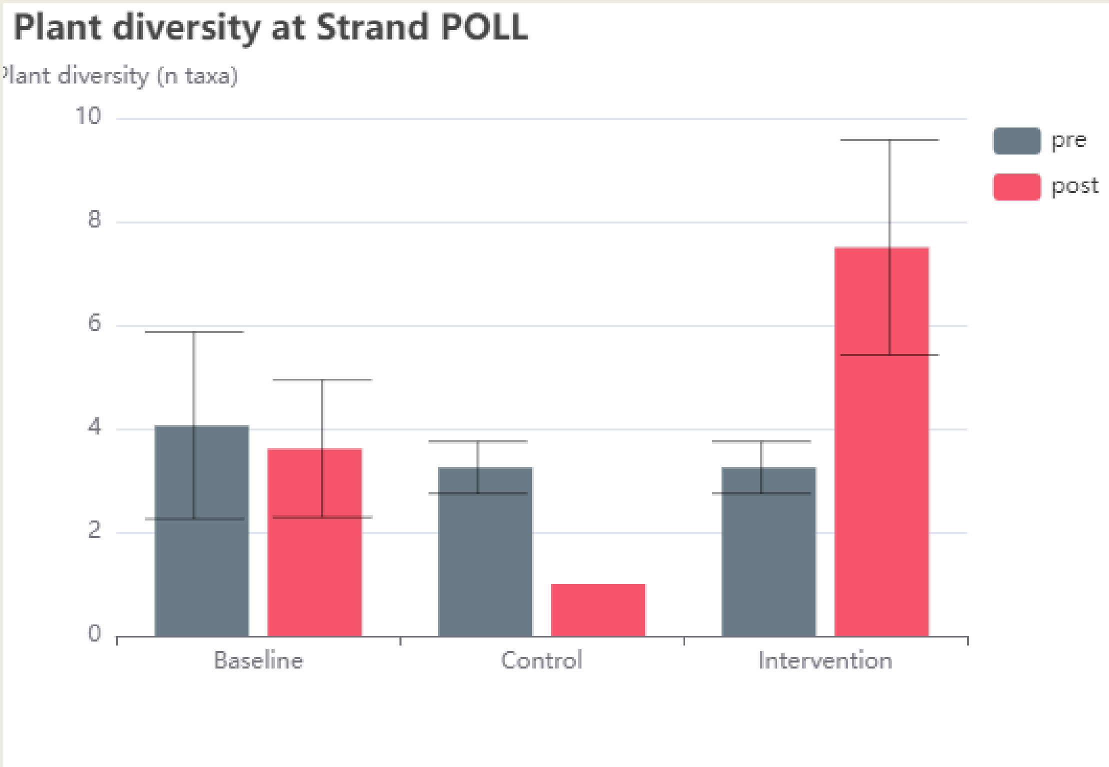
Summary plot example for pollinator verge: Sub-Demo C: Lower SuDs POLL



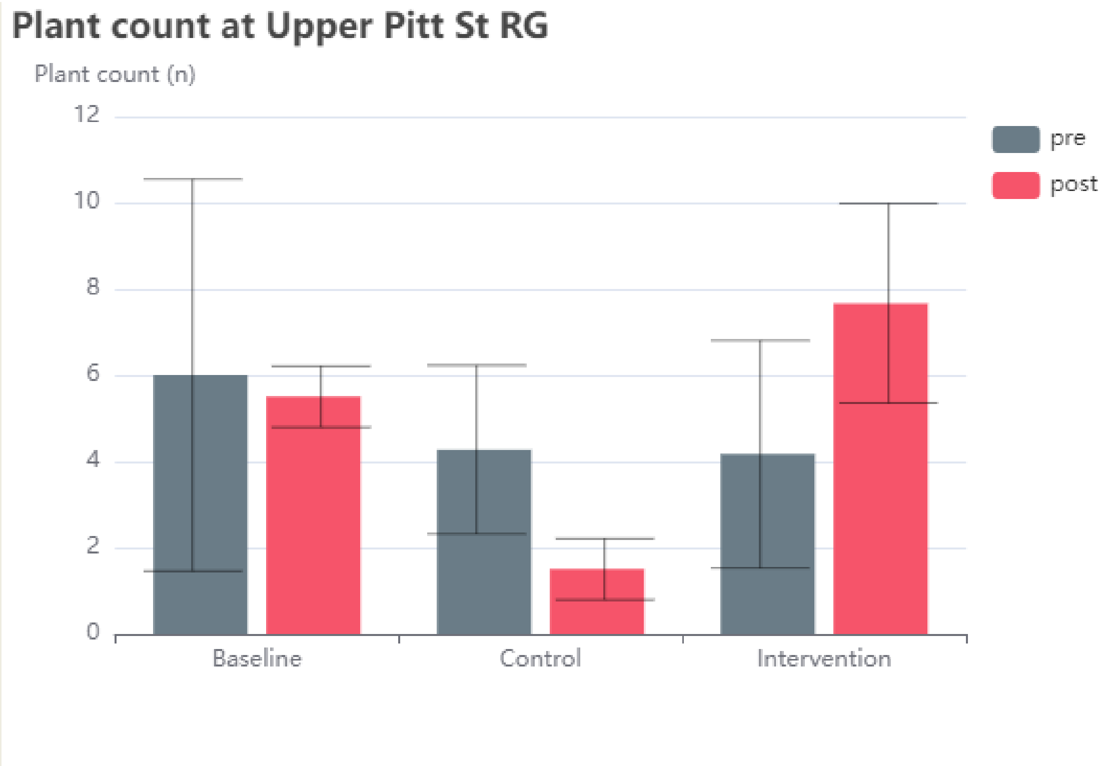


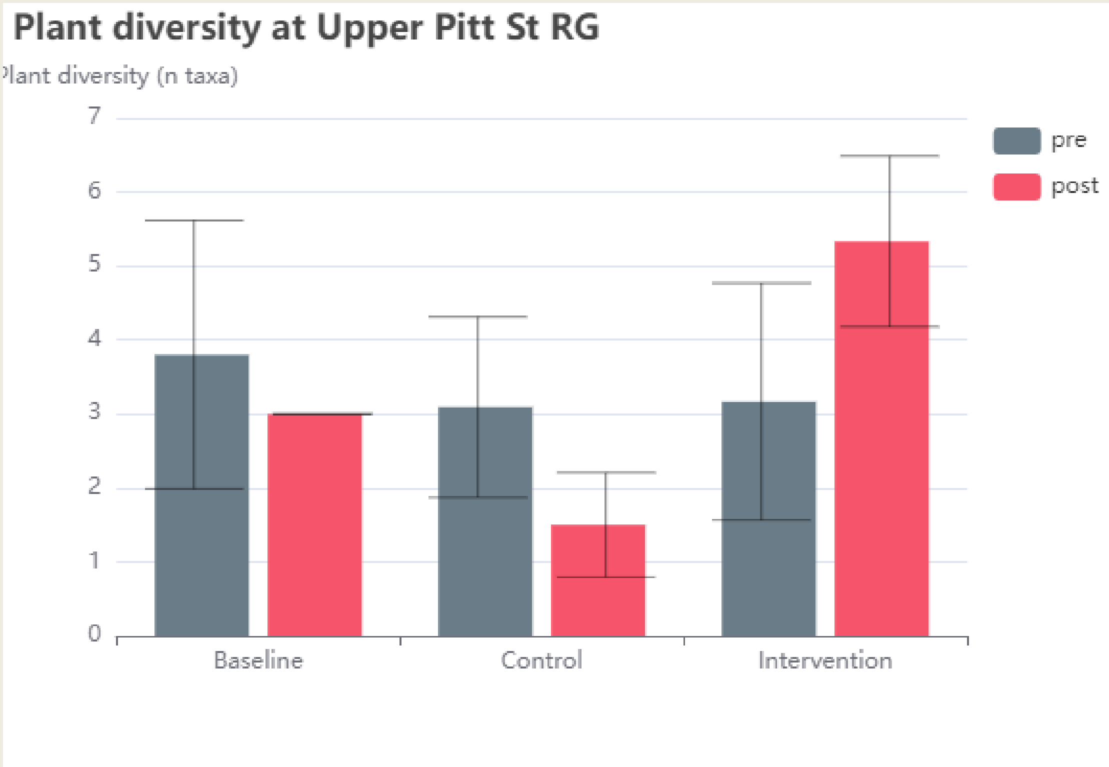
Summary plot example for pollinator verge: Sub-Demo A: Strand POLL





Summary plot example for sub demo A Rain garden:





The data showed positive changes throughout all areas, particularly for sub demo A with 118% and 73% increases in plant counts and diversity of plant families respectively. Sub demo C (34% and 20% respectively) and overall Liverpool (90% and 55% respectively) also showed increase in these counts with the Urban GreenUP project.

From the detailed breakdown, the pollinator walls showed the most important positive increase (1108% and 542% respectively) with pollinator verges (77% and 55% respectively) and Suds and rain garden (68% and 52% respectively) also important. The floating gardens again had a low number of observations, but still showed an increase in plant count (33%).

The rain garden in sub demo A was important in increasing the plant diversity (84% and 68% respectively for plant count and plant family diversity), plus the entire Lower Suds area was important at 53% and 36% respectively. The green wall percentage changes could not always be calculated, but all showed an increased number and diversity of plants, with Parr Street showing a 1108% plant count and 541% plant diversity increase. The pollinator verges were very important, particularly Strand POLL (280% and 131% respectively) and Park Lane POLL (121% and 136% respectively). Please see example plots.

Overall, all sites and areas showed an increase in plant counts and diversity of plant families.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
None	
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed

None	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data comparisons with comparative data sources such as local BioBank and iNaturalist records would be useful to understand the impact of the interventions on the plant species and diversity.

Overall, all sites and areas showed an increase in plant counts and diversity of plant families. This was particularly shown for large, planted areas.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.18 CH0413 Insectivore increase

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0413	INSECTIVORE INCREASE	CFT
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc8, LAc12, LAc13, LAc14, LAc16	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Observational transects

Quantitative monitoring data results:

Bat (Chiroptera) results for the vicinity of each intervention: Number of Bat passes (Note this is not the same as the number of bats) and maximum diversity noted:

	BAT PASSES		
Bats recorded in the vicinity of interventions	**PRE-INTERVENTION**	**POST-INTERVENTION**	**% Change**

St Johns GW			
RoyaL Court GR			
Strand Tree SuDS	10		-100.0
Parr St GW			
Sub demo A pollinator sites	1		-100.0
Wapping FI			
SPL FI	141	564	300.0
Upper SuDS	13	6	-53.8
Lower SuDS	10	15	50.0
Sub Demo C pollinator sites	1	42	4100.0
Total sub demo A	**1**		-100.0
Total sub demo B	**10**		-100.0
Total sub demo C	**165**	**627**	280.0

	BAT DIVERSITY		
Bats recorded in the vicinity of interventions	**PRE-INTERVENTION**	**POST-INTERVENTION**	**% Change**
St Johns GW			
RoyaL Court GR			
Strand Tree SuDS	1		-100.0
Parr St GW			
Sub demo A pollinator sites	1		-100.0
Wapping FI			
SPL FI	5	5	0.0
Upper SuDS	1	1	0.0
Lower SuDS	2	2	0.0
Sub Demo C pollinator sites	1	4	300.0
Total sub demo A	**1**		-100.0
Total sub demo B	**1**		-100.0
Total sub demo C	**5**	**5**	0.0

Dragonfly and damselfly (Odonata) results:

Sefton Park Floating island: Odonata abundance and diversity:

Odonata Abundance	**SP FI**		
Distance from intervention (m)	**pre**	**post**	**% Change**
0-50	13	4	-69.2
<250	9	2	-77.8
<500	65	19	-70.8
<750	55	21	-61.8
<1000	36	35	-2.8
<1250	35	39	11.4
<1500	0	10	
1500+	2	7	250.0

Odonata Diversity	**SP FI**		
Distance from intervention (m)	**pre**	**post**	**% Change**
0-50	3	1	-66.7
<250	3	1	-66.7
<500	5	1	-80.0
<750	3	3	0.0
<1000	3	3	0.0
<1250	4	4	0.0
<1500	0	2	
1500+	1	2	100.0

Upper SuDs water retention pond: Odonata abundance and diversity:

Odonata Abundance	**Upper SuDs**		
Distance from intervention (m)	**pre**	**post**	**% Change**
0-50	0	0	

<250	0	0	
<500	6	0	-100.0
<750	9	12	33.3
<1000	13	4	-69.2
<1250	59	19	-67.8
<1500	43	27	-37.2
1500+	85	75	-11.8

Odonata Diversity	**Upper SuDs**		
Distance from intervention (m)	**pre**	**post**	**% Change**
0-50	0	0	
<250	0	0	
<500	4	0	-100.0
<750	3	2	-33.3
<1000	3	1	-66.7
<1250	5	1	-80.0
<1500	3	3	0.0
1500+	4	4	0.0

Lower SuDs water retention pond: Odonata abundance and diversity:

Odonata Abundance	**Lower SuDs**		
Distance from intervention (m)	**pre**	**post**	**% Change**
0-50	0	10	Positive
<250	0	0	
<500	0	0	
<750	0	0	
<1000	8	7	-12.5
<1250	9	2	-77.8
<1500	13	4	-69.2
1500+	185	114	-38.4

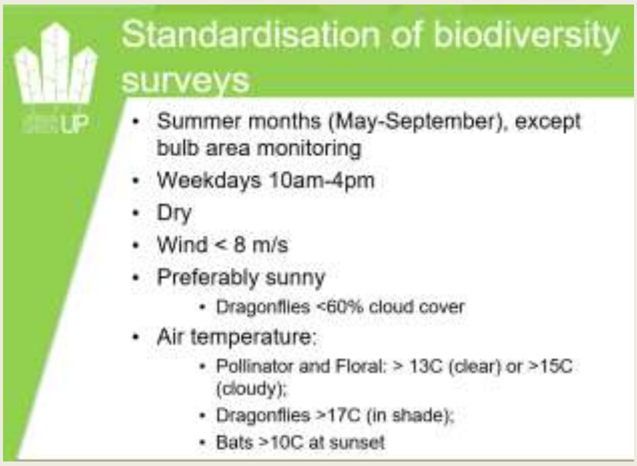
Odonata Diversity	Lower SuDs		
Distance from intervention (m)	pre	post	% Change
0-50	0	2	Positive
<250	0	0	
<500	0	0	
<750	0	0	
<1000	4	2	-50.0
<1250	3	1	-66.7
<1500	3	1	-66.7
1500+	5	4	-20.0

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

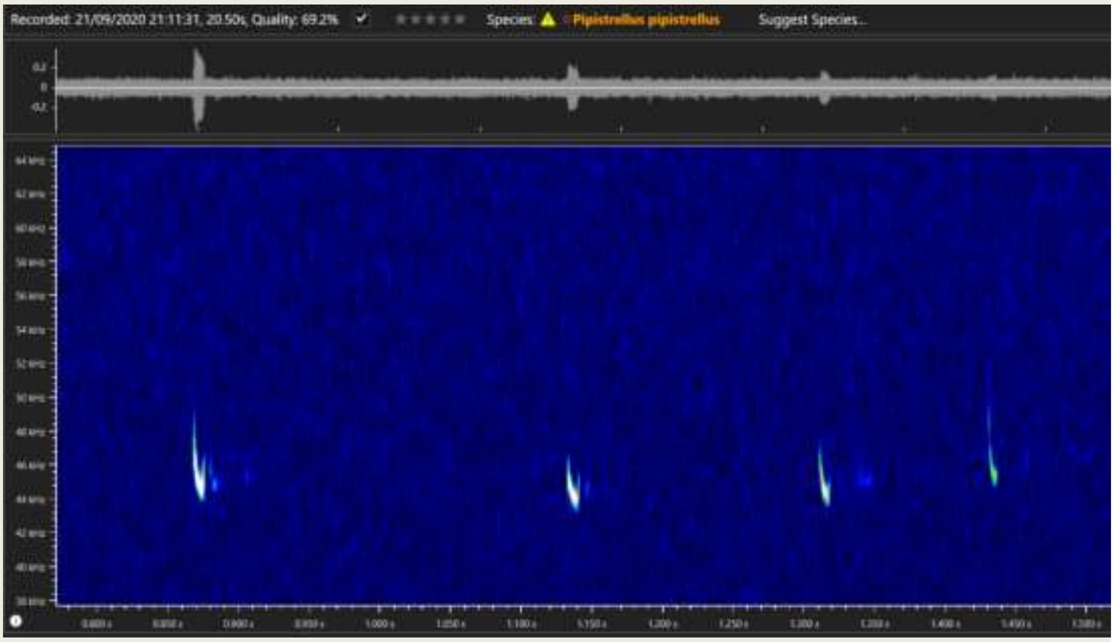
For related intervention site names, please see table below:

FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0413	INSECTIVORE INCREASE	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		Upper SuDS, Lower SuDS
		LAc12	Pollinator Planting Spaces and Verges	Baltic Green Route POLL, Cornwallis St POLL, Pitt St POLL, Park Lane POLL, Baltic Hub POLL, Strand POLL, Wapping POLL		Princes Av POLL, Princes roundabt POLL, Ullet Rd POLL, Top SP Aig Dr POLL, Top SP roundabt POLL, Bott SP Aig Dr POLL, Upper SuDS POLL, Lower SuDS POLL
		LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW, L1GW	
		LAc14	Pollinator roofs		RoyaL Court GR	
		LAc16	Floating gardens	Wapping FI		SPL FI

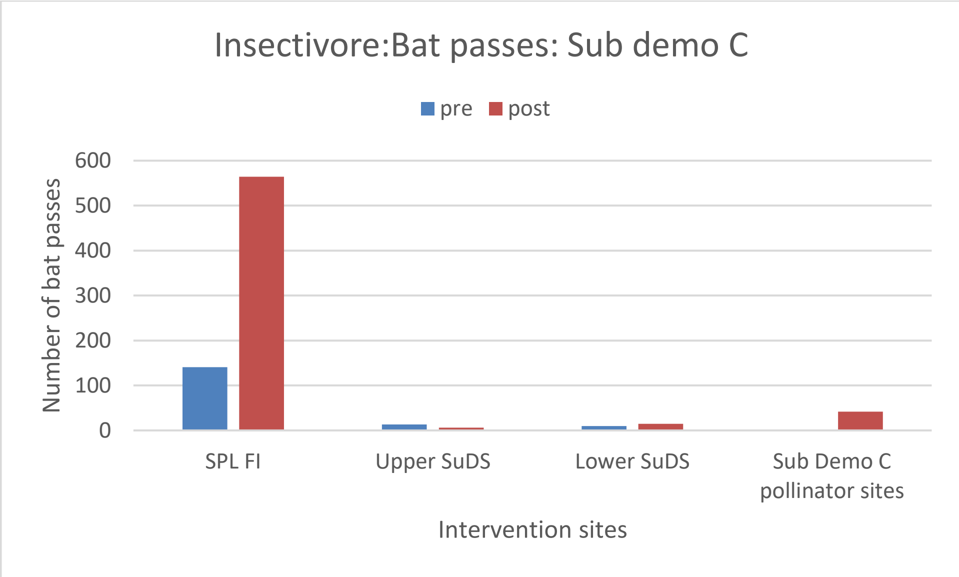
Map of monitoring locations, equipment and methodology:

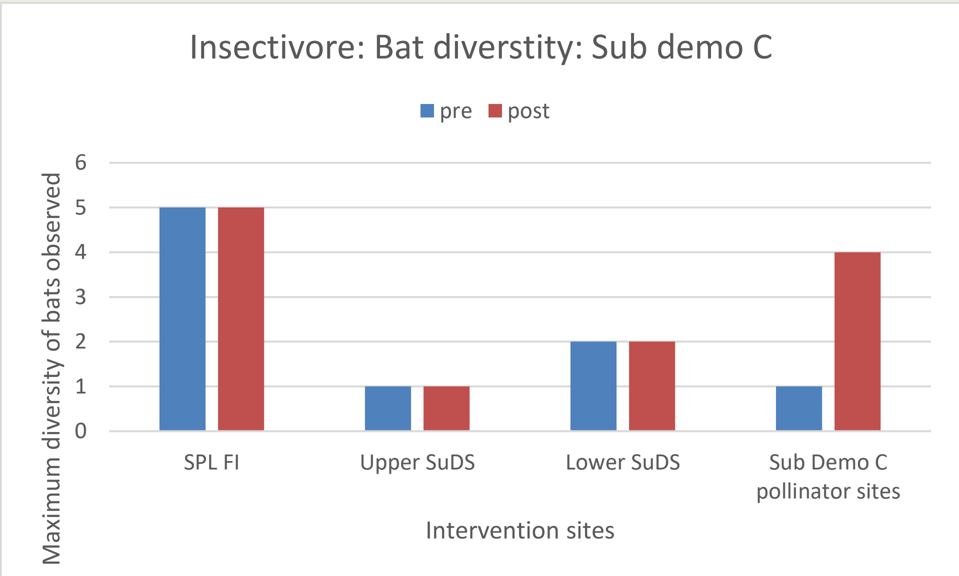


Example sonogram from bat monitoring recorded using a Batlogger M detector and sonogram produced using Batexplorer software (Elekon, Switzerland): Common Pipistrelle adjacent to Lower Suds:

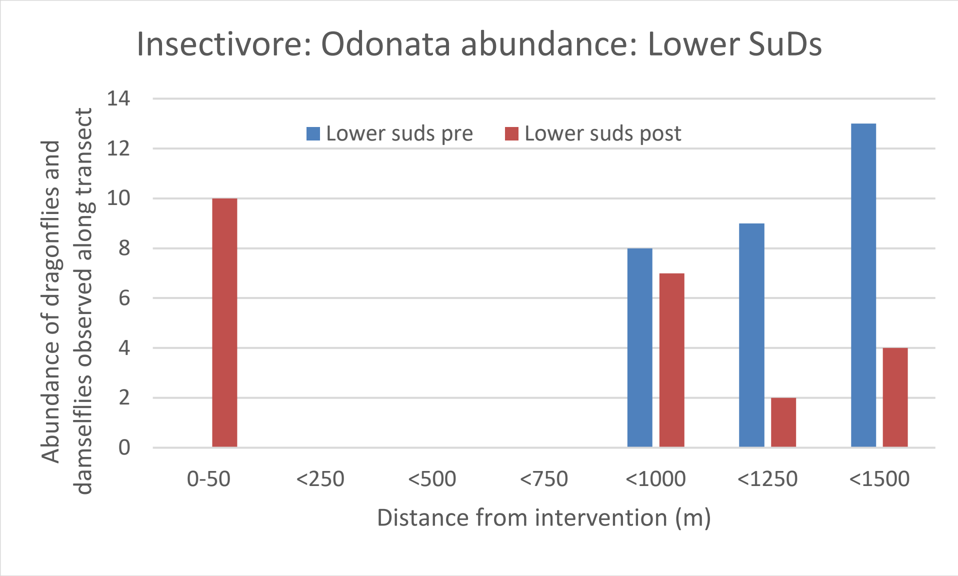


Bat data: Example summary plots: Bat passes and diversity in sub demo C:

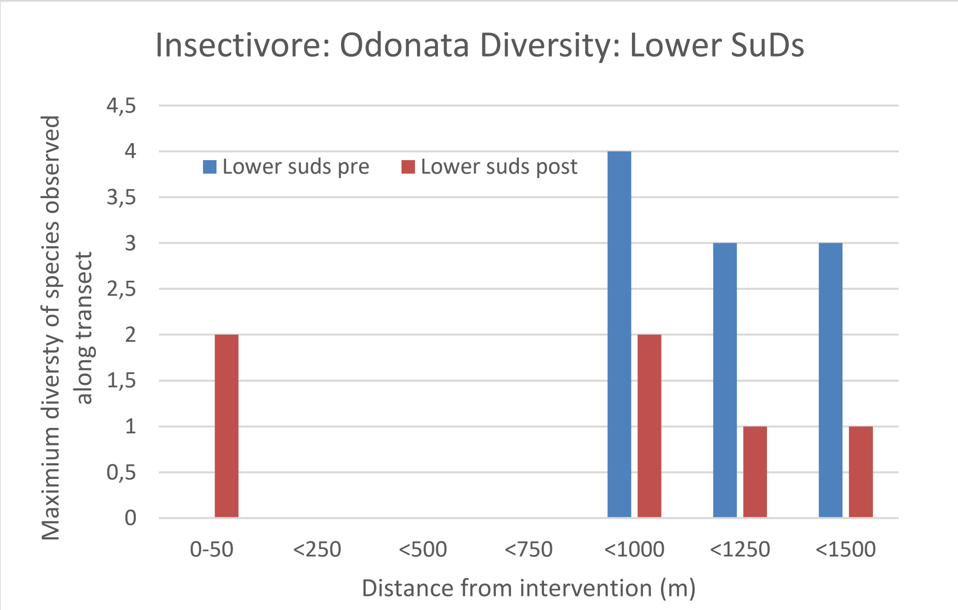




Example summary distance from intervention plot: Odonata Abundance: Lower SuDs



Example summary distance from intervention plot: Odonata Diversity: Lower SuDs



The bat data showed great variations in number of bat passes. This group varied greatly according to climatic conditions. Not many bats were observed within the more central sub demos A and B, but plenty of bats were observed in sub demo C, particularly on Sefton Park Lane adjacent to the floating island (SPL FI). Positive increases with the introduction of the interventions were observed for Sefton Park floating island, the lower SuDs water retention pond and the pollinator planting sites. The pollinator planting sites seemed to increase the diversity of the bats foraging as well. So overall, a positive effect was observed after the interventions were added, but further analyses to look a weather conditions would help to better interpret these data.

The Odonata, dragonflies and damselflies, showed great variations in their abundance and diversity of species according to the season and overall climatic conditions (historical and on the day of survey). Due to this variation, it was difficult to determine any effect from the interventions, except where a pond was added as at the Lower SuDs site. At the Lower Suds site, the dragonflies and damselflies were provided with a habitat, so the numbers increased. Even thorough binoculars it was difficult to see small damselflies on the Sefton Park floating island (SP FI), so the observations here may be less than in reality and climatic conditions may have caused the drop in observations noted at the time of survey. At the Upper SuDs site, water may have been flowing too fast to provide an adequate habitat. Hence, the results were generally inconclusive, except for a positive change where a waterbody habitat was introduced.

Overall, the insectivores appeared to show a positive change with the introduction of the Urban green up interventions.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
None	
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Insectivore numbers highly variable due to environmental factors. Ideally the methodology would have included more intensive surveying.	Awareness of limitation of data

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data analyses with comparative data sources such as shown in the table below, would be useful to understand any impacts of the interventions on the diversity and abundances of the insectivores observed.

Insectivores: NBS & Comparative Data Sources

KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS			OTHER COMPARATIVE DATA SOURCES				OTHER VARIABLES
INSECTIVORE INCREASE	LAc1 & LAc2	New green cycle route & Green travel route				Local climate	Liverpool climate	Biobank/ Naturalist records		
	LAc8	Rain Garden (SUDs)	Upper SuDS	Lower SuDS	Upper Pitt St RG	Local climate	Liverpool climate	Biobank/ Naturalist records		
	LAc12	Pollinator Planting Spaces and Verges	POLL-A *6	POLL-C *8		Local climate	Liverpool climate	Biobank/ Naturalist records		
	LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW	LE GW	Local climate	Liverpool climate	Biobank/ Naturalist records		
	LAc14	Pollinator roofs	Royal Court GR			Local climate	Liverpool climate	Biobank/ Naturalist records		
	LAc16	Floating gardens	SPL FI	Wapping FI		Local climate	Liverpool climate	Biobank/ Naturalist records		

As the number of insectivores observed, bats and dragonflies, varied greatly with seasonal and environmental conditions, further analyses would be helpful to distinguish patterns in the data.

Results were very variable, but positive changes with the project were seen where a pond habitat was added as for the Lower SuDs site and for the floating island habitat area in Sefton Park (for the bats).

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.19 CH0501 Deaths related to pollution and contamination

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	CFT
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

GI-VAL results:

CH0501: Deaths related to Pollution and Contamination	**GI-VAL BENEFITS**	**Sub-Demo Areas**			**Overall Liverpool**	**BENEFIT QUANTIFICATION**
Functions	**Tools**	**A**	**B**	**C**		
Provision of attractive opportunities for exercise	4.2 Reduced mortality from increased walking and cycling	0.81	0.88	26.31	26.50	lives saved per yr

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The closest indicator by the modelling analysis program GI-VAL demonstrates a reduced mortality from increased walking and cycling levels by 26.5% for overall Liverpool.

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project. GI-VAL could not provide a precise indicator for this KPI.	Awareness of limitations of model
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Positive change in the form of a reduced mortality resulting from increased exercise. This is used as an indicator for this KPI.
What was the impact? (positive/negative, significant/non-significant)?
Positive

Other comments

Optional: Any other relevant comments that you would like to include.

Unfortunately, the modelling software available could not provide a closer indicator for this KPI.

1.2.20 CH0502 Annual mean levels of fine PM2.5 particules

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	CFT and LCC
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc4, LAc8, LAc12, LAc13, LAc14, LAc17	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Portable photometric sampler

MODELLING: GI-Val

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY									
CH0502: PM 2.5									
Pre-Intervention				**Post-Intervention**				**% Change**	**Area**
n_obs	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**		
427	22	10.1	9.9	291	30	8.0	7.4	-20.6	**Overall Liverpool**
78	4	9.4	10.4	47	5	6.8	7.4	-28.2	**Sub-Demo A**
277	12	11.0	10.5	150	15	8.8	7.1	-20.7	**Sub-Demo B**
42	3	8.1	5.7	24	3	5.3	3.0	-35.0	**Sub-Demo C**

QUANTITATIVE DATA SUMMARY		
CH0502: PM 2.5		
NBS	**NBS Name**	**% Change**
LAc4	Urban catchment forestry	-49.3
LAc8	SuDs & Rain Garden	-62.6

LAc12	Pollinator verges and spaces	9.0
LAc13	Pollinator walls/vertical	-7.4
LAc14	Pollinator roofs	-57.3
LAc17	Green filter area	-13.8

QUANTITATIVE DATA SUMMARY										
CH0502: PM 2.5		Pre-Intervention				Post-Intervention				% Change
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	
LAc4	Strand Tree SuDS	110	4	11.7	13.1	40	4	6.0	6.1	-49.3
LAc8	Upper Pitt St RG	30	2	9.9	13.9	2	2	2.0	0.0	-79.8
LAc8	Upper SuDS	18	2	9.2	5.5	22	2	5.0	3.0	-45.3
LAc12	Bott SP Aig Dr POLL	24	1	7.3	5.9	2	1	8.0	2.8	9.1
LAc12	Cornwallis St POLL	33	1	8.3	7.7	3	1	9.0	5.6	8.8
LAc13	L1 GW	30	3	5.3	2.8	70	7	8.1	8.7	52.0
LAc13	Parr St GW	15	1	11.0	7.1	42	2	6.8	7.6	-37.9
LAc13	St Johns GW	29	2	15.6	8.5	47	5	9.9	6.8	-36.3
LAc14	Royal Court GR	2	1	26.0	8.5	35	1	11.1	7.5	-57.3
LAc17	Lime St TREES	86	3	10.0	8.3	10	3	6.8	7.2	-31.9
LAc17	Stafford St TREES	50	2	8.1	6.5	18	2	8.4	7.5	4.3

GI-VAL results:

CH0502: PM2.5 trends: GI-VAL BENEFITS	Sub-Demo Areas			Overall Liverpool	BENEFIT QUANTIFICATION
Tools	A	B	C		
4.6 Reduced air pollution	0.0004	0.0017	0.0003	0.0000	t/yr of PM2.5 removed

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

For intervention site names used for the quantitative data monitoring, see table below.

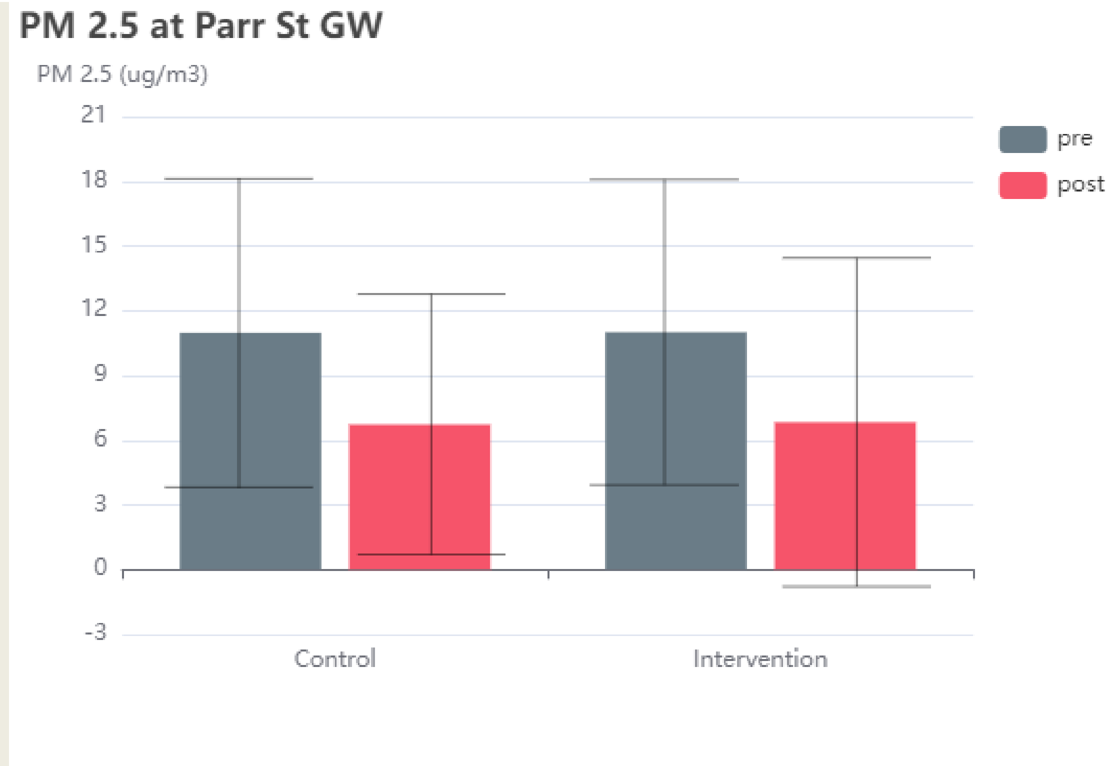
FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc4	Urban Catchment forestry		Strand Tree SuDS	
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		
		LAc12	Pollinator Planting Spaces and Verges	Baltic Green Route POLL, Cornwallis St POLL, Pitt St POLL, Park Lane POLL, Baltic Hub POLL, Strand POLL, Wapping POLL		Princes Av POLL, Princes roundabt POLL, Ullet Rd POLL, Top SP Aig Dr POLL, Top SP roundabt POLL, Bott SP Aig Dr POLL, Upper SuDS POLL, Lower SuDS POLL
		LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW, L1GW	
		LAc14	Pollinator roofs		RoyaL Court GR	
		LAc17	Green filter area with large urban trees		Green_Filter_TREES	

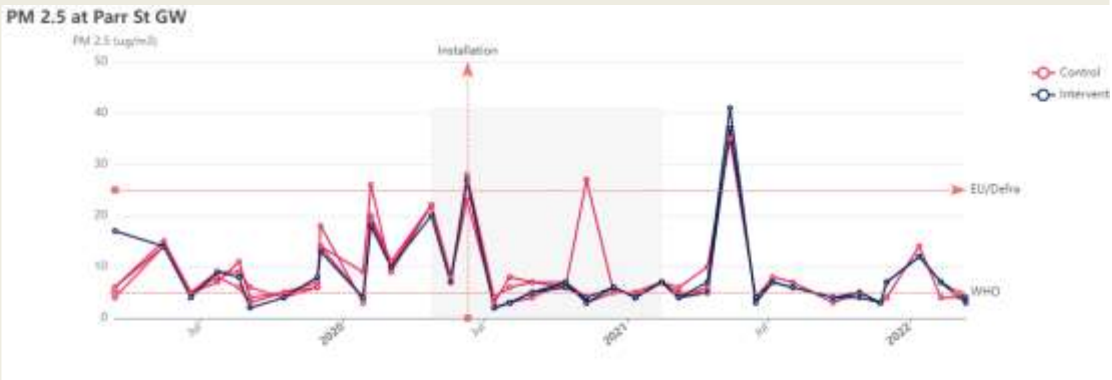
Map of monitoring locations

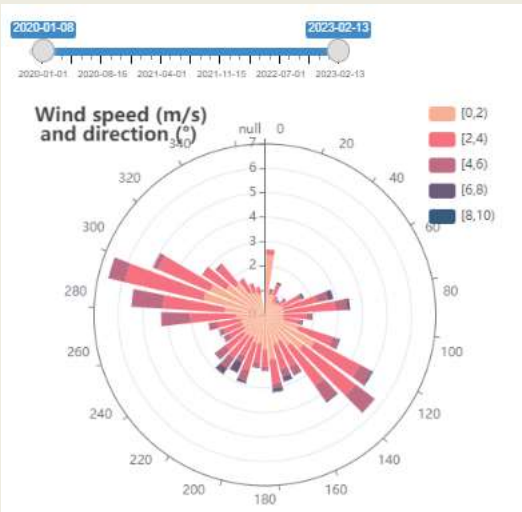
Equipment and methodology:

<u>Summary plot example: Vertical green wall:</u>

Box plots showing pre and post intervention at wall and control sites; Time-line showing installation of green wall (shading showing covid lockdown period); wind rose showing wind direction and speeds over the monitoring period.

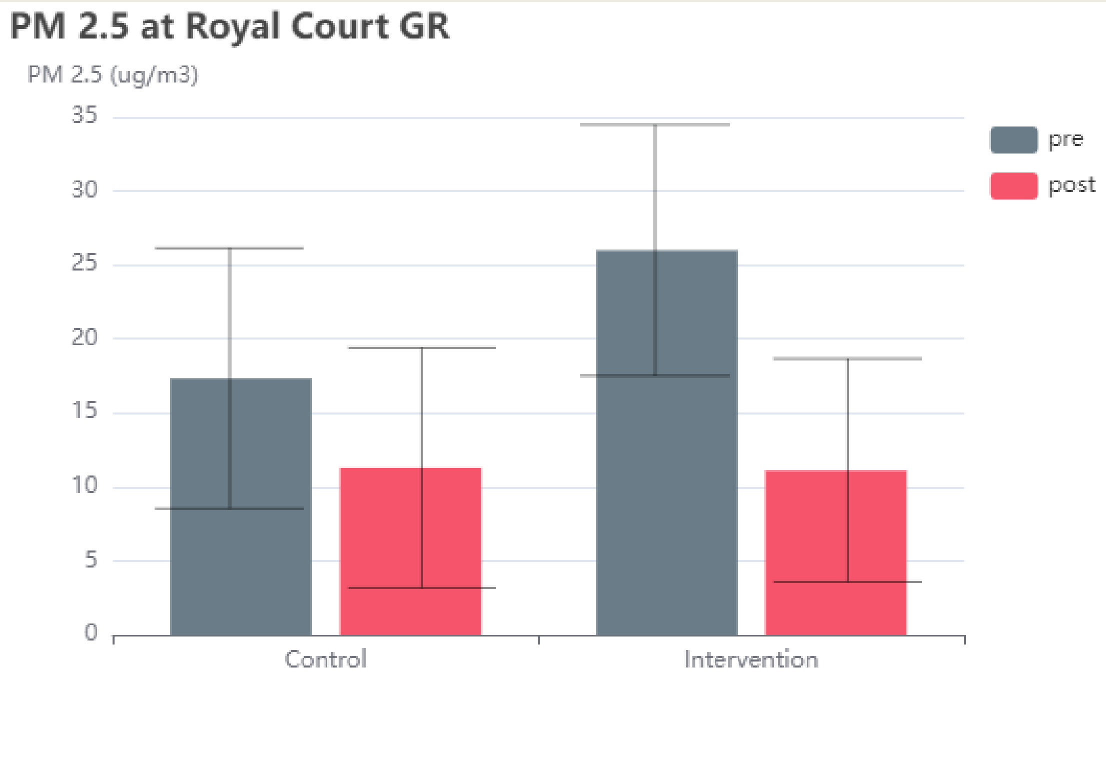

PM 2.5 at Parr St GW
PM 2.5 (ug/m3)
21
18
15
12
9
6
3
0
-3
pre
post
Control
Intervention

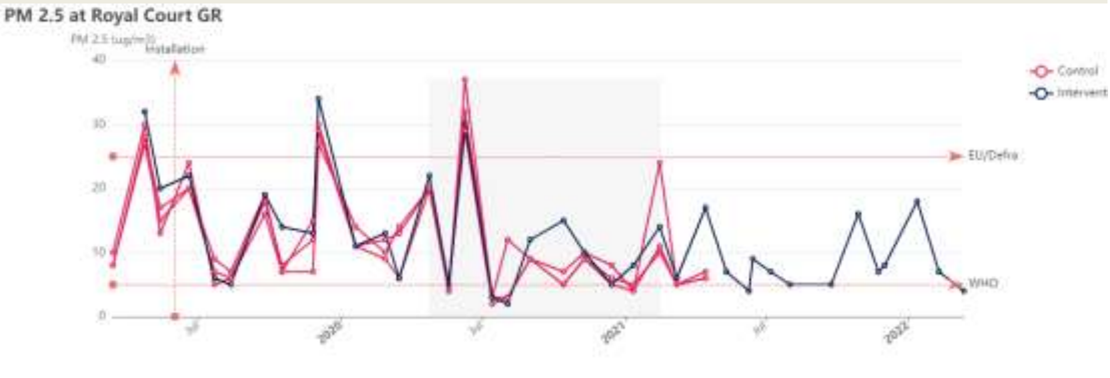

PM 2.5 at Parr St GW
Installation
Control
EU/Defra
WHO
50
40
30
20
10
0
Jul
2020
2021
2022

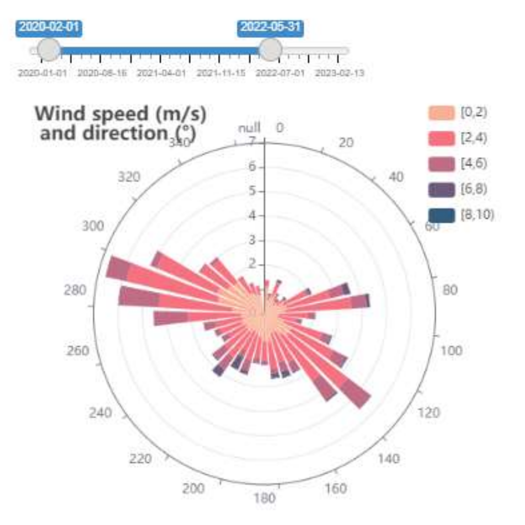

2020-01-08
2023-02-13
Wind speed (m/s) and direction (°)
[0,2)
[2,4)
[4,6)
[6,8)
[8,10)
null
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340

Summary plot example: Pollinator roof at Royal Court:

Box plots showing pre and post intervention at wall and control sites; Time-line showing installation of green wall (shading showing covid lockdown period); wind rose showing wind direction and speeds over the relevant monitoring period.







These example summary plots show a reduction in the PM2.5 values with the installation of the interventions for both the green wall and the pollinator roof. These are as reflected in the data summary tables for these interventions (-7% and -57% respectively).

The overall data summary for the quantitative data showed clear reductions in PM2.5 particulate pollution throughout all areas of Liverpool, in particular within sub demo C at -35%. This was followed by sub demo A at -28% and sub demo B at -20%. Over all Liverpool, the change was calculated to be -20%.

When the effect of interventions were considered, the SuDs and rain garden surprisingly showed high reductions (-63%), but pollinator roofs (-57%) and the urban catchment Strand trees (-49%) were also important. The green filter trees (-14%) vertical green walls (-7%) were also important, but the pollinator verges and spaces actually showed a slight increase in pollution overall at 9%. From a further detailed comparison, the rain garden in the Baltic showed a high decrease in particulate matter at -80% change, but this was based on a low number of observations so may have been due to other external factors. The upper SuDs water retention pond also, though, showed decreased levels of particulate pollution after the interventions at -45%. The green walls varied in effectiveness as the Liverpool One green wall showed an increase (52%), but the Parr Street and St Johns green walls demonstrated decreased changes (-38% and -36% respectively). The Royal Court green roof showed a high decrease in pollution observed at -57%. Trees acting as green filters were important particularly on Lime Street (-32%), but Stafford trees were not as effective and even showed an increase of 4%. It would be interesting to see the progression as the tree canopies expand and mature.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL analyses showed the interventions within sub demo B reduced the PM2.5 particulate pollution the most (0.0017 t/yr), followed by sub demo A (0.0004 t/yr) then negligible results for sub demo C and overall Liverpool.

Overall, the results for the KPI monitoring and modelling demonstrated a reduction in PM2.5 particulate air pollutants.

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
The particulate pollution was found to be enormously impacted by if the wind direction was from nearby industries, so the wind speed and direction had to be considered. Dust and debris from adjacent may have impacted on the monitoring results. Covid lockdowns had impact on behaviour but not so much on particulate pollution	Local climate recorded and awareness of limitations of data emphasized. Awareness of limitations of sampling methodology and timings of works. Awareness of timings of Covid lockdowns.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data analyses with comparative data sources (see table below) such as wind direction would further understanding of the impact of the interventions, but the main indications from the data demonstrate reductions in PM2.5 from both the site monitoring and modelling.

KPI NAME	NBS Ref No.	NBS NAME	OTHER POSSIBLE COMPARATIVE DATA SOURCES			OTHER VARIABLES
ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	LAc1	New green cycle route	Local climate	Liverpool climate		COVID lockdown
	LAc2	Green travel route	Local climate	Liverpool climate		COVID lockdown
	LAc4	Urban Catchment forestry	Local climate	Liverpool climate		COVID lockdown
	LAc8	Rain Garden (SUDs)	Local climate	Liverpool climate	Detectronic Flow meter	COVID lockdown
	LAc12	Pollinator Planting Spaces and Verges	Local climate	Liverpool climate		COVID lockdown
	LAc13	Pollinator walls/vertical	Local climate	Liverpool climate		COVID lockdown
	LAc14	Pollinator roofs	Local climate	Liverpool climate		COVID lockdown
	LAc17	Green filter area with large urban trees	Local climate	Liverpool climate		COVID lockdown

Positive impact overall areas and over most interventions in reducing the air pollutant PM2.5

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.21 CH0503 Annual mean levels of fine PM10 particules

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	CFT and LCC
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc4, LAc8, LAc12, LAc13, LAc14, LAc17	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Portable photometric sampler

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY									
CH0503: PM 10									
Pre-Intervention				Post-Intervention				% Change	Area
n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd		
427	22	17.7	12.1	291	30	15.8	10.5	-11.0	**Overall Liverpool**
78	4	16.3	12.0	47	5	12.8	7.5	-21.6	**Sub-Demo A**
277	12	18.9	12.9	150	15	16.7	11.1	-11.9	**Sub-Demo B**
42	3	15.8	7.8	24	3	14.2	7.8	-9.9	**Sub-Demo C**

QUANTITATIVE DATA SUMMARY		
CH0503: PM 10		
NBS	NBS Name	% Change
LAc4	Urban catchment forestry	-36.7
LAc8	SuDs & Rain Garden	-27.7
LAc12	Pollinator verges and spaces	32.8
LAc13	Pollinator walls/vertical	-14.1
LAc14	Pollinator roofs	-49.3
LAc17	Green filter area	30.2

QUANTITATIVE DATA SUMMARY										
CH0503: PM 10		Pre-Intervention				Post-Intervention				% Change
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	
LAc4	Strand Tree SuDS	110	4	19.6	14.5	40	4	12.4	9.5	-36.7
LAc8	Upper Pitt St RG	30	2	16.7	15.8	2	2	10.5	0.7	-37.1
LAc8	Upper SuDS	18	2	16.8	5.9	22	2	13.7	7.7	-18.2
LAc12	Bott SP Aig Dr POLL	24	1	15.0	9.0	2	1	19.5	9.2	30.0
LAc12	Cornwallis St POLL	33	1	14.8	8.8	3	1	20.0	7.0	35.5
LAc13	L1 GW	30	3	13.0	6.8	70	7	16.4	11.2	26.0
LAc13	Parr St GW	15	1	19.0	9.1	42	2	12.4	7.5	-34.8
LAc13	St Johns GW	29	2	24.0	11.7	47	5	16.0	8.6	-33.5
LAc14	Royal Court GR	2	1	37.5	7.8	35	1	19.0	8.9	-49.3
LAc17	Lime St TREES	86	3	18.6	12.8	10	3	21.7	15.8	16.7
LAc17	Stafford St TREES	50	2	14.5	7.4	18	2	20.8	17.4	43.7

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

For intervention site names, see table below.

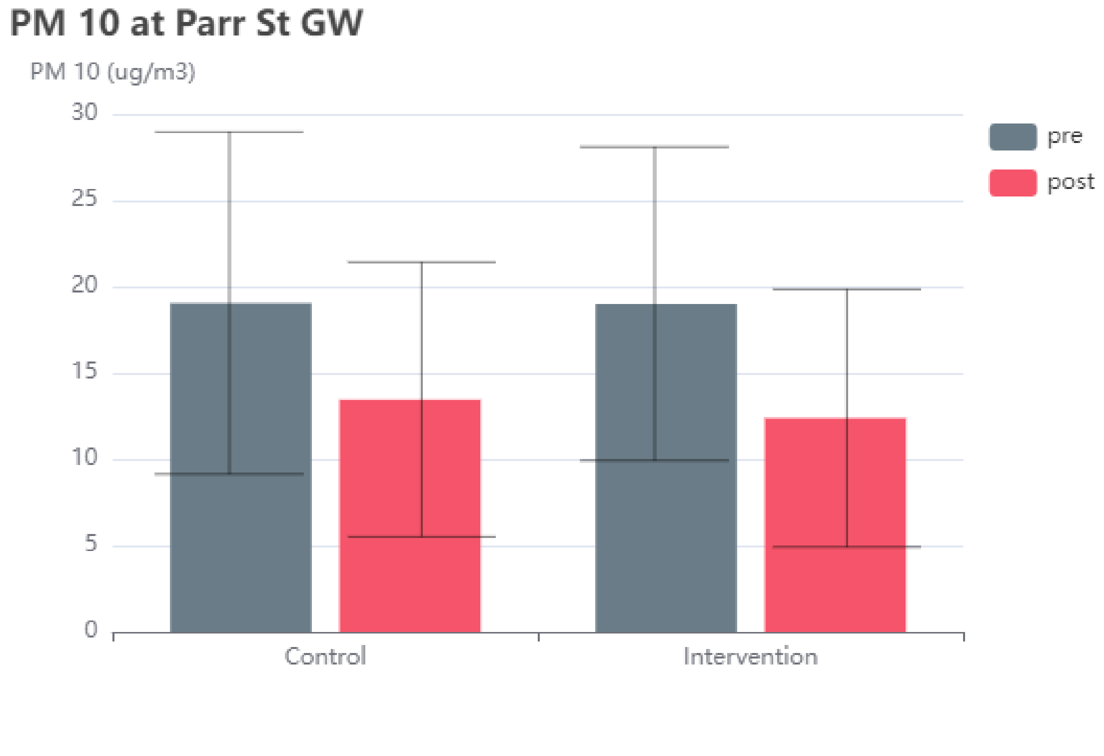
FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc4	Urban Catchment forestry		Strand Tree SuDS	
		LAc8	Rain Garden (SUDs)	Upper Pitt St RG		
		LAc12	Pollinator Planting Spaces and Verges	Baltic Green Route POLL, Cornwallis St POLL, Pitt St POLL, Park Lane POLL, Baltic Hub POLL, Strand POLL, Wapping POLL		Princes Av POLL, Princes roundabt POLL, Ullet Rd POLL, Top SP Aig Dr POLL, Top SP roundabt POLL, Bott SP Aig Dr POLL, Upper SuDS POLL, Lower SuDS POLL
		LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW, L1GW	
		LAc14	Pollinator roofs		RoyaL Court GR	
		LAc17	Green filter area with large urban trees		Green_Filter_TREES	

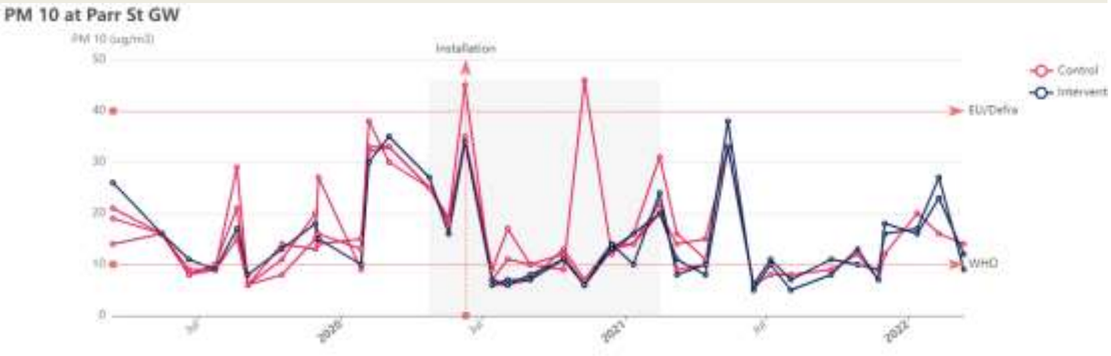
Map of monitoring locations: See CH0502

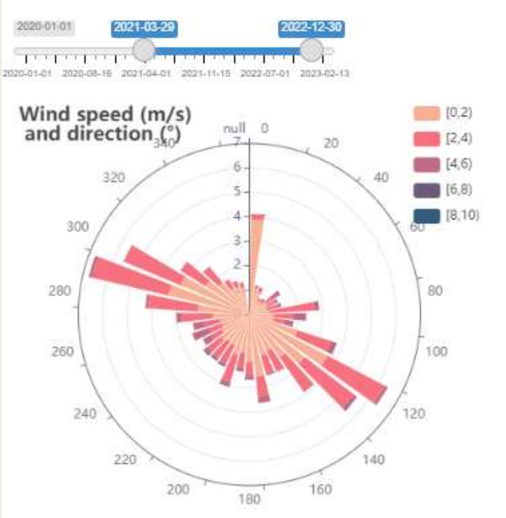
Equipment and methodology: See CH0502

<u>Summary plot example: Vertical green wall:</u>

Box plots showing pre and post intervention at wall and control sites; Timeline showing installation of green wall (shading showing covid lockdown period); wind rose showing wind direction and speeds over the monitoring period post intervention installation:

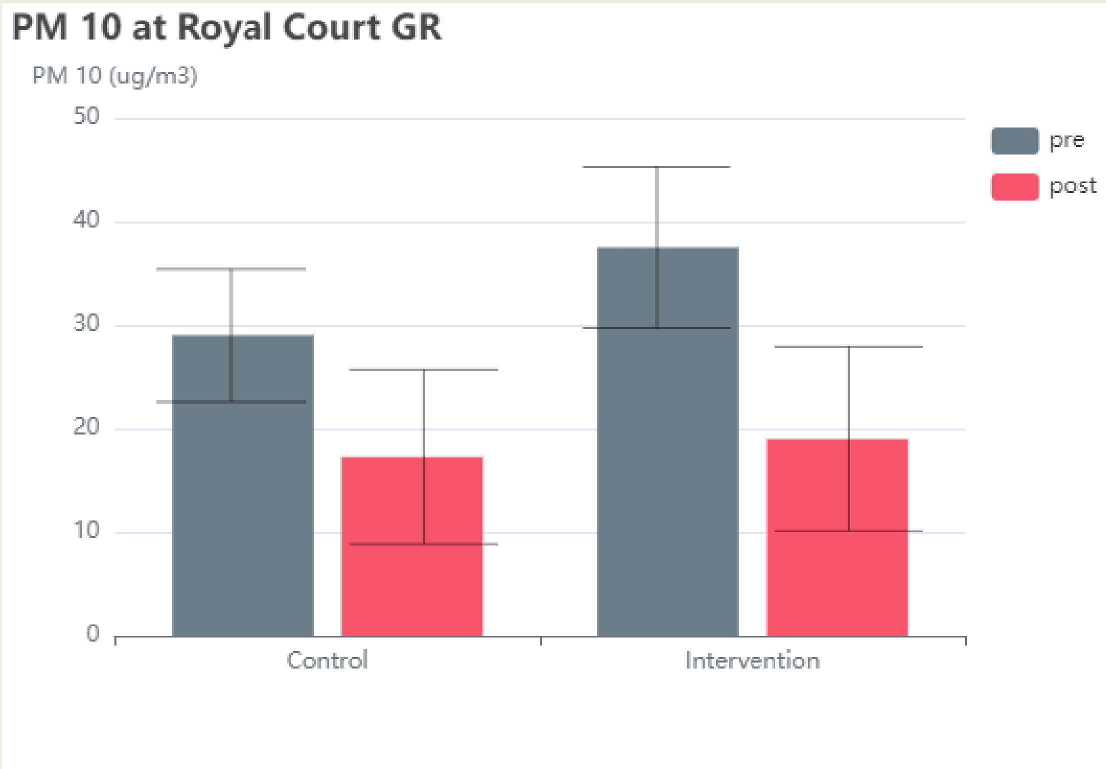


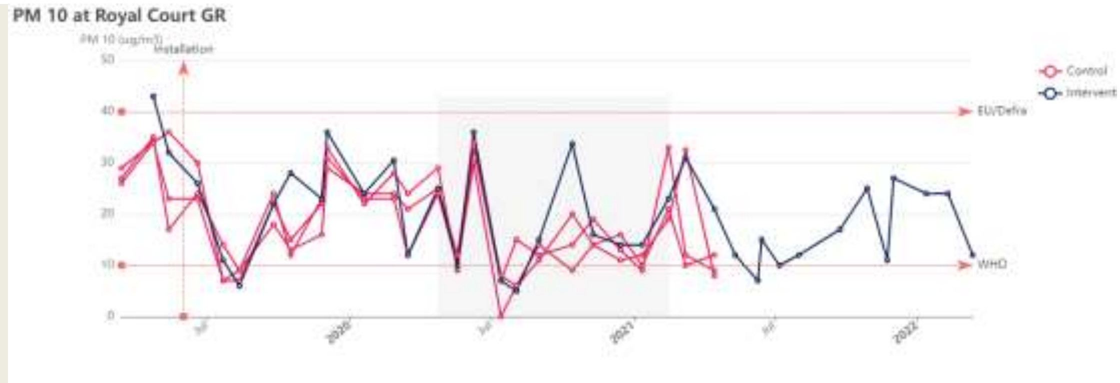


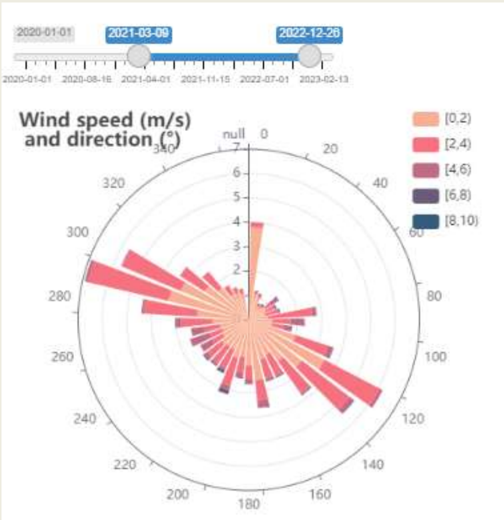


Summary plot example: Pollinator roof at Royal Court:

Box plots showing pre and post intervention at wall and control sites; Timeline showing installation of green wall (shading showing covid lockdown period); wind rose showing wind direction and speeds over the relevant monitoring period.







The overall data summary table for the quantitative data shows an overall decrease of PM10 particulate pollution of the duration of the Urban GreenUP project, particularly for Sub demo A at -21.6%. Sub demo B was found to be -11.9% and sub demo C was -9.9%. Overall Liverpool showed a -11% change in PM10 particulate pollution.

From the separation of the interventions, pollinator roof was found to be really important for this category at -49% reduction (see example plots), followed by the Strand tree SuDs at -37% (urban catchment forestry. The Suds and rain garden also demonstrated an important reduction at -28% change. The green walls had a better impact than for the PM2.5 particulates (see CH0502) but together were not so important a reduction (-14%) as other interventions. Both the pollinator verge planting (33%) and green filter trees (30% change throughout the Liverpool sites) showed an increase in PM10 pollutants after the interventions were introduced. Further analyses of the data with comparative data would be best to understand these increases.

When individual intervention sites were analysed, the Royal court green roof was the highest reduction at -49%. The Baltic rain garden in Upper Pitt Street showed a better reduction than the upper SuDS water retention pond site (-37% and -18% respectively). The Strand tree SuDs or urban catchment forestry showed a reduction (-37%) when the green filter tree sites, 'Lime St TREES' and 'Stafford St TREES' (17% and 44%) demonstrated an increase in pollution. Both pollinator sites in the analysis showed an increase in pollution as well for this factor (Bott SP Aig Dr POLL and Cornwallis St POLL at 30% and 36% respectively). For the green walls, the

Liverpool One green wall showed an increase (as for PM2.5) of 26%, but the Parr St and St Johns green walls demonstrated a reduction (see example plot) of both -34%.

Except for some pollinator planting and green filter trees, overall all areas and overall Liverpool there was found to be a reduction in PM10 particulate pollution over the duration of the Urban GreenUP project.

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

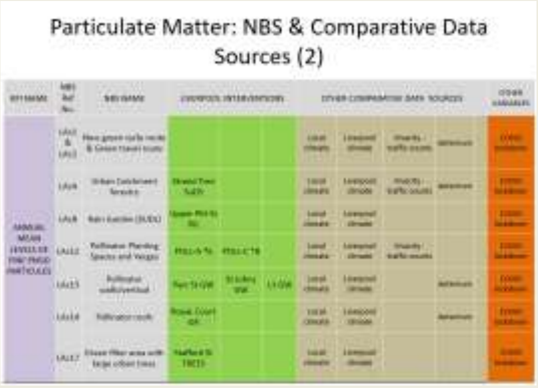
Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Dust and debris from adjacent works and Covid lockdowns may have impacted on the monitoring results. The particulate pollution was found to be enormously impacted by if the wind direction	Awareness of limitations of sampling methodology and covid lockdown periods. Awareness of need to run analyses with wind speed and direction.

was from nearby industries, so the wind speed and direction had to be considered.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data comparations with comparative data sources (as shown in table below) would increase understanding of the impact of the interventions on this pollutant. Many increases in pollution may also be caused by nearby work dust, proximity to nearby roads with increased vehicular traffic levels, so further analyses would be useful to carry out.


Particulate Matter: NBS & Comparative Data Sources (2)

For the overall data summary for the sub demo areas and for Liverpool as a whole, a reduction in PM10 pollutants were observed, so a positive change over the course of the Urban GreenUP project.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.22 CH0504 NOx trends

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0504	NOx TRENDS	CFT and LCC

CITY	*RELATED NBS*
LIV	LAc1, LAc2, LAc4, LAc12, LAc13, LAc14, LAc17

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Diffusion tube data

MODELLING: GI-Val

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY									
CH0504: NO2									
Pre-Intervention				**Post-Intervention**				**% Change**	**Area**
n_obs	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**		
782	31	35.9	11.7	420	30	30.5	9.6	-15.2	**Overall Liverpool**
85	5	30.6	6.8	112	5	25.6	5.0	-16.3	**Sub-Demo A**
289	11	44.1	11.6	143	10	36.4	10.6	-17.5	**Sub-Demo B**
319	12	29.2	7.9	148	12	27.4	7.6	-6.1	**Sub-Demo C**

QUANTITATIVE DATA SUMMARY		
CH0504: NO2		
NBS	**NBS Name**	**% Change**
LAc4	Urban catchment forestry	-13.7
LAc8	SuDs & Rain Garden	-19.8
LAc12	Pollinator verges and spaces	-7.9
LAc13	Pollinator walls/vertical	-10.6
LAc14	Pollinator roofs	-26.2
LAc17	Green filter area	-9.7

QUANTITATIVE DATA SUMMARY										
CH0504: NO2		**Pre-Intervention**				**Post-Intervention**				**% Change**
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	
LAc4	Strand Tree SuDS	87	4	40.1	9.3	57	4	34.6	8.7	-13.7

LAc8	Upper SuDS	29	2	39.3	11.9	44	2	31.5	9.2	-19.8
LAc1 2	Top SP Aig Dr POLL	101	3	29.1	5.6	20	3	26.5	5.8	-8.7
LAc1 2	Top SP roundabt POLL	34	1	23.0	5.7	7	1	21.7	5.7	-5.9
LAc1 2	Ullet Rd POLL	105	4	26.6	6.5	57	4	24.2	5.9	-9.1
LAc1 2	Bott SP Aig Dr POLL	50	2	33.3	5.9	20	2	30.7	4.0	-8.0
LAc1 3	Parr St GW	85	5	30.6	6.8	112	5	25.6	5.0	-16.3
LAc1 3	St Johns GW	29	2	39.0	12.9	36	2	32.7	11.2	-16.2
LAc1 3	L1 GW	89	3	38.8	8.7	17	3	39.1	8.3	0.7
LAc1 4	Royal Court GR	4	1	54.7	8.0	32	1	40.4	12.3	-26.2
LAc1 7	Lime St TREES	169	6	46.7	11.7	18	5	42.2	7.7	-9.7

GI-VAL results:

CH0504: NO2 trends: GI-VAL BENEFITS	Sub-Demo Areas			Overall Liverpool	BENEFIT QUANTIFICATION
Tools	A	B	C		
4.6 Reduced air pollution	0.0001	0.0006	0.0001	0.0008	t/yr of NO2 removed

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL analyses indicated that the interventions overall Liverpool reduced the air pollutant NO2 the most at 0.0008t/yr, with sub demo B showing the most reduced levels of NO2 (0.0006 t/yr) out of the sub demo areas.

For intervention site names used in the quantitative data, see table below.

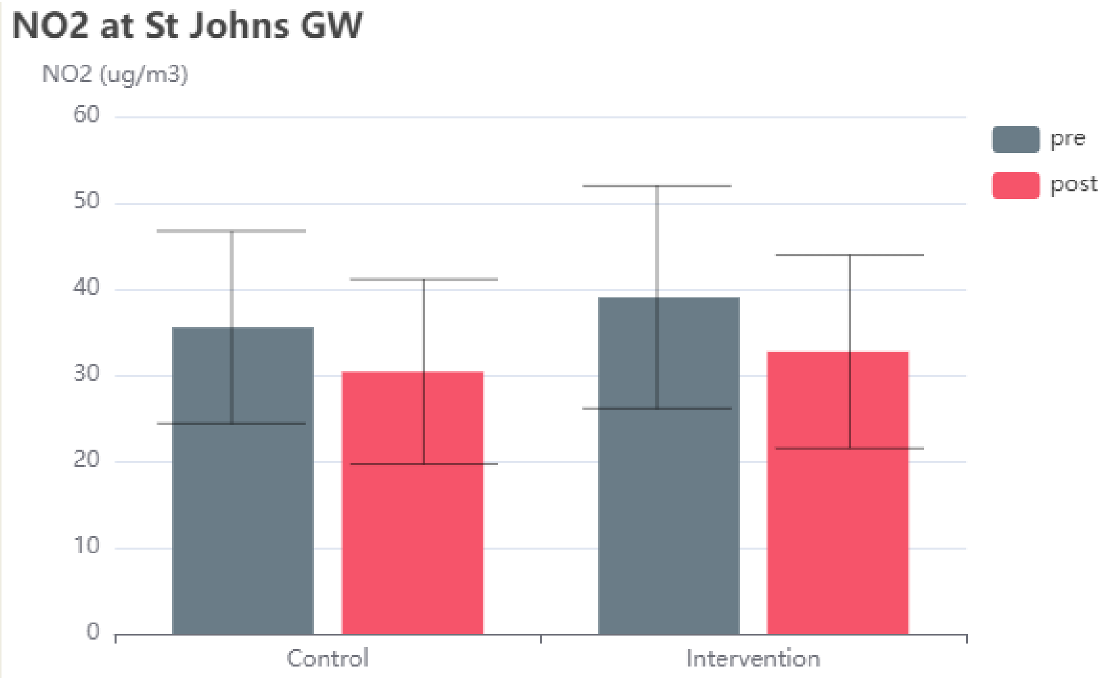
FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0504	NOx TRENDS	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc4	Urban Catchment forestry		Strand Tree SuDS	
		LAc12	Pollinator Planting Spaces and Verges	Baltic Green Route POLL, Cornwallis St POLL, Pitt St POLL, Park Lane POLL, Baltic Hub POLL, Strand POLL, Wapping POLL		Princes Av POLL, Princes roundabt POLL, Ullet Rd POLL, Top SP Aig Dr POLL, Top SP roundabt POLL, Bott SP Aig Dr POLL, Upper SuDS POLL, Lower SuDS POLL
		LAc13	Pollinator walls/vertical	Parr St GW	St Johns GW, L1GW	
		LAc14	Pollinator roofs		RoyaL Court GR	
		LAc17	Green filter area with large urban trees		Green_Filter_TREES	

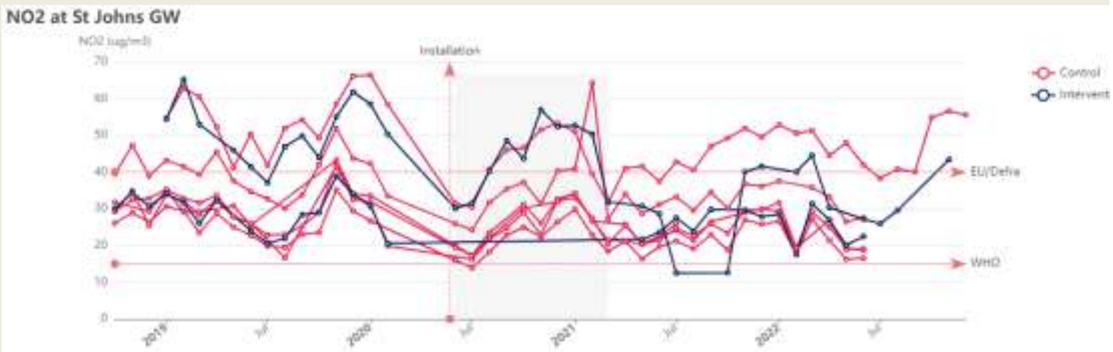
Map of monitoring locations: See CH0502

Equipment and methodology:

<u>Summary plot example: St Johns Green wall</u>

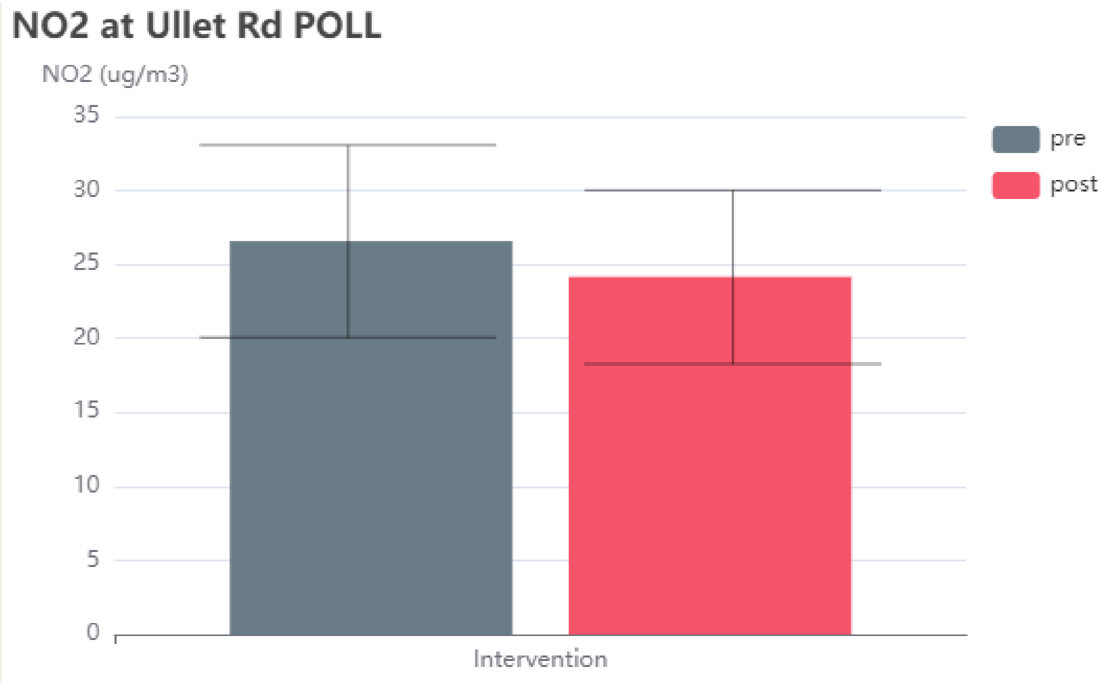
Box plots showing pre and post intervention at wall and control sites; Timeline showing installation of green wall (shading showing covid lockdown period);

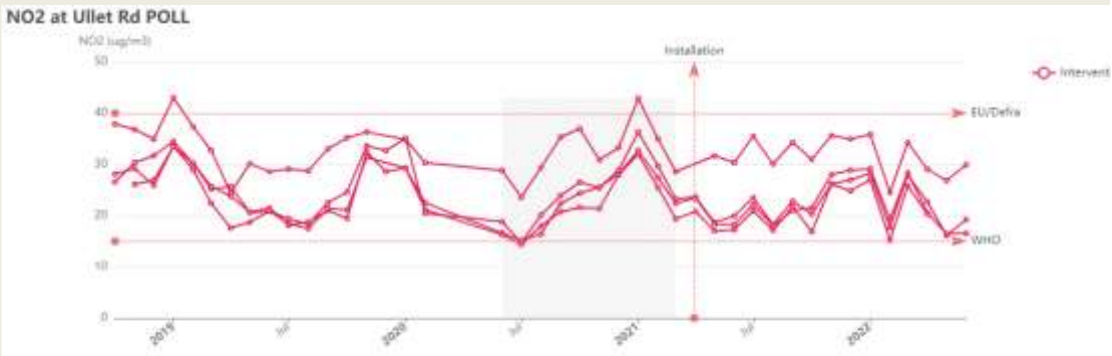




<u>Summary plot example: Ullet road pollinator and tree planting site</u>

Box plots showing pre and post intervention at wall and control sites; Time-line showing installation of green wall (shading showing covid lockdown period);





The overall data summary showed a reduction in Nitrogen dioxide (NO2) over the duration of the Urban GreenUP project, particularly for sub demos A and B (116.5% and -17.5% respectively). Overall Liverpool showed a -15.2% change in NO2 levels.

With respect to interventions, pollinator roof was most important (-26%) followed by the Suds and rain garden (-19.8% overall), in this case the Upper SuDs site in sub demo C (-20%). The Urban catchment forestry site (Strand tree SuDs at -13.7%), and green walls (-10.6%) also showed important reductions. An example plot is shown for the St Johns green wall site. The Green filter area trees (on Lime Street) and the pollinator verges also demonstrated reductions in Nitrogen dioxide (-9.7% and -7.9% respectively).

A further detailed comparison of the intervention sites within the data summaries showed within the pollinator verge sites that the Aigburth Drive plantings at the top and base of Sefton Park demonstrated -9% and -8% reductions respectively, but that the Ullet road planting (Ullet Rd POLL) had the most effect at -9% (see plot shown). The smallest reduction was for the roundabout at the top of Sefton Park at -6%. These planting areas comprised tree planting in addition to wildflower planting, which may have affected the reduction of this pollutant. For the green wall sites, the Liverpool One site showed a small increase of NO2 at 1%, but both the Parr Street and St Johns green walls showed -16% change in NO2 levels.

Overall reductions in NO2 were observed and calculated for all intervention sites, all areas and overall Liverpool.

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

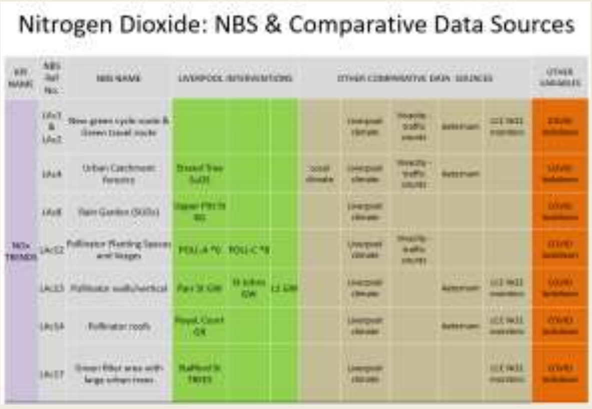
Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Some, due to lab shutdown in Covid lockdown.	Awareness of data limitations

Covid Lockdowns also caused changes in travel behaviour, so may have impacted on the amount of pollutant recorded.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further data comparations with comparative data sources (as in table below) would further understanding of the actual impact of the interventions on this pollutant.



Positive NO2 reductions over all Liverpool and particularly for sub demos A and B were shown for both the data summaries and modelled GI-VAL data.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.23 CH0505 SOx trends

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0505	Sox TRENDS	CFT and LCC
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc17	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: Diffusion tube data [STOPPED EARLY]: Advised to stop data collection due to negligible results

MODELLING: GI-Val

GI-VAL results:

CH0505: SO2 trends: GI-VAL BENEFITS	Sub-Demo Areas			Overall Liverpool	BENEFIT QUANTIFICATION
Tools	A	B	C		
4.6 Reduced air pollution	0.0000	0.0001	0.0000	0.0001	t/yr of SO2 removed

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

GI-Val results showed that the interventions had an overall reduction of SO2 pollution, particularly in Sub demo B at 0.0001 t/yr

The quantitative data showed very low results for Sulphur dioxide, so monitoring stopped very early on in the project.

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or	Awareness of limitations of model

encourage, depending upon the type of project.	
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
None	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Very little quantitative data were available due to being advised to stop early. Data collection stopped well before any interventions were installed.

SO_2 reduction shown by GI-VAL for all the interventions over all Liverpool and for sub demo B.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.24 CH0508 Run-off mitigation/ mitigation through cooling and sequestration

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0508	RUN-OFF MITIGATION/ MITIGATION THROUGH COOLING AND SEQUESTRATION	CFT with LJMU
CITY	*RELATED NBS*	

LIV	All NBS

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

N-Crat model not possible/inconclusive

GI-VAL results:

CH0508: Mitigation through cooling and sequestration	GI-VAL BENEFITS		Sub-Demo Areas			Overall Liverpool	
Functions	**Tools**	**GVA value**	**A**	**B**	**C**		**BENEFIT MONETISATION**
Shelter from wind	1.1 Reduced building energy consumption for heating	**GVA value**	15049.7	0.0	0.0	0.0	£
Cooling through shading and evapo-transpiration	1.5 Reduced building energy consumption for cooling	**GVA value**	211.6	670.7	0.0	882.4	£
		Total Climate Change benefit monetisation:	15261.3	670.7	0.0	**882.4**	£

CH0508: Mitigation through cooling and sequestration	GI-VAL BENEFITS		Sub-Demo Areas			Overall Liverpool	
Functions	**Tools**	**Other economic value**	**A**	**B**	**C**		**BENEFIT MONETISATION**
Shelter from wind	1.2 Avoided carbon emissions from building energy saving for heating	**Other economic value**	255.7	0.0	0.0	0.0	£

Cooling through shading and evapo-transpiration	1.6 Avoided carbon emissions from building energy saving for cooling	**Other economic value**	6.1	19.3	0.0	25.4	£
Carbon storage and sequestration	1.7 Carbon sequestered by trees	**Other economic value**	164.6	632.0	115.4	942.5	£
Carbon storage and sequestration	1.8 Carbon sequestered through other land use change	**Other economic value**	7207.6	7207.6	33389.2	33389.2	£
		Total Climate Change benefit monetisation :	7634.0	7858.9	33504.6	**34357.1**	£

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project. Non- significant values were obtained for benefit monetisations for avoiding damage from wind and storms, reduction of urban heat island effect. Some output could only be gained for one of GVA value or 'Other Economic value'. The simplified table is as shown above.

The GI-VAL analyses for the impact of the interventions found positive Climate change benefit monetisations throughout where analyses were possible: a total of £882 'GVA' and £34357 'other economic value' for overall Liverpool. Sub demo A produced the highest GVA value benefit for reduced building energy consumption for heating (£15050), but sub demo C produced the highest benefit for the 'other economic value' factor 'carbon sequestered through other land use change' at £33389. Overall Liverpool showed the highest benefit amount for Carbon sequestered by trees at £943.

The factor 'Shelter from the wind' assessing reduced building and carbon emissions for heating consumption was best for Sub demo A at £256, but in terms of cooling energy consumption, sub demo B and overall Liverpool were the most important (£19.3 and £25 respectively). In terms of sub demo areas, for carbon sequestration by trees, sub demo B interventions had the most impact at £632 (also see CH0104 Carbon sequestration), but in terms of other land use change, carbon sequestration savings were most important for sub demo C (and overall Liverpool) at £33389.

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project. N-Crat modelling software was found to produce inconclusive results for the scale of interventions	Awareness of limitations of models
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Positive effect of all interventions in all sub demo areas and overall Liverpool were found for the Climate Change benefit monetisations.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.25 CH0509 Energy savings

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0509	ENERGY SAVINGS	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

Also see data in CH0508-Mitigation through cooling and sequestration

GI-VAL results:

CH0509: Energy Savings: GI-VAL BENEFITS		Sub-Demo Areas			Overall Liverpool	
Tools	GVA value	A	B	C		BENEFIT MONETISATION
7.3 Savings from reduced absenteeism from work	GVA value	199686.8	199686.8	56713.1	56713.1	£

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

GI-VAL analyses show high GVA values for all sub demo areas and overall Liverpool, particularly for sub demo A and B areas (£199686.8 and £199686.8 respectively), for savings from reduced absenteeism from work. Other positive monetised benefits can be seen in CH0508.

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Positive monetisation benefits can be seen for all areas with GI-VAL.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.26 CH0510 Increase in property value

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0510	INCREASE IN PROPERTY VALUE	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

SOCIO-ECONOMIC : Data in CH1004-Land and Property price change.

GI-VAL results:

CH0510: Increase in property value	**GI-VAL BENEFITS**		**Sub-Demo Areas**			**Overall Liverpool**	
Functions	**Tools**	**Other economic value**	**A**	**B**	**C**		**BENEFIT MONETISATION**
Catalyst for community cohesion and pride	3.1 Willingness to pay for a view of urban green space	**Other economic value**	426551.2	1258325.9	1389427.7	1024768.2	£
Catalyst for community cohesion and pride	3.2 Increase in volunteering	**Other economic value**	n.a.	n.a.	n.a.	n.a.	£

	GI-VAL BENEFITS	**Total Place & Communities benefit monetisation**	426551.2	1258325.9	1389427.7	**1024768.2**	£
Setting for higher value residential and commercial properties	5.1 Residential land and property values uplift	**Land and property value**	10647693.3	19492758.4	10565155.7	12236330.1	£
Land management	11.2 Employment supported by land management	**Land and property value**	n.a.	n.a.	n.a.	n.a.	£

Socio-economic data: please see report 3 (SE-REPORT_3_WP5-KPI CH1004_Housing_prices_NBS-Report) and see CH1004.

House Prices	Otterspool	Sefton Park	Baltic Triangle
2008 (baseline average price)	£215,053.57	£155,730.86	£163,713.17
2019 (pre-installation) reported crimes	£230,229.13	£218,412.50	£130,652.08
2020 (post-installation) reported crimes	£248429.67	£223,722.25	£139,276.29
% change (2019-2020)	+7.9%	+7.0%	+6.8%
% change 2008-2020	+15.5%	+50%	-15%

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL modelling produced positive monetary benefits for all areas for a willingness to pay for a view of urban green space (sub demo C the most important at £1389427.7), and land and property value increases for residential land (sub demo B the most important at £19492758.4).

Socio-economic data: please see report 3 (SE-REPORT_3_WP5-KPI CH1004_Housing_prices_NBS-Report).

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project. Land values unable to be accessed in the same way as property value/ sales.	Awareness of limitation of model Awareness of limitations of data available
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

A positive monetized benefit of all the interventions added to each area was calculated using GI-VAL.

Socio-economic data: please see report 3 (SE-REPORT_3_WP5-KPI CH1004_Housing_prices_NBS-Report) and see CH1004. This report found that it is not possible for demonstrate that the Urban GreenUP interventions led to any increases in property prices.

Hence the KPI can only have an inconclusive result.

What was the impact? (positive/negative, significant/non-significant)?

Inconclusive

1.2.27 CH0511 Value of air quality improvements

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0511	(GI VAL TO CALCULATE THE) VALUE OF AIR QUALITY IMPROVEMENTS	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: EcoServR, GI-VAL;

Also refer to CH0513-Total monetary value of urban forests including air quality

N-Crat model not possible/inconclusive

EcoServR results:

EcoServR: CH0511: Air quality improvements		**% Change**
sub demo A	Air.purification	3.1
sub demo B	Air.purification	1.6
sub demo C	Air.purification	-0.1
Overall Liverpool	Air.purification	0.0

EcoServR: CH0511: Air quality improvements		
NBS	**NBS Name**	**% Change**
lac4	Urban catchment forestry	
lac5	shade trees	1.4
lac6	cooling trees	8.4

lac8	SuDs & Rain Garden	-1.6
lac12	Pollinator verges and spaces	10.5
lac13	Pollinator walls/vertical	15.0
lac14	Pollinator roofs	31.2
lac16	Floating gardens	12175.5
lac17	Green filter area	16.3

EcoServR: CH0511: Air quality improvements		
Pollinator walls/vertical	**radius (m)**	**% Change**
L1 GW	20	0.0
Parr St GW	20	
St Johns GW	20	
L1 GW	100	0.0
Parr St GW	100	5.5
St Johns GW	100	54.5

EcoServR: CH0511: Air quality improvements		
SuDs & Rain Garden	**radius (m)**	**% Change**
Upper Pitt St RG	20	5.5
Upper SuDS	20	-8.1
Lower SuDS	20	-4.0
Upper Pitt St RG	100	4.6
Upper SuDS	100	-5.2
Lower SuDS	100	-2.6

EcoServR: CH0511: Air quality improvements			
NBS	**NBS Name**	**radius (m)**	**% Change**
lac4	Urban catchment forestry	20	
lac5	shade trees	20	1.7

lac6	cooling trees	20	10.0
lac17	Green filter area	20	21.7
lac4	Urban catchment forestry	100	
lac5	shade trees	100	1.1
lac6	cooling trees	100	6.8
lac17	Green filter area	100	11.0

EcoServR: CH0511: Air quality improvements		
Floating gardens	**radius (m)**	**% Change**
SPL FI	20	0.2
Wapping FI	20	
SPL FI	100	0.1
Wapping FI	100	36526.2

EcoServR: CH0511: Air quality improvements			
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**
A	Baltic Hub POLL	20	0.6
A	Baltic POLL	20	17.4
A	Cornwallis St POLL	20	12.1
A	Park Lane POLL	20	0.0
A	Pitt St POLL	20	2.9
A	Strand POLL	20	13.3
A	Wapping POLL	20	
C	Bott SP Aig Dr POLL	20	1.5
C	Lower SuDS POLL	20	-3.7
C	Princes Av POLL	20	6.8
C	Princes roundabt POLL	20	2.7
C	Top SP Aig Dr POLL	20	2.0
C	Ullet Rd POLL	20	2.5
C	Upper SuDS POLL	20	-7.4
A	Baltic Hub POLL	100	1.8

A	Baltic POLL	100	8.6
A	Cornwallis St POLL	100	9.3
A	Park Lane POLL	100	0.1
A	Pitt St POLL	100	2.9
A	Strand POLL	100	31.3
A	Wapping POLL	100	177.1
C	Bott SP Aig Dr POLL	100	0.6
C	Lower SuDS POLL	100	-2.2
C	Princes Av POLL	100	4.1
C	Princes roundabt POLL	100	1.9
C	Top SP Aig Dr POLL	100	1.0
C	Ullet Rd POLL	100	1.0
C	Upper SuDS POLL	100	-4.8

GI-VAL results:

CH0511: Value AQ improvements: GI-VAL BENEFITS		**Sub-Demo Areas**			**Overall Liverpool**		**Sub-Demo Areas**			**Overall Liverpool**	
Tools	**GVA value**	**A**	**B**	**C**		**Other economic value**	**A**	**B**	**C**		**BENEFIT MONETISATION**
4.6 Reduced air pollution	**GVA value**	956.6	3672.5	670.6	5476.89	**Other economic value**	n.a.	n.a.	n.a.	n.a.	£

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The EcoServR model assessed the air purification mitigation by vegetation in the following way. Vegetation can trap particulate matter and other airborne pollutants and therefore improve air quality locally. Using the aspect, the model assigned relative scores (0-100) to habitat types from the natural capital baseline based on their relative capacity to trap pollutants and improve air quality. Tall, dense vegetation (especially evergreen) scored the highest. Therefore, the best habitats for this service were woodland (especially coniferous), with scrubland and other semi-natural habitats scoring lower. Built-up areas were considered to have a score of 0. Because the benefits that a habitat provides may be felt a certain distance away from the habitat itself, focal statistics summed the scores at A) a short (20 m) and B) local (100 m) range. The two were then combined (summed) to produce the final capacity map. Patches smaller than 100 m2 were removed as they are unlikely to provide the service to any meaningful extent. Raw units do not represent a biophysical value. A rescaled (0-100) version was provided where 100 is the highest capacity in the area mapped.

EcoServR model found a positive reduction in air pollution for all areas, in particular sub demo A (3.1%) and sub demo B (1.6%), but except for sub demo C (-0.1%). EcoServR does not take account of the addition of SuDs systems and so penalised the loss of woodland * and the loss of other habitat for the SuDs in Otterspool Woods. In additions, the scores are so low at Wapping floating island that the large percentage change is not very meaningful.

From a more detailed breakdown of the effect of the interventions by the EcoServR model, floating gardens showed an extremely high percentage change of 12176% Further investigation into how the model applies the habitat codes is needed to further understand this high percentage change. The SuDs and rain garden category produced a negative change*. Positive changes were found for the pollinator sites: pollinator roofs (31.2%), pollinator walls (15%), and pollinator verges (10.5%), as well as for the tree interventions: green filter area(16.3%), shade trees (1.4%), and cooling trees (8.4%).

For the green walls, not all percentage changes could be calculated, but St Johns wall showed a 55% change, Parr Street a 6% positive change. With regards to the Suds and rain garden, the SuDs (Upper and Lower) showed a negative result as expected in EcoServR*, but the rain garden showed the most important improvement at 5.5% at 20m or 4.6% at 100m radius. As expected, the green filter area trees showed the most important result within the tree-based interventions (21.7% at 20m, 11.0% at 100m), but all showed a positive change. Within the floating gardens category, both showed a positive change, with an extreme change for Wapping dock as previously mentioned. For the pollinator verges, the Wapping dock pollinator site (Wapping POLL) showed the best positive change at a 100m radius (177%), followed by Strand POLL (13% at 20m, 31% at 100m), Baltic POLL (the pollinator pillars at 17% at 20m, 9% at 100m) and Cornwallis POLL (12% at 20m, 9% at 100m). The remainder all generally showed positive results.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL analyses found the positive monetary savings from reduced air pollution for all areas, in particular sub demo B (£3672.5), but also for Sub demo A, C and overall Liverpool (£956.6, £670.6 and £5476.89 respectively).

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project. *EcoServR does not take drainage systems or SuDs into account and penalizes any loss of woodland. N-Crat modelling software was found to produce inconclusive results for the scale of interventions	Awareness of limitations of models
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Positive percentage changes in air purification were found for all areas (except sub demo C due to model characteristics) and positive monetary impacts found for reduced air pollution using GI-VAL

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.28 CH0512 Value of air pollution reduction

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0512	VALUE OF AIR POLLUTION REDUCTION	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELS: GI-Val: No data possible as expertise left project N-Crat model not possible/inconclusive Please see other KPIS: CH0513 -Total monetary value of urban forests including air quality (Unit €/m2) and CH0511 Value of air quality improvements (unit €)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

n/a

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*

Lack of expertise to upgrade model. N-Crat modelling software was found to produce inconclusive results for the scale of interventions	KPI unable to be calculated. Awareness of model limitations.
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Unknown as KPI impossible to assess due to lack of necessary models and expertise.
What was the impact? (positive/negative, significant/non-significant)?
Unknown

1.2.29 CH0513 Total monetary value of urban forests including air quality

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0513	TOTAL MONETARY VALUE OF URBAN FORESTS INCLUDING AIR QUALITY	CFT with LJMU
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

Also refer to CH0511-Value of air quality improvements

N-Crat model not possible/inconclusive

GI-VAL results:

CH0513: Value urban forests	**GI-VAL BENEFITS**		**Sub-Demo Areas**			**Overall Liverpool**	
Functions	**Tools**	**Other economic value**	**A**	**B**	**C**		**BENEFIT MONETISATION**
Provision of attractive opportunities for exercise	4.2 Reduced mortality from increased walking and cycling	**Other economic value**	18304628	18713431	597015437	599573041	£
Tourism attraction	8.1 Tourism expenditure	**GVA value**	9979926	9979926	9979926	9979926	£
Tourism attraction	8.2 Employment supported by tourism	**GVA value**	10329224	10329224	10329224	10329224	£
Provision of recreation opportunities	9.1 Recreational value for use by local population	**Other economic value**	1985590	1985590	1985590	1985590	£
Provision of recreation opportunities	10.1 Willingness to pay for protection or enhancement of biodiversity	**Other economic value**	0	2	99	72	£

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL model found monetary benefits for green spaces such as for increased active travel, tourism expenditure and employment, recreational use and willingness to pay for protection of biodiversity. These were found for all areas and overall Liverpool. Of particular importance were sub demo C and overall Liverpool for active travel (£597,015,437 and £599,573,041 respectively).

For further plots, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project. N-Crat modelling software was found to produce inconclusive results for the scale of interventions	Awareness of limitation of models
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Positive monetary benefits found for related factors and for the value of the project interventions for all sub demo areas and overall Liverpool.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.30 CH0602 Benefits from interventions

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0602	BENEFITS FROM INTERVENTIONS	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

SOCIO-ECONOMIC: See other KPIs and combined report on KPI CH1005 New Business, CH1002 Job Creation, CH0602 Benefits of NBS Interventions and CH0703 Social Learning

GI-VAL results:

CH0602: Benefits from Interventions	**GI-VAL BENEFITS**	**Sub-Demo Areas**			**Overall Liverpool**	**BENEFIT QUANTIFICATION**
Functions	**Tools**	**A**	**B**	**C**		
Provision of recreation opportunities	10.1 Willingness to pay for protection or enhancement of biodiversity	0.00	0.00	0.16	0.16	Ha of land w/ biodiversity value added

Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL results indicate an increase of land possible to increase biodiversity and an increase in willingness to pay for the protection and enhancement of this land. This is particularly shown for sub demo C at 0.16 Ha of land with biodiversity value added. Overall Liverpool also showed 0.16 Ha of land had been added for this output.

Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning).

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
Impacts on number of face-to-face surveys due to Covid restrictions	Online interviews and postal surveys became the focus of the Socio-economic investigations

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes, a positive impact of the benefits from the addition of the interventions.

Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning): Perceptions of NBS/greenspace quantity, quality, and accessibility in the city centre among interviewees were negative. There are concerns over a lack of inter-connectivity between spaces and the impact this has on the mental and physical health of city centre dwellers. There is also concern regarding NBS/greenspace inequities in the city as a whole, with the South possessing more high-quality spaces than the North..

Conflicting indications were found, so this KPI is assumed to be inconclusive.

What was the impact? (positive/negative, significant/non-significant)?

Inconclusive

1.2.31 CH0703 Social learning

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0703	SOCIAL LEARNING	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

NON-TECHNICAL: Nature4Health (N4H), Webinar audience numbers

SOCIO-ECONOMIC: Data within other KPIS. Also refer to report 'Analysis of NBS in Liverpool' which assesses CH0403-Green Space Accessibility, CH0702 Citizen Participation, CH0703 Social Learning, CH0705 Engagement with NBS and CH0904 Health Quality Perception. See also other KPIs and combined report on KPI CH1005 New Business, CH1002 Job Creation, CH0602 Benefits of NBS Interventions and CH0703 Social Learning.

Non-technical: Nature for Health data:

CH0703-Social Learning: Nature for Health Non-Technical					
Mental Well-being WEMWBS scores**	**Total number of participants**	**Before**	**After**	**Change in points**	**% change**
Community Forest Trust (2018) Nature4Health: Impact Report	1936	47.6	53.8	6.2	13

St. Margaret's, Toxteth	16	42.9	53.8	10.9	25.5
St. Michaels in the City	11	46.5	51.9	5.4	11.5
Totals adjacent to UGU NBS	**27**	**44.7**	**52.9**	**8.2**	**18.2**
**Warwick-Edinburgh Mental Wellbeing Scale: https://warwick.ac.uk/fac/sci/med/research/platform/wemwbs/					

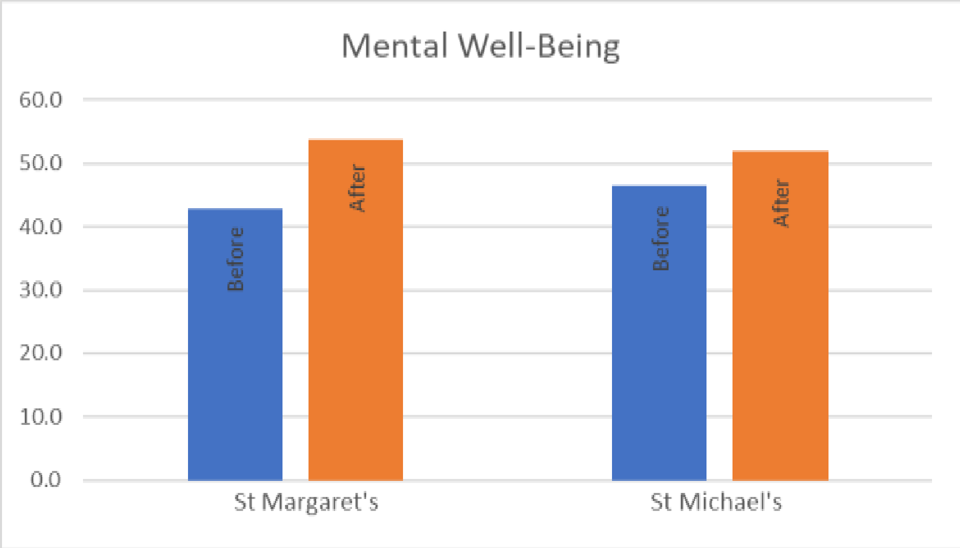
Non-technical: Event participant numbers for Liverpool

Urban GreenUP Liverpool partner meetings and events								
Sum of Size of audience								
Year	**Conference**	**Meeting**	**Fairs**	**Visit (one to one meeting)**	**Workshop**	**Public lecture**	**Other**	**TOTALS**
2017	660	130	0	2	120	0	0	**912**
2018	550	121	200	0	562	0	0	**1433**
2019	820	185	500	11	244	0	0	**1760**
2020	50	84	0	0	100	0	0	**234**
2021	196	1	0	0	124	165	220	**706**
2022	0	85	0	0	0	80	0	**165**
TOTALS	**2276**	**606**	**700**	**13**	**1150**	**245**	**220**	**5210**

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final) and Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The Non-technical data for Nature for Health comprised results from participant surveys during a twelve-week horticultural therapy course targeting 'hard to reach' people from areas of need. This course aimed to improve mental and physical wellbeing through gardening and growing food. More information can be found in the 2018 Community Forest Trust Nature4Health impact report.



The Nature for Health participants in horticultural therapy reported an increased sense of mental well-being during the course.

The non-technical data from event audience numbers were calculated from any events or webinars based in Liverpool. These data showed that these events reached at least 5000 participants.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final) and Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning).

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
n/a	
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed

n/a	
Environmental (including COVID)	How they have been addressed
Impacts on number of face-to-face surveys due to Covid restrictions	Online interviews and postal surveys became the focus of the Socio-economic investigations

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Positive impact of learning through horticultural therapy on mental well-being. The participant numbers showed a reach for the project of at least 5000 participants.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final) and Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning). Also see CH0702. An insight from report 4 is: Many interviewees believe that urban greening has a beneficial impact on business rates, and the mental wellbeing of workers, visitors, and urban dwellers alike. Those involved in the implementation of specific NBS interventions illustrated that the public response to their implementation has been more positive than what had been perhaps expected. This suggest that community buy-in for projects already exists. However, there are concerns amongst local people over the degree of impact small-scale interventions can have upon large-scale urban sustainability issues. By reducing urban greening interventions to solution providers, some interviewees warned that this simultaneously risks oversimplifying the complexity of sustainability issues and overselling the transformative power of nature.

Overall there were positive indications for this KPI.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.32 CH0702 Citizen perception

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0702	CITIZEN PERCEPTION	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

NON-TECHNICAL: Nature4Health

SOCIO-ECONOMIC: Also relates to CH0705. Also refer to report 'Analysis of NBS in Liverpool' which assesses CH0403-Green Space Accessibility, CH0702 Citizen Participation, CH0703 Social Learning, CH0705 Engagement with NBS and CH0904 Health Quality Perception.

GI-VAL results:

CH0702: Citizen Perception: GI-VAL BENEFITS	**Sub-Demo Areas**			**Overall Liverpool**	**BENEFIT QUANTIFICATION**	
Tools	**A**	**B**	**C**			
7.3 Savings from reduced absenteeism from work	122.83	122.83	34.88	34.88	Min	work days los avoided per yr
7.3 Savings from reduced absenteeism from work	655.08	655.08	186.05	186.05	Max	work days los avoided per yr

Non-technical Nature for Health results:

CH0702-Citizen Perception: Nature for Health Non-Technical					
Question: "Connected to nature?"	**Total number of participants**	**Before**	**After**	**Change in points**	**% change**
St. Margaret's, Toxteth	24	3.0	4.2	1.2	40.8
St. Michaels in the City	7	3.7	4.4	0.7	19.2
Totals adjacent to UGU NBS	31	3.3	4.3	1.0	**28.8**

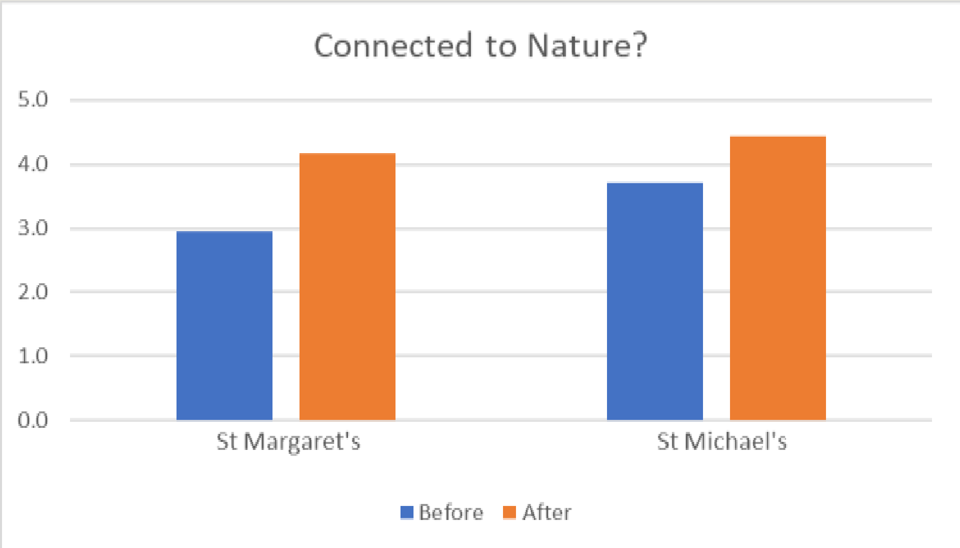
Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL modelled analyses showed a benefit in that there were saving due to reduced absenteeism from work due to the impact of the project interventions.

The Non-technical data for Nature for Health comprised results from participant surveys during a twelve-week horticultural therapy course targeting 'hard to reach' people from areas of need. This course aimed to improve mental and physical wellbeing through gardening and growing food. More information can be found in the 2018 Community Forest Trust Nature4Health impact report.



The Nature for Health data from horticultural therapy participants reported an increase in connection to Nature during the course. The sites chosen were adjacent to Urban GreenUP sites and were assumed to reflect on these interventions in a positive light.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final)

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model

Economical barriers	How they have been addressed
n/a	

Social barriers	How they have been addressed
n/a	

Environmental (including COVID)	How they have been addressed
Impacts on number of face-to-face surveys due to Covid restrictions	Online interviews and postal surveys became the focus of the Socio-economic investigations

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Positive impact on reduced absenteeism from work and on connection to Nature.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final): Responses to what impact greenspace/NBS can have on social issues were generally more positive than on environmental issues. The issue that garnered the largest 'neutral/no impact' selection was social inequality: 34% of responses in Sefton Park and 37% in Otterspool.

Hence, all data indicated a positive perception.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.33 CH0705 Engagement with nbs

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0705	ENGAGEMENT WITH NBS	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

NON-TECHNICAL: BIOAPP-Lancashire Wildlife Report, Nature4Health:

SOCIO-ECONOMIC: Refer to report 'Analysis of NBS in Liverpool' which assesses CH0403-Green Space Accessibility, CH0702 Citizen Participation, CH0703 Social Learning, CH0705 Engagement with NBS and CH0904 Health Quality Perception.

GI-VAL results:

CH0705: Engagement with NBS	**GI-VAL BENEFITS**	**Sub-Demo Areas**			**Overall Liverpool**	**BENEFI QUANTIFICA**
Functions	**Tools**	**A**	**B**	**C**		
Tourism attraction	8.1 Tourism expenditure	100000	100000	100000	100000	Visitor days
Provision of recreation opportunities	9.1 Recreational value for use by local population	500000	500000	500000	500000	Local users

Non-technical Nature for Health results:

CH0702-Citizen Perception: Nature for Health Non-Technical					
Question: "Connected to nature?"	**Total number of participants**	**Before**	**After**	**Change in points**	**% change**
St. Margaret's, Toxteth	24	3.0	4.2	1.2	40.8
St. Michaels in the City	7	3.7	4.4	0.7	19.2
Totals adjacent to UGU NBS	31	3.3	4.3	1.0	**28.8**

Non-technical BioApp iNaturalist results:

Year 1

Indicator	Expected	Actual	Comments
Number of people engaged in City Nature Challenge 2020	Engagement of 200 people	180 people engaged	national coronavirus lockdown impacted on number of people who participated
Number of iNaturalist observations collected during City Nature Challenge 2020	Collect 1000 observations	5954 observations	

Number of species recorded on iNaturalist during City Nature Challenge 2020		975 species recorded	
Number of observations collected on iNaturalist Baltic Triangle project	Collect 1500 observations	269 observations	Coronavirus lockdown prevented project officer being employed, therefore promotion of the project has been limited and no events were run
Number of species recorded on iNaturalist Baltic Triangle project	Identify 150 species on the green corridors	128 species record	
Number of webinars delivered	2	0	no webinars delivered due to staff being furloughed
Number of people engaged in webinars	500	0	As above

Year 2:

Indicator	Expected	**Actual**	Comments
Number of people engaged in City Nature Challenge 2021	Engagement of 400 people	111 observers 381 identifiers	Target exceeded
Number of iNaturalist observations collected during City Nature Challenge 2021	Collect 7000 observations	8,901 observations	Target exceeded
Number of species recorded on iNaturalist during City Nature Challenge 2021	1000	941 species	
Number of observations collected on iNaturalist Baltic Triangle project	Collect 1500 observations	829	Limited opportunities for events unt end of national restrictions at the end c 2021 impacted number of observation:
Number of species recorded on iNaturalist Baltic Triangle project	200	271	Target exceeded

Number of iNaturalist events	30	25	- 7 x Facebook videos (for CNC, iNatur project) - 12 x Self-guided challenges posted (f City Nature Challenge, 30 Days Wild, Wildlife competition) - 6 x Wildlife walks
Number of people engaged in iNaturalist events	-	553 (online) 12 (in person) = 565	Online figures calculated thr comments, 'reactions' to the post and s to other sites. Lack of engagement with the w competition for primary school chil Consistent promotion efforts made social media, press releases, radio inter email and telephone contact with sch offer of assemblies;
Number of webinars delivered	4	2	- City Nature Challenge webinar (21/0 - Recording wildlife in Liverpool City C (26/05)
Number of people engaged in webinars	750	80	41 for City Nature Challenge webinar (2 39 for Recording wildlife in LCC we (26/05)

Bioapp Media Activity:

Timetable	Media/Activity	Sites
April	1 x Webinar event promoted and hosted on the LWT 'What's On' page	LWT v Faceb
April	1 x Blog post promoting the Urban GreenUP project and wildlife recording around the intervention sites.	LWT v
April – May	4 x Social media videos promoting the intervention sites (location) and wildlife recording for City Nature Challenge.	Faceb
April	1 x Post/advert on permanent web page for the art trail	Art-dc websi
April	1 x Webinar event promoted and hosted on the LWT 'What's On' page	LWT v Faceb
April – May	4 x Social media posts promoting webinar and showcasing 'what's been found in the Baltic Triangle'.	Faceb
May	1 x Blog post on Farm Urban's website promoting the Urban GreenUP intervention sites, wildlife recording and upcoming webinar (May 26th)	Farm websi

May	1 x Press release advertising the Baltic Bingo Wildlife Competition for Years 4-6, including information on the Urban GreenUP project and intervention sites.	Press
May	1 x Webpage advertising the Baltic Bingo Wildlife Competition and wildlife recording across Liverpool City Centre for the Urban GreenUP project.	LWT v
May	1 x radio interview advertising the Baltic Bingo Wildlife Competition and wildlife recording across Liverpool City Centre for the Urban GreenUP project.	BBC Merse
June	8 x Social media posts promoting the focus sites (including art trial, insects found in the BT for national insect week) and the Baltic Bingo Wildlife Competition. Promotional content will tie into 30 Days Wild to increase engagement.	Faceb
June	1 x Article in Lapwing (ed. Summer 2021) about Urban GreenUp project and wildlife recording.	Maga: article
July	6 x Events (wildlife walks) promoted and hosted on the LWT 'What's On' page. Social media template sent to wide range of contacts to promote the events via newsletters, social media posts, website content and word of mouth.	LWT v Faceb
July	5 x Social media posts promoting the Urban GreenUP project and use of iNaturalist at focus sites.	Faceb
July	Facebook live broadcast ('iNaturalist Q&A) answering questions about iNaturalist submitted by the public.	Faceb
August	2 x Social media posts promoting Baltic Triangle Record & Ramble walks,	Faceb
August	1 x Press release detailing wildlife recording findings in the Baltic Triangle since the start of the year.	Press
August	1 x Blog post promoting the Urban GreenUP wildlife recording project – developments since March when promotion began.	LWT v

For further bioapp information, please see Lancashire Wildlife Trust report.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The GI-VAL modelling analyses show 100000 visitor days, and 500000 local users may have passed close to the interventions, so an assumed positive benefit to Liverpool from the addition of the interventions is made.

The Non-technical data for Nature for Health comprised results from participant surveys during a twelve-week horticultural therapy course targeting 'hard to reach' people from areas of need. This course aimed to improve mental and physical wellbeing through gardening and growing food. More information can be found in the 2018 Community Forest Trust Nature4Health impact report.

The non-technical data for the bioapp, iNaturalist, were data from event audience numbers and observations made using the app.

The non-technical data (see CH0702 Citizen Perception) show an increase in connection with Nature. Other non-technical data regarding the use of the bioapp, iNaturalist demonstrate a successful increase in numbers of users, awareness of the app and knowledge of the biodiversity (16%) in the Sub-demo A Baltic area.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final).

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model

Economical barriers	How they have been addressed
n/a	

Social barriers	How they have been addressed
n/a	

Environmental (including COVID)	How they have been addressed
Impacts on number of face-to-face surveys due to Covid restrictions for the Socio-economic data. In addition, events and activities to promote the bioapp, iNaturalist, were really restricted due to Covid restrictions and staff furlough.	Online interviews and postal surveys became the focus of the Socio-economic investigations. Bioapp were organized where possible and social media/ webinars used to promote the use of the iNaturalist app.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Assumed positive benefit from increase in visitor and local user numbers, even though a true number of people who look at or interact with the interventions could not be determined. Successful increase in awareness and use of the bioapp, iNaturalist, plus the knowledge of the biodiversity of the Baltic area increased by 16%. Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final) and other related KPIs.

What was the impact? (positive/negative, significant/non-significant)?
Positive

1.2.34 CH0801 Crime reduction

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0801	CRIME REDUCTION	UOL with LCC

CITY	*RELATED NBS*
LIV	All NBS

Results and Discussion

Table of results (summary, from Task 5.4)

SOCIO-ECONOMIC

Socio-economic data: please see report 2 (SE-REPORT_2_WP5-KPI CH0801 - Crime Reduction_Report).

Crime	Otterspool	Sefton Park	Baltic Triangle
2019 (pre-installation) reported crimes	259	184	557
2020 (post-installation) reported crimes	235	170	464
% change (increase/decrease reported crimes)	-9%	-8%	-17%

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Socio-economic data: please see report 2 (SE-REPORT_2_WP5-KPI CH0801 - Crime Reduction_Report).

Overall a decrease in crime rates occurred with sub demos C and A, but please see report for detailed analysis.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
n/a	

Economical barriers	How they have been addressed
n/a	

Social barriers	How they have been addressed
n/a	

Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Socio-economic data: please see report 2 (SE-REPORT_2_WP5-KPI CH0801 - Crime Reduction_Report): Overall, it is not possible to state that NBS interventions in the three study areas led to decreases in the numbers of reported crimes. Although, the data highlights a general decrease in the reporting of crimes from 2019 to 2020 the impact of Covid-19, the micro-scale of the interventions, as well as the breadth of interventions cannot be deemed to have significantly lower crime. Moreover, to make such claims would require explicit qualitative/contextual data to validate such claims. This does not though question the role that well-managed, well designed, light with good sightlines, and well used NBS have on reducing crime, as noted in the literature. For the three intervention areas examined for URBAN GreenUP claims regarding links between crime reduction and NBS interventions cannot be substantiated.

What was the impact? (positive/negative, significant/non-significant)?

Inconclusive

1.2.35 CH0902 Walking area increase

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0902	WALKING AREA INCREASE	UOL/UOM with LCC
CITY	*RELATED NBS*	
LIV	LAc1, LAc2, LAc5, LAc6, LAc12, LAc25, LAc26	

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: VIVACITY sensor data

NON-TECHNICAL: Nature4Health

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY									
CH0902: Walking									
Pre-Intervention				Post-Intervention				% Change	Area
n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd		
4492	4	739.9	495.3	2519	3	842.4	501.9	13.9	**Overall Liverpool**

Non-technical Nature for Health results:

CH0703-Social Learning: Nature for Health Non-Technical					
Mental Well-being WEMWBS scores**	**Total number of participants**	**Before**	**After**	**Change in points**	**% change**
Community Forest Trust (2018) Nature4Health: Impact Report	1936	47.6	53.8	6.2	13
St. Margaret's, Toxteth	16	42.9	53.8	10.9	25.5
St. Michaels in the City	11	46.5	51.9	5.4	11.5
Totals adjacent to UGU NBS	**27**	**44.7**	**52.9**	**8.2**	**18.2**
**Warwick-Edinburgh Mental Wellbeing Scale: https://warwick.ac.uk/fac/sci/med/research/platform/wemwbs/					

CH0902-Walking Area Increase: Nature for Health Non-Technical									
		IPAQ 5				IPAQ 6			
IPAQ*-Walking Activity	**Total number of participants**	**Before**	**After**	**Difference**	**% change**	**Before**	**After**	**Difference**	**% change**
		days	days	days		mins per day	mins per day	mins per day	
Community Forest Trust (2018) Nature4Health: Impact Report	1936					63	85.5		36
St. Margaret's, Toxteth	21	5.0	5.6	0.6	11.4	80.4	102.9	22.4	27.9
St. Michaels in the City	11	5.5	6.5	1.0	18.3	115.4	122.0	6.5	5.7
Totals adjacent to UGU NBS	**32**	**5.2**	**6.0**	**0.8**	**15.0**	**97.9**	**112.4**	**14.5**	**14.8**

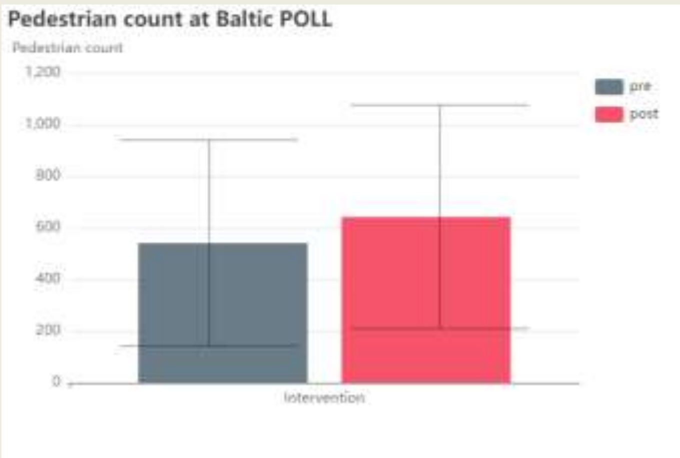
Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

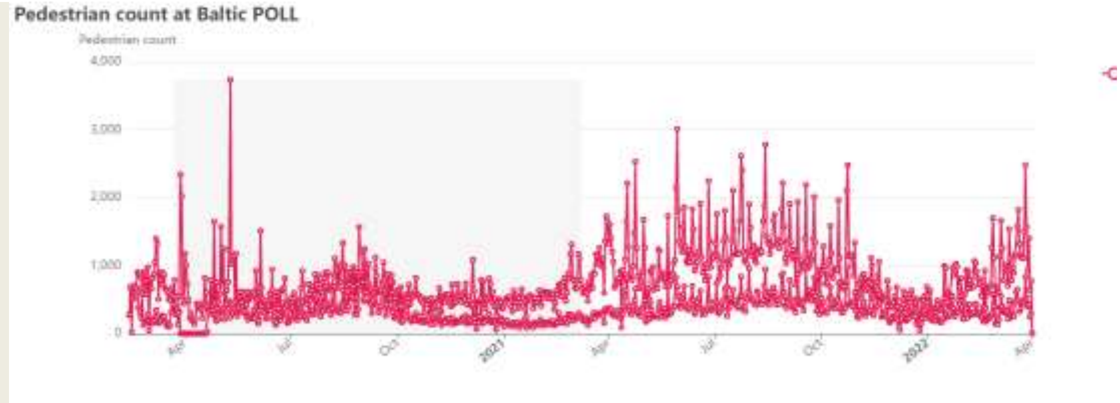
The related interventions are in the table below:

FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0902	WALKING AREA INCREASE	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc5	Shade trees	Shade_TREES	Shade_TREES	Shade_TREES
		LAc6	Cooling trees	Cooling_TREES	Cooling_TREES	
		LAc25	GI for Physical health	ALL	ALL	ALL
		LAc26	GI for Mental health	ALL	ALL	ALL

Map of monitoring locations

Equipment and methodology: Vivacity traffic sensor:



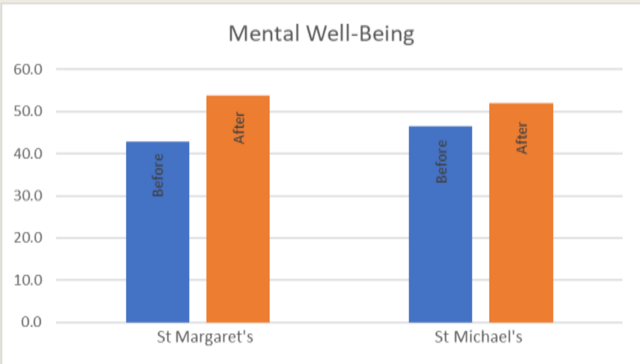


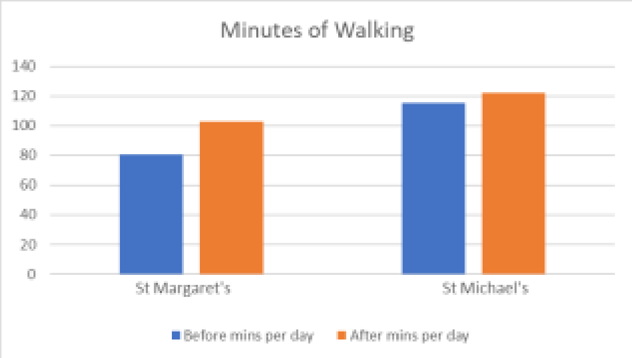
The timeline for the Vivacity data (example plot from the Baltic sub demo A Green Route) shows the depression in numbers with lockdown (grey background) and seasonal effects. The box plot demonstrates a slight increase after the interventions were added for pedestrians. Further analyses may help to determine if any particular interventions made a difference to the walking levels.

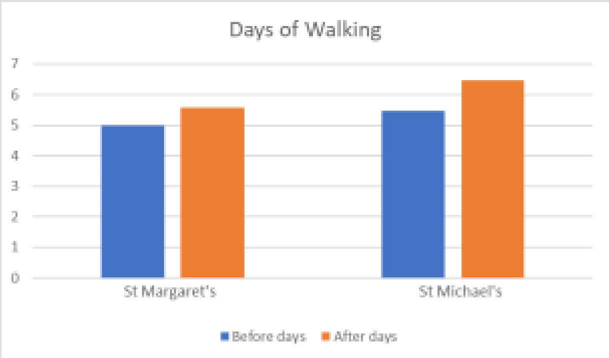
The overall data summary data for Liverpool from the Vivacity sensor data demonstrates a positive increase in walking levels of 13.9%.

The Non-technical data for Nature for Health comprised results from participant surveys during a twelve-week horticultural therapy course targeting 'hard to reach' people from areas of need. This course aimed to improve mental and physical wellbeing through gardening and growing food. More information can be found in the 2018 Community Forest Trust Nature4Health impact report.

The Non-technical data shows a positive increase in mental wellbeing of 18% from being associated with horticultural therapy undertaken at sites adjacent to Urban GreenUP interventions.







The walking data from the Nature for Health programme demonstrate an increase in walking for both days(15 days) and minutes per day (increase of 15 minutes per day for both sites adjacent to Urban GreenUP interventions.

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Sensor locations did not always transect the entire street corridor or road junctions or were not able to be located close to the interventions.	Awareness of limitations of data in counting actual numbers of pedestrians actually passing interventions or along designated green routes.
Economical barriers	How they have been addressed
None	

Social barriers	How they have been addressed
None	

Environmental (including COVID)	How they have been addressed
Covid lockdowns severely temporarily reduced walking levels	Awareness of timings of lockdowns when assessing the data.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Further analyses to assess the impact of Covid lockdown periods, seasonality and climate would be useful to increase understanding of the impact of the Urban GreenUP project on activity levels.

Positive in terms of quantitative Vivacity sensor data and in terms of non-technical participant surveys.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.36 CH0903 Cycling area increase

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0903	CYCLING AREA INCREASE	UOL/UOM with LCC

CITY	*RELATED NBS*
LIV	LAc1, LAc2, LAc5, LAc6, LAc12, LAc25, LAc26

Results and Discussion

Table of results (summary, from Task 5.4)

QUANTITATIVE: VIVACITY sensor data: SEE CH0902

NON-TECHNICAL: Nature4Health (data in CH0703-Social Learning)

Quantitative monitoring data results:

QUANTITATIVE DATA SUMMARY									
CH0903: Cycling									
Pre-Intervention				Post-Intervention				% Change	Area
n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd		
4492	4	105.7	118.0	2519	3	99.7	96.9	-5.6	Overall Liverpool

Non-technical Nature for Health results:

CH0903-Cycling Area Increase: Nature for Health Non-Technical									
		IPAQ 1				IPAQ 2			
IPAQ*-Cycling activity	Total number of participants	Before	After	Difference	% change	Before	After	Difference	% change
		days	days	days		mins per day	mins per day	mins per day	
Community Forest Trust (2018) Nature4Health: Impact Report	1936					8.4	9.4		12.0
St. Margaret's, Toxteth	13	1.1	1.8	0.8	71.4	53.1	85.4	32.3	60.9
St. Michaels in the City	10	1.1	2.1	1.0	90.9	27.0	36.0	9.0	33.3
Totals adjacent to UGU NBS	**23**	**1.1**	**2.0**	**0.9**	**81.3**	**40.0**	**60.7**	**20.7**	**51.6**
		IPAQ 3				IPAQ 4			
		Before	After	Difference	% change	Before	After	Difference	% change
		days	days	days		mins per day	mins per day	mins per day	
Community Forest Trust (2018) Nature4Health: Impact Report	1936					20.5	27.7		35.0
St. Margaret's, Toxteth	13	2.0	3.5	1.4	69.8	133.8	125.8	-8.1	-6.0
St. Michaels in the City	10	2.1	2.0	-0.1	-4.8	33.0	66.0	33.0	100.0

Totals adjacent to UGU NBS	**23**	**2.1**	**2.7**	**0.7**	**32.0**	**83.4**	**95.9**	**12.5**	**14.9**

CH0903-Cycling Area Increase: Nature for Health Non-Technical				
	IPAQ1&3	**% change**	**IPAQ2&4**	**% change**
		days		**mins per day**
Totals adjacent to UGU NBS		56.6		33.3

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

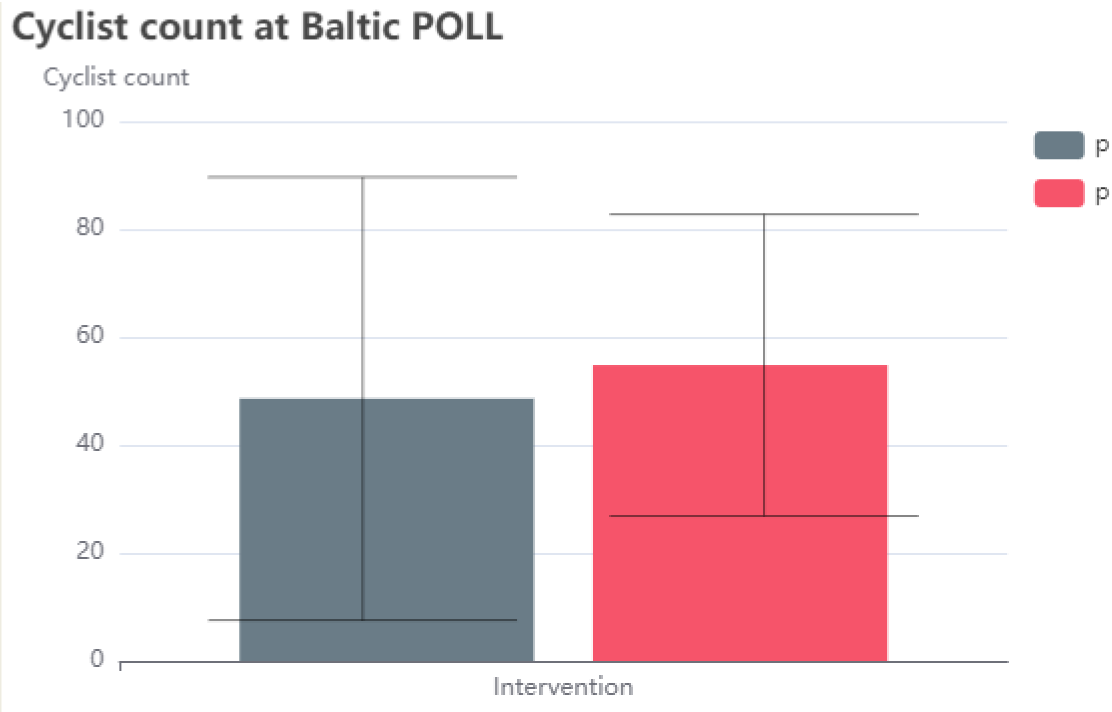
The related interventions are in the table below:

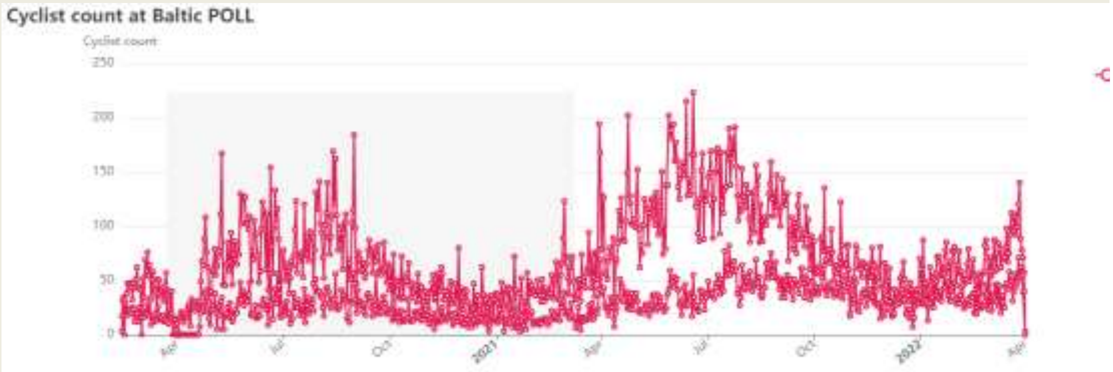
FINAL KPI CODE	KPI NAME	NBS Ref No.	NBS NAME	LIVERPOOL INTERVENTIONS: Sub-demo A	LIVERPOOL INTERVENTIONS: Sub-demo B	LIVERPOOL INTERVENTIONS: Sub-demo C
CH0903	CYCLING AREA INCREASE	LAc1	New green cycle route	ALL	ALL	ALL
		LAc2	Green travel route	ALL	ALL	ALL
		LAc5	Shade trees	Shade_TREES	Shade_TREES	Shade_TREES
		LAc6	Cooling trees	Cooling_TREES	Cooling_TREES	
		LAc25	GI for Physical health	ALL	ALL	ALL
		LAc26	GI for Mental health	ALL	ALL	ALL

Map of monitoring locations: See CH0902

Equipment and methodology: See CH0902

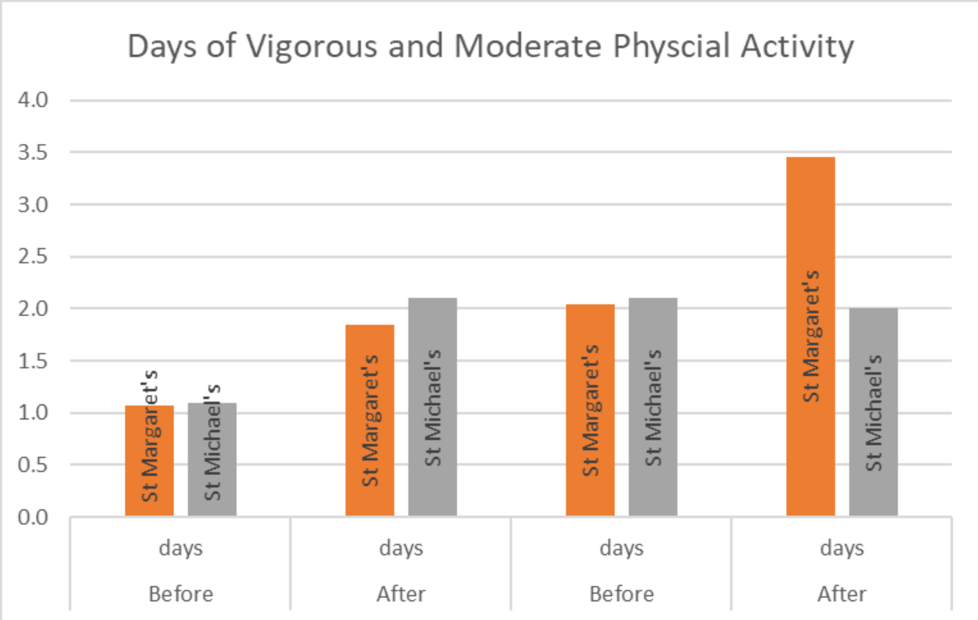
The overall data summary data for Liverpool from the Vivacity sensor data demonstrates a slight negative effect on cycling levels of -5.6% from the addition of the Urban GreenUP interventions.

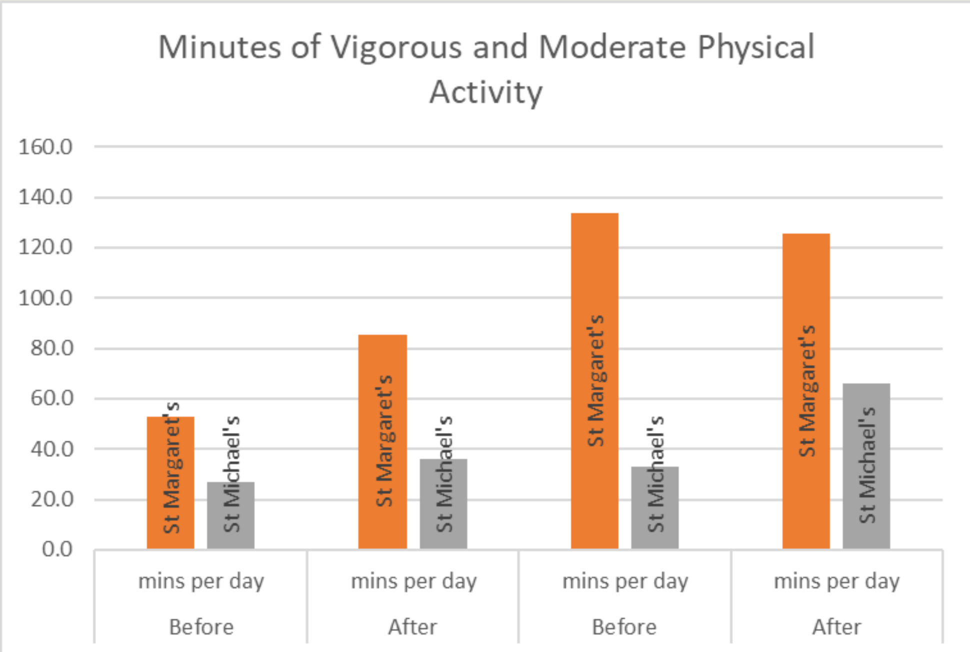




The timeline for the Vivacity data (example plot from the Baltic sub demo A Green Route) shows the depression in numbers with lockdown (grey background) and seasonal effects. The box plot demonstrates a slight increase after the interventions were added for people cycling. Further analyses may help to determine if any interventions made a difference to the cycling levels.

The Non-technical data for Nature for Health comprised results from participant surveys during a twelve-week horticultural therapy course targeting 'hard to reach' people from areas of need. This course aimed to improve mental and physical wellbeing through gardening and growing food. More information can be found in the 2018 Community Forest Trust Nature4Health impact report.





The non-technical participant surveys demonstrated and increase of cycling levels in terms of day (56.6%) and minutes per day (33.3%). This effect was more noticeable for the St Margaret's site (adjacent to Princes Ave pollinator planting and cycle way improvements) than for the St Martins site (adjacent to Baltic sites such as the rain garden).

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Sensor locations did not always transect the entire street corridor or road junctions, or were not able to be located close to the interventions	Awareness of limitations of data in counting actual numbers of people cycling who actually passing interventions or travelled along designated green routes
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Covid lockdowns severely temporarily reduced cycling levels	Awareness of timings of lockdowns when assessing the data.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Further analyses to assess the impact of Covid lockdown periods, seasonality and climate would be useful to increase understanding of the impact of the Urban GreenUP project on activity levels. Negative in terms of quantitative Vivacity sensor data, but positive and in terms of non-technical participant surveys
What was the impact? (positive/negative, significant/non-significant)?
Inconclusive

1.2.37 CH0904 Health quality perception

KPI CODE	*KPI NAME*	*PARTNER(S)*

CH0904	HEALTH QUALITY PERCEPTION	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

SOCIO-ECONOMIC: Refer to report 'Analysis of NBS in Liverpool' which assesses CH0403-Green Space Accessibility, CH0702 Citizen Participation, CH0703 Social Learning, CH0705 Engagement with NBS and CH0904 Health Quality Perception.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final)

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
n/a	
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed

n/a	
Environmental (including COVID)	How they have been addressed
Impacts on number of face-to-face surveys due to Covid restrictions	Online interviews and postal surveys became the focus of the Socio-economic investigations

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Socio-Economic data: Please see report 1 'Analysis of NBS in Liverpool' (SE-REPORT_1_WP5-KPI CH0403-CH0904-CH0702-CH0703-CH0705-Final): People in both sites strongly hold that greenspace/NBS has a positive impact on both mental and physical health. On greenspace/NBS impact on mental health, 77% of respondents in Sefton Park and 70% in Otterspool selected 'very positive impact', whilst 68% of respondents in Sefton Park and 70% in Otterspool selected the same option regarding physical health. With these perceptions in mind, it is perhaps unsurprising that people in both sites believe that greenspace/NBS has a highly positive impact on quality of life. 67% of responses in Sefton Park and 69% in Otterspool were for 'very positive impact'.

Hence, a positive impact was found.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.38 CH1002 Job creation

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH1002	JOB CREATION	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

MODELLING: GI-VAL

SOCIO-ECONOMIC: See also other KPIs and combined report on KPI CH1005 New Business, CH1002 Job Creation, CH0602 Benefits of NBS Interventions and CH0703 Social Learning

GI-VAL results:

CH1002: Job Creation	GI-VAL BENEFITS		Sub-Demo Areas			Overall Liverpool	BENEFIT QUANTIFICATION
Functions	Tools		A	B	C		
Tourism attraction	8.2 Employment supported by tourism		60	60	60	60	FTE jobs
Land management	11.2 Employment supported by land management		2	2	2	2	FTE jobs

Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The GI-VAL toolkit used standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits were assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.

The Gi-VAL modelling produced a positive increase in employment due to tourism and land management associated with the Urban GreenUP project. For all areas and overall Liverpool, these were calculated as 60 jobs connected with tourism and 2 jobs within land management.

Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning).

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
The GI-VAL toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions that the green infrastructure may perform, support or encourage, depending upon the type of project.	Awareness of limitations of model
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Positive impact on employment levels according to the modelling analyses.

Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning) and see CH1005.

Overall, positive indications were found.

What was the impact? (positive/negative, significant/non-significant)?

Positive

1.2.39 CH1004 Land and property price change

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH1004	LAND AND PROPERTY PRICE CHANGE	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

SOCIO-ECONOMIC: See also CH0510-Increase in Property value. Land values unable to be accessed in the same way as property value/ sales.

Socio-economic data: please see report 3 (SE-REPORT_3_WP5-KPI CH1004_Housing_prices_NBS-Report).

House Prices	Otterspool	Sefton Park	Baltic Triangle
2008 (baseline average price)	£215,053.57	£155,730.86	£163,713.17
2019 (pre-installation) reported crimes	£230,229.13	£218,412.50	£130,652.08
2020 (post-installation) reported crimes	£248429.67	£223,722.25	£139,276.29
% change (2019-2020)	+7.9%	+7.0%	+6.8%
% change 2008-2020	+15.5%	+50%	-15%

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Socio-economic data: please see report 3 (SE-REPORT_3_WP5-KPI CH1004_Housing_prices_NBS-Report).

For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
. Land values unable to be accessed in the same way as property value/ sales.	Awareness of limitations of data.
Economical barriers	How they have been addressed
n/a	
Social barriers	How they have been addressed
n/a	
Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Socio-economic data: please see report 3 (SE-REPORT_3_WP5-KPI CH1004_Housing_prices_NBS-Report): The overall conclusion from the analysis presented above is that it is not possible to statistically state that the URBAN GreenUP interventions have led to increases in property prices. Although evidence exists linking increased house prices to NBS/greenspace these point to larger interventions and/or interventions in areas of limited greenspace/NBS as being moist influential.

In two of the three research areas the existing greenspace baseline in terms of parks, trees, and access to water features is high and therefore the evidence does not suggest an additional uplift in house prices associated with the micro-scale URBAN GreenUP NBS interventions. Moreover, although proximity (and by association accessibility) is noted as being key variables in understanding house prices when the majority of an area is located within a 10-minute and/or 500m radius of a high-quality greenspace/NBS it is difficult to isolate the added value of micro-scale NBS interventions.

Hence, for the result was inconclusive for this KPI.

What was the impact? (positive/negative, significant/non-significant)?

Inconclusive

1.2.40 CH1005 New businesses

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH1005	NEW BUSINESSES	UOL/UOM
CITY	*RELATED NBS*	
LIV	All NBS	

Results and Discussion

Table of results (summary, from Task 5.4)

SOCIO-ECONOMIC: See also other KPIs and combined report on KPI CH1005 New Business, CH1002 Job Creation, CH0602 Benefits of NBS Interventions and CH0703 Social Learning Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning). *For further plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP: Username: ugu; Password: Baltic*

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
n/a	

Economical barriers	How they have been addressed
n/a	

Social barriers	How they have been addressed
n/a	

Environmental (including COVID)	How they have been addressed
n/a	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Socio-Economic data: Please see Report 4 (SE-REPORT_4_WP5-KPI CH1005 New Business_CH1002 Job Creation_CH0602 Benefits of NBS Intervention_CH0702 Social Learning): 2. Many interviewees believe that urban greening has a beneficial impact on business rates, and the mental wellbeing of workers, visitors, and urban dwellers alike.

Overall a small positive indication was found.

What was the impact? (positive/negative, significant/non-significant)?

Postitive

1.3 Izmir

1.3.1 CH0102 Ton CO2 Carbon removed ha per year

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0102	Ton CO_2 Carbon removed ha per year	EGE Landscape
CITY	*RELATED NBS*	
IZM	Green shady structure, urban carbon sink, green parklets and new green corridor	

Results and Discussion

Table of results (summary, from Task 5.4)

Carbon sequestration capacity of trees and shrubs per year in hectare was estimated based on I-tree Eco v6 and canopy cover value. For baseline and monitoring calculations of carbon sequestration potentials of vegetation, structural data of plants was collected from the field.

The carbon sequestration potential of plant cover in ha/year in Peynircioğlu increased up to 190 % in the 1st monitoring and 217 % in the 2nd monitoring period compared to baseline value (Table 1).

The carbon sequestration potential of plants in Sasalı enhanced up to 183 % (Table 2).

	Baseline	1st monitoring	2nd monitoring
Carbon sequestration (C t/ha year)	3,78	10,98	11,99

Table 1: Carbon sequestered by vegetation in Peynircioğlu.

	Baseline	1st monitoring
Carbon sequestration (C t/ha year)	8,4	23,77

Table 2: Carbon sequestered by vegetation in Sasalı.

Figure 2: Plants in Peynircioğlu (left) and Sasalı (right).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Increasing number of trees and expanding canopy cover in Peynircioğlu enhanced carbon sequestration ecosystem service in the site (Figure 2).

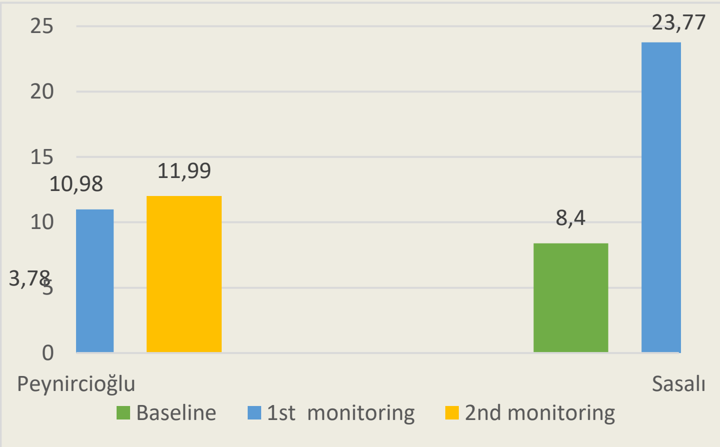


Figure 2: Carbon sequestered by vegetation in Peynircioğlu and Sasalı.

Oriental plane *(Platanus orientalis*), Turkey oak (Quercus cerris), Mediterranean cypress (*Cupressus sempervirens*) and Cherry plum (*Prunus cerasifera*) had high contribution for carbon sequestration.

In Sasalı; planting climate-resilient high numbers of native tree and shrub species provide contribution to carbon sequestration in ha/year (Figure 2). Based on monitoring outcomes, Eucalyptus trees (*Eucalyptus cameldulensis*), Strawberry tree (*Arbutus unedo*) and Goat willow (*Salix caprea*) support carbon sequestration in the site.

Conclusions and recommendations

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	

Economical barriers	How they have been addressed
No barriers detected.	

Social barriers	How they have been addressed
No barriers detected.	

Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Since increasing concentration of atmospheric carbon is the main reason for climate change, removal of carbon from the atmosphere greatly contributes to climate change and climate mitigation. There is a significant impact based on the outcomes of monitoring. This impact increases over time.

What was the impact? (positive/negative, significant/non-significant)?

Planting new trees and increasing tree cover create a significant impact on C sequestration in the area of the Urban Carbon Sink. The contribution to the “Challenge 1: Climate mitigation & adaptation" is positive in the values. The planting of trees in the city will contribute more to carbon sequestration in the mid and long terms.

1.3.2 CH0103 Carbon stored by vegetation

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0103	CARBON STORED BY VEGETATION	EGE Landscape
CITY	*RELATED NBS*	
IZM	Green shady structure, urban carbon sink, green parklets and new green corridor	

Results and Discussion

Table of results (summary, from Task 5.4)

Carbon storage capacity of trees and shrubs was estimated based on their biomass by using I-tree Eco v6. For baseline and monitoring calculations of carbon storage potentials of vegetation structural data of plants were collected from the field observations.

Carbon storage capacity of plant cover in Peynircioğlu increased up to 35 % in the 1st monitoring and 87 % in the 2nd monitoring period compared to baseline value (Table 1).

Before implementation trees in Sasalı estimated to store 107,7 carbon ton/year. After implementation as a result of removing many large trees from the site, this number reduced 50 % (Table 2).

	Baseline	1st monitoring	2nd monitoring
Number of plant species	306	3966	3936
Carbon storage (metric ton)	281,1	380,8	526,3

Table 1: Carbon stored by vegetation in Peynircioğlu.

	Baseline	1st monitoring
Number of plant species	299	3936
Carbon storage (metric ton)	107,7	53,6

Table 2: Carbon stored by vegetation in Sasalı.

Figure 1: Vegetation of Peynircioğlu (left) and Sasalı (right).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Monitoring results showed that carbon storage function of plants in Peynircioğlu increased more than 80 % (Figure 2). Oriental plane *(Platanus orientalis*), Turkey oak (*Quercus cerris*), Mediterranean cypress (*Cupressus sempervirens*), Cherry plum (*Prunus cerasifera*) had high contribution for carbon storage. Considering that the plants used are quite young, the carbon storage amount of these plants will increase over time.

The calculated decline for carbon storage potential of plants in Sasalı is related to tree cover reduction after the implementation (Figure 2). Based on monitoring outcomes, Eucalyptus trees (*Eucalyptus cameldulensis*), Strawberry tree (*Arbutus unedo*) and Goat willow (*Salix caprea*) greatly support carbon storage.

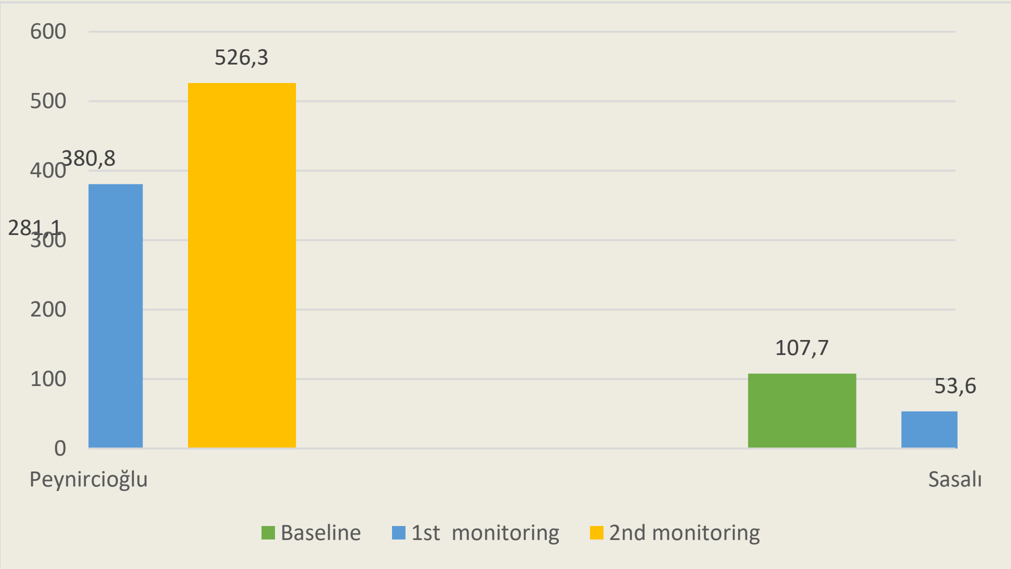


Figure 2: Carbon stored by plants in Peynircioğlu and Sasalı.

Conclusions and recommendations

Proper maintenance measures are required to keep the plants growing and healthy in order to increase the amount of carbon stored over time. Large canopy trees are highly recommended to keep a large canopy cover.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	

Economical barriers	How they have been addressed
No barriers detected.	

Social barriers	How they have been addressed
No barriers detected.	

Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Since increasing concentration of atmospheric carbon is the main reason for climate change, Increased carbon storage capacity of urban green would have a very important impact on climate mitigation and adaptation challenges.

What was the impact? (positive/negative, significant/non-significant)?

Implementations in Peynircioğlu obviously impacted climate change challenge very positively. That positive impact is expected to increase over time.

Sasali on the other hand, stayed on the negative side with its the decreased number of large trees. But, that negative impact would turn into positive one as the trees grow and expand by volumetric.

1.3.3 CH0104 Carbon sequestration by vegetation

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0104	CARBON SEQUESTRATION BY VEGETATION	EGE Landscape
CITY	*RELATED NBS*	
IZM	Green shady structure, urban carbon sink, green parklets and new green corridor	

Results and Discussion

Table of results (summary, from Task 5.4)

Carbon sequestration capacity of trees and shrubs were estimated based on their biomass by using I-tree Eco v6. For baseline and monitoring calculations of carbon sequestration potentials of vegetation, structural data of plants was collected from the field. Every tree was measured based on required data. Having a large amount of biomass was the here.

The carbon sequestration of plant cover in Peynircioğlu increased up to 632 % in the 1st monitoring and 675 % in the 2nd monitoring period compared to baseline value (Table 1). This is a very significant increase that also indicates a very sharp increase in the biomass of

Peynircioğlu.

The carbon sequestration potential of plants in Sasalı enhanced up to 186 % (Table 2).

	Baseline	1st monitoring	2nd monitoring
Number of plant species	306	3966	3936
Carbon sequestered (ton/year)	1,85	11,7	12,49

Table 1: Carbon sequestration by vegetation for Peynircioğlu.

	Baseline	1st monitoring
Number of plant species	299	3936
Carbon removed (ton/ year)	2.48	4.62

Table 2: Carbon sequestration by vegetation for Sasalı.

Figure 2: Plants in Peynircioğlu (left) and Sasalı (right).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Renaturing Peynircioğlu stream and expanding the park along the stream (blue) corridor include planting new big trees. Increasing number of trees greatly enhanced carbon sequestration ecosystem service in the site (Figure 2). Oriental plane *(Platanus orientalis*), Turkey oak (Quercus cerris), Mediterranean cypress (*Cupressus sempervirens*) and Cherry plum (*Prunus cerasifera*) had high contribution for carbon sequestration.

In the implementation in Sasalı; some of large eucalyptus trees, which are not among the natural species of the region, have been removed from the area, climate-resilient native species have been replaced and a bio-swale was created to facilitate the infiltration of stormwater into the ground (Figure 2). Based on monitoring outcomes, Eucalyptus trees (*Eucalyptus cameldulensis*), Strawberry tree (*Arbutus unedo*) and Goat willow (*Salix caprea*) support carbon ssequestration in the site.

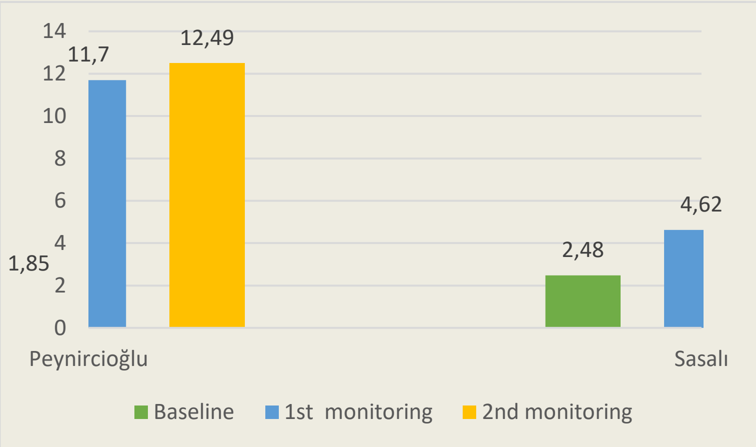


Figure 2: Carbon sequestration by plants in Peynircioğlu and Sasalı.

Conclusions and recommendations

Proper maintenance measures are required to keep the plants growing and healthy in order to increase the amount of carbon sequestered over time. Large biomass is highly recommended to fix a large amount of carbon. Increasing biomass and keep it that way should be one of the main goals in both areas.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed

No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Carbon sequestration by plants greatly contributes to climate mitigation and climate mitigation by fixing carbon into biomass. Since increasing concentration of atmospheric carbon is the main reason for climate change, Increased carbon sequestration capacity of urban green would have a very significant impact on climate mitigation and adaptation challenges.

What was the impact? (positive/negative, significant/non-significant)?

In both cases (Peynircioğlu and Sasalı), impacts are definitely positive. Implementations in Peynircioğlu impacted climate change challenge very positively. Moreover, that positive impact is expected to increase over time by increasing biomass. Sasalı showed a positive performance in sequestration as well.

1.3.4 CH0105- CH0106 Temperature decrease- temperature reduction (projection)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0105- CH0106	TEMPERATURE DECREASE- TEMPERATURE REDUCTION (PROJECTION)	IZT-EGE-BIT

CITY	*RELATED NBS*
IZM	Green shady structures, green covering shelters, cool pavements, shade and cooling trees, parklets.

Results and Discussion

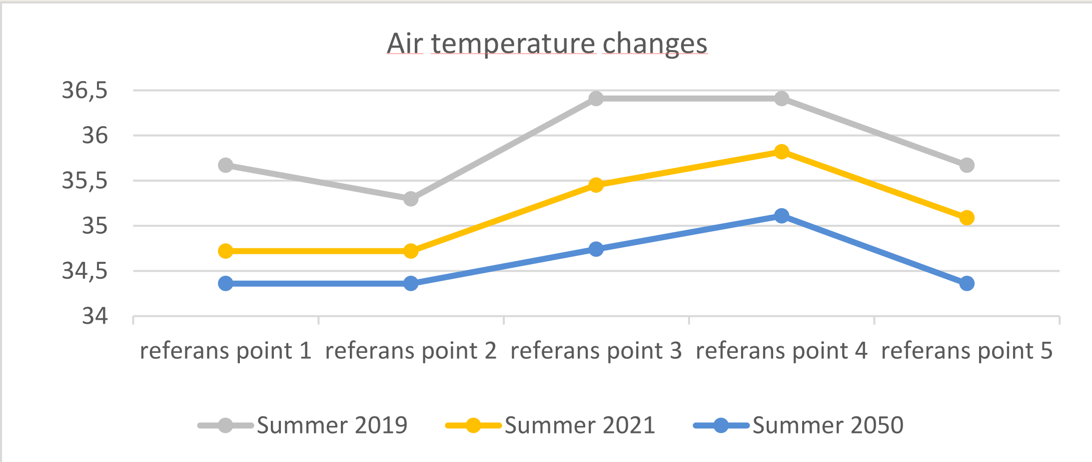
Table of results (summary, from Task 5.4)

Envi-Met, which is used in the study, is a program that simulates the built environment and uses the principles of fluid dynamics and thermodynamics to calculate surface-air-plant, thermal interactions and air quality in urban structures and open spaces (Koerniawan, 2015). In the study where the microclimate was calculated, mobile measurements were made based on reference points. The reference points were determined according to different material types and sun-shade conditions. Therefore, the changes in the microclimate of the area after the applications were easily calculated.

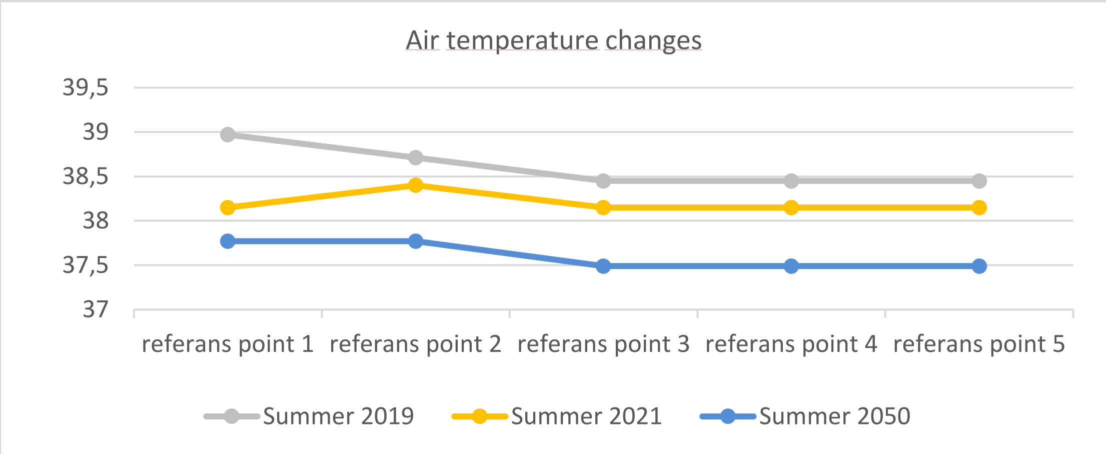
In the study, data on climate parameters were collected from fixed and mobile stations. Data on mobile measurements were first collected in 2019 before implementation. The measurements were then repeated on high-temperature days in the summer of 2020 and 2021. Finally, the future simulations of 2050, which was determined as the date when the planted plants will reach mature form, were calculated.

The monitoring and calculations are made for Girne Avenue, Sasali Wildlife and Vilayetler Evi Car Park Areas where IAc3 arboreal areas implementations are made.

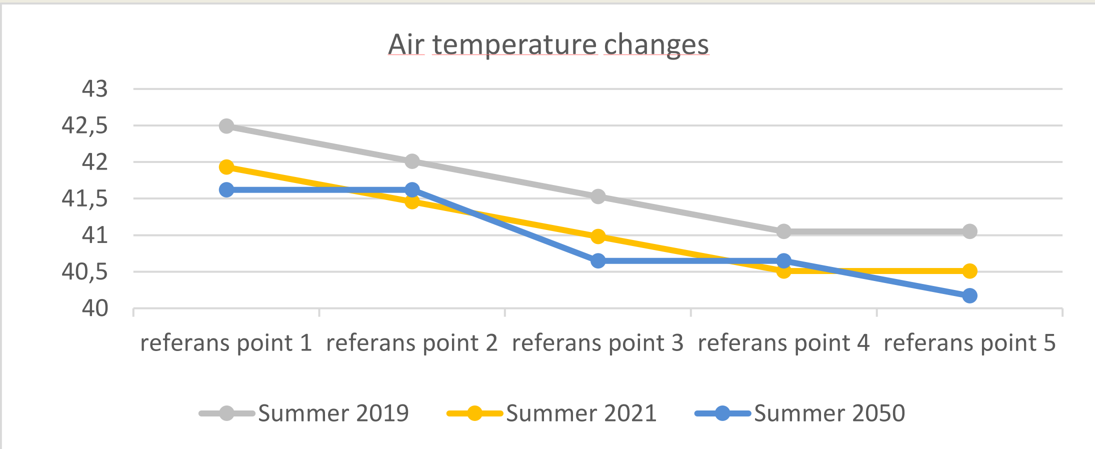
GİRNE AVENUE		1	2	3	4	5	max	Min
2019	Air temperature	35.30-35.67	34.93-35.30	36.04-36.41	36.04-36.41	35.30-35.67	38.25	34.56
2021	Air temperature	34.72-35.09	34.72-35.09	35.45-35-82	35.82-36.19	35.09-35.45	38.03	34.35
2050	Air temperature	34.36-34.74	34.36-34.74	34.74-35.11	35.11-35.48	34.36-34.74	37.72	33.99



SASALI WİLDLİFE PARK CAR PARK		1	2	3	4	5	max	min
2019	Air temperature	38.71-38.97	38.45-38.71	38.19-38.45	38.19-38.45	37.92-38.45	40.55	37.92
2021	Air temperature	38.15-38.40	38.40-38.65	38.15-38.40	38.15-38.40	38.15-38.40	40.43	37.89
2050	Air temperature	37.77-38.05	37.77-38.05	37.49-37.77	37.49-37.77	37.49-37.77	40.00	37.21



VİLAYETLER EVİ CAR PARK		1	2	3	4	5	max	Min
2019	Air temperature	42.01-42.49	41.53-42.01	41.05-41.53	40.57-41.05	40.57-41.05	44.41	39.61
2021	Air temperature	41.93-42.40	41.46-41.93	40.98-41.46	40.51-40.98	40.51-40.98	44.30	39.56
2050	Air temperature	41.62-42.10	41.62-42.10	40.65-41.14	40.65-41.14	40.17-40.65	44.04	39.20



Considering the baseline air temperature data in demo areas in different urban areas; The highest temperature values of 2019 at 13.00 were measured at 44.41 ^{0}C in the car park of the

Vilayetler Evi. The lowest value in terms of maximum temperatures was measured at 38.25 ^{0}C on Girne Street. The reason for the lower temperatures measured in this area is thought to be due to the shadow and canyon effect created by the buildings.

As can be seen in the tables, a small positive change was observed in all demo areas in the post-implementation measurements (2020-2021). But significant changes were calculated in the future simulation of 2050 by using Envi-met software.

Conclusions and recommendations.

Regarding the monitorization process

Technical barriers	*How they have been addressed*
No barriers detected	

Economical barriers	How they have been addressed

Social barriers	How they have been addressed

Environmental (including COVID)	How they have been addressed
The ivies planted in the car parks for shading have not yet covered the entire structure. Therefore, significant changes in the monitoring data could not be measured.	We expect the ivies to cover a wider area, then we will observe the impact of the interventions on the air temperature data.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Since the planted trees, ivies have not grown within the project period. During the beginning of the pandemic proper maintenance could not be done. The plants are in better condition now which also proves that the long term effects will be much higher than already calculated.

What was the impact? (positive/negative, significant/non-significant)?
Positive. As can be seen in the tables and graphics above, a positive change, albeit small, was calculated in the post-application measurements in terms of air temperatures. Also, similar to the thermal comfort data, the most significant changes were calculated in the simulations of the future projection, 2050.

1.3.5 CH0107 Measures of human comfort

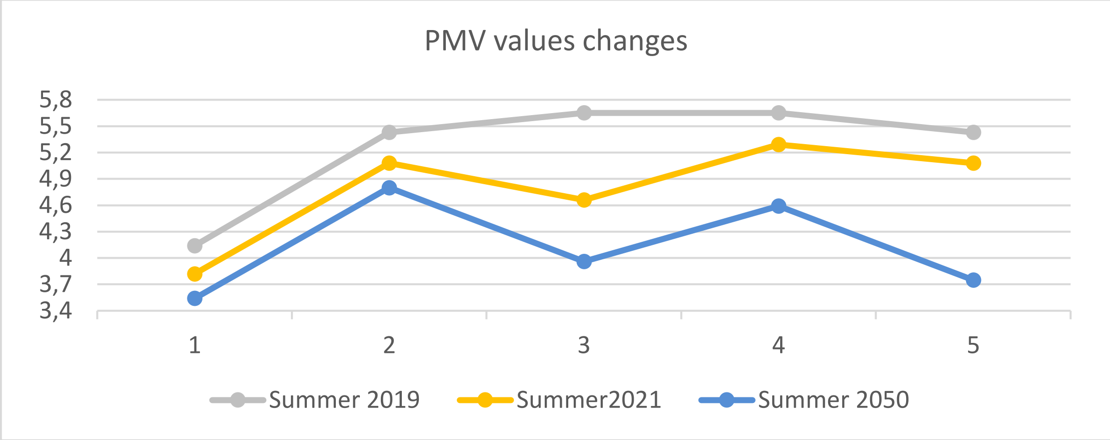
KPI CODE	KPI NAME	PARTNER(S)
CH0107	MEASURES OF HUMAN COMFORT	IZT-EGE

CITY	RELATED NBS
IZM	Green shady structures, green covering shelters, shade and cooling trees, cool and green pavements.

Results and Discussion

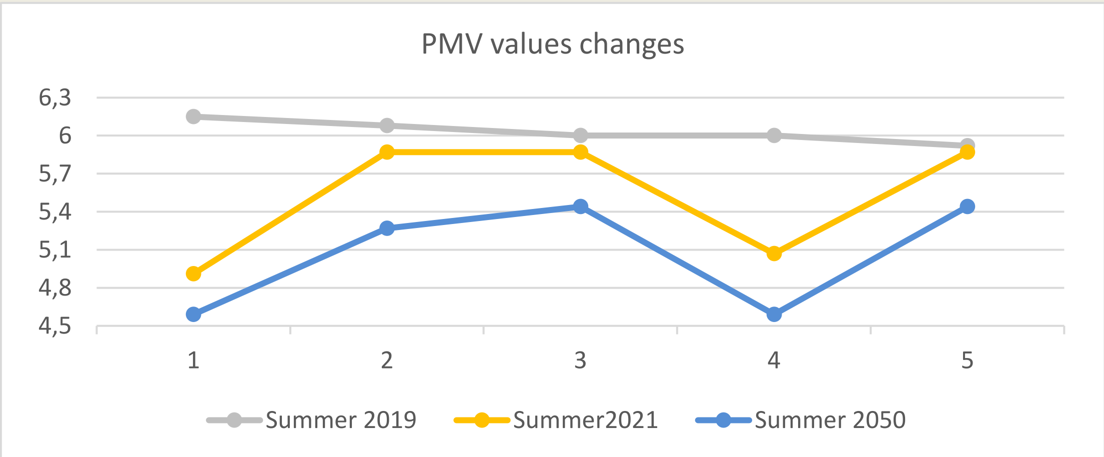
In the study, data on climate parameters were collected from fixed and mobile stations from Girne Avenue, Sasalı Wildlife and Vilayetler Evi Car Parks. Then, the thermal comfort values of the demo areas were calculated with the envi-met software. Calculations are based on the hottest days of the year.

GİRNE AVENUE		1	2	3	4	5	max	min
2019	PMV	3.92-4.14	5.22-5.43	5.43-5.65	5.43-5.65	5.22-5.43	6.08	3.92
	TMRT	52.87-55.21	71.57-73.91	71.57-73.91	71.57-73.91	71.57-73.91	76.25	52.87
2021	PMV	3.82-4.03	5.08-5.29	4.66-4.87	5.29-5.50	5.08-5.29	5.92	3.82
	TMRT	50.60-52.99	69.75-72.15	60.18-62.57	69.75-72.15	69.75-72.15	74.54	50.60
2050	PMV	3.54-3.75	4.80-5.01	3.96-4.17	4.59-4.80	3.75-3.96	5.65	3.54
	TMRT	47.31-49.78	67.11-69.58	54.73-57.21	67.11-69.58	52.26-54.73	72.06	47.31

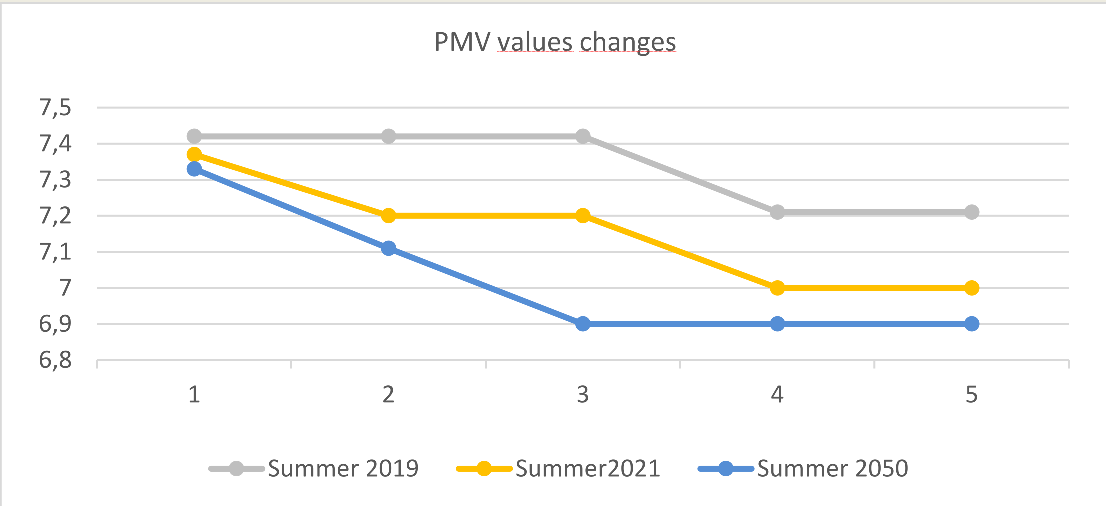


(The resulting maps have not been added.)

SASALI WİLDLİFE PARK CAR PARK		1	2	3	4	5	max	min
2019	PMV	6.08-6.15	6.00-6.08	5.92-6.00	5.92-6.00	5.85-5.92	6.62	5.85
	TMRT	82.94-83.94	82.94-83.94	82.94-83.94	82.94-83.94	82.94-83.94	82.94	82.94
2021	PMV	4.91-5.07	5.87-6.04	5.87-6.04	5.07-5.23	5.87-6.04	6.52	4.91
	TMRT	64-76-66.52	80.67-82.44	80.67-82.44	68.29-70.06	80.67-82.44	82.44	64.76
2050	PMV	4.59-4.76	5.27-5.44	5.44-5.61	4.59-4.76	5.44-5.61	6.30	4.59
	TMRT	62.78-64.58	77.11-78.90	78.90-80.69	62.78-64.58	78.90-80.69	80.69	62.78



VİLAYETLER EVİ CAR PARK		1	2	3	4	5	max	min
2019	PMV	7.21-7.42	7.21-7.42	7.21-7.42	7.00-7.21	7.00-7.21	7.85	5.72
	TMRT	82.42-84.29	82.42-84.29	82.42-84.29	82.42-84.29	82.42-84.29	84.29	65.65
2021	PMV	7.37-7.54	7.20-7.37	7.20-7.37	7.00-7.20	7.00-7.20	7.84	6.10
	TMRT	82.05-83.57	82.05-83.57	82.05-83.57	82.05-83.57	82.05-83.57	84.39	65.32
2050	PMV	7.33-7.54	7.11-7.33	7.11-7.33	6.90-7.11	6.90-7.11	7.75	5.61
	TMRT	80.69-82.64	80.69-82.64	82.64-84.59	80.69-82.64	80.69-82.64	84.59	65.12



According to the baseline measurements (2019) in the city of Izmir, where summer temperatures are quite high, all demo areas are under extreme heat stress. This calculation is based on Matrazakis' index of psychological stress.

As can be seen in the graphics, there is a decrease in PMV values in the calculations just after the application (2021) in all demo areas. In addition, the biggest change is seen in future simulations of 2050 created via Envi-met software.

Conclusions and recommendations.

Regarding the monitorization process

Technical barriers	*How they have been addressed*
At the beginning of the pandemic the maintenance could not be properly done right after the implementations which might have affected the growth of the plants.	

Economical barriers	How they have been addressed
No barriers detected.	

Social barriers	How they have been addressed
No barriers detected.	

Environmental (including COVID)	How they have been addressed
The ivies planted in the car parks for shading have not yet covered the entire structure. Therefore, significant changes in the monitoring data could not be measured.	We expect the ivies to cover a wider area, then we will observe the impact of the interventions on the air temperature data.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Yes.

What was the impact? (positive/negative, significant/non-significant)?
As can be seen in the tables and graphs above, there are small positive changes between the 2019 measurements, which are baseline measurements, and the monitoring (2021) measurements. However, the most obvious differences were observed in the simulations of the future projection, 2050.

1.3.6 CH0108 Heatwave risk

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0108	HEATWAVE RISK	IZT
CITY	*RELATED NBS*	

IZM	Horizontal green interventions, green covering shelter, green roof, green shady structures, tree related actions

Results and Discussion

Heatwave risks are described as 3 days of combined tropical nights (>20°C) and 3 hot days (>35°C).

Interventions applied to demo sites are installing green shady structures and replacing concrete pavements with permeable ones (Fig.1-2).

Air temperature data obtained from the meteorological stations at demo sites (Vilayetler Evi and Sasalı Natural Life Park) and number of tropical nights and hot days are determined monthly for summer season (June-August). Data for 2020 are obtained from meteoblue.com because of the lockdown during the Covid-19 pandemic.

(a) (b)

Figure 1. Vilayetler Evi Parking Lot (a) 2020, (b) 2022.

(a) (b)

Figure 2. Sasalı Natural Life Park Parking Lot (a) 2020, (b) 2022.

Table 2 and 3 present number of days with heatwave risk and encountered maximum air temperatures for daytime and night time. Highest temperatures (around 40°C) are recorded in July and August in both 2020 and 2021.

Table 1. Heatwave occurrences and maximum air temperatures at Vilayetler Evi.

Vilayetler Evi												
Months	June				July				August			
Year	2019	2020	2021	2022	2019	2020	2021	2022	2019	2020	2021	2022
Daytime												
No. of days	2	1	2	1	15	8	5	5	13	9	4	3
Max. air temp. (°C)	40.6	38.0	39.8	37.0	40.0	42.3	41.5	40.0	38.0	42.9	41.1	38.0
Night time												
No. of days	9	9	10	10	10	10	10	10	10	10	10	10
Max. air temp. (°C)	33.6	33.3	34.9	31.0	35.6	34.5	36.9	35.0	33.7	34.6	36.3	34.0
Total (Daytime + night time)	11	10	12	11	25	18	15	15	23	19	14	13

Table 2. Heatwave occurrences and maximum air temperatures at Sasalı Natural Life Park.

Sasalı Natural Life Park												
Months	June				July				August			
Year	2019	2020	2021	2022	2019	2020	2021	2022	2019	2020	2021	2022
Daytime												
No. of days	1	0	2	0	0	2	5	1	4	1	4	0
Max. air temp. (°C)	38.3	35.5	39.9	34.0	36.3	39.0	41.2	37.0	39.0	37.9	40.7	36.0
Night time												
No. of days	10	9	8	10	10	10	10	10	10	10	10	10
Max. air temp. (°C)	31.9	29.3	33.5	32.0	31.0	31.7	34.6	33.0	31.0	31.1	34.5	33.0
Total (Daytime + night time)	11	9	10	10	10	12	15	11	14	11	14	10

Total number of days with heatwave risk is combined from Table 1 and 2, and listed in Table 3 for both demo sites. Decrease in heatwave risk for Vilayetler Evi (urban area) compared with 2019 (ex-ante) is 20.3%, 30.5% and 33.9% for 2020,2021 and 2022, respectively. In Sasalı Natural Life Park (rural area), while decrease in heatwave risk is 8.6% and 11.4% for 2020 and 2022, an 11.4% increase is encountered in 2021. As can be seen from the Table 2, temperatures are quite high in 2021 summer compared with other years.

Table 3. Comparison of demo sites.

Year	Vilayetler Evi		Sasalı	
	No. of days	No. of days change based on 2019 (%)	No. of days	No. of days change based on 2019 (%)
Ex-ante (2019)	59	-	35	-
Ex-post (2020)	47	-20.3	32	-8.6
Ex-post (2021)	41	-30.5	39	+11.4
Ex-post (2022)	39	-33.9	31	-11.4

Conclusions and recommendations

It is worth to note that decrease in heatwave occurrences at Vilayetler Evi (dense urban area) is 3 times higher than Sasalı Natural Life Park (rural area) for 2019 (ex-ante) and 2022 (ex-post). This result emphasizes the powerful impact of NBS implementations on decreasing temperatures in urban areas over the rural areas. Maximum air temperatures in urban area are approximately 2°C higher than the rural area at daytime and as high as 4.6°C at night time. This is an indication of urban heat island effect.

Regarding the monitorization process

Technical barriers	*How they have been addressed*
No barriers detected.	

Economical barriers	How they have been addressed
No barriers detected.	

Social barriers	How they have been addressed
No barriers detected.	

Environmental (including COVID)	How they have been addressed
Monitoring has been delayed for a period due to COVID in 2020.	When the restrictions loosened in 2021 it was possible to do the monitoring. 2020 data for the locations were obtained from meteoblue.com

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Yes, there is a positive impact on the number of heatwave occurrences and encountered maximum daytime and night time maximum air temperatures.

What was the impact? (positive/negative, significant/non-significant)?
Positive impact is observed on both demo sites even though the ivies planted for green shady structures have not covered the whole structure yet. Comparing the number of heatwave occurrences at demo sites for 2019 (ex-ante) and 2022 (ex-post) summer seasons, a 33.9% and 11.4% decrease encountered for Vilayetler Evi and Sasalı Natural Life Park, respectively (Table 3). When the structures are fully covered, the impact is expected to improve.

1.3.7 CH0109 Energy saving from reduced building consumption

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0109	Energy saving from reduced building consumption	IZT
CITY	*RELATED NBS*	
IZMIR	Green shady structures, green covering shelters, cool pavements, shade and cooling trees	

Results and Discussion

NBSs in Izmir do not have any building level interventions such as green roof and green façade. Green shady structures and permeable pavements are implemented in parking lots which has no connection with buildings. Therefore, energy and carbon savings from reduced building energy consumption is obtained using a dynamic building energy performance software, TRNSYS.

Vilayetler Evi parking lot demo site is located in a densely populated urban area. Therefore, a sample residential building which represents the buildings around the demo site is modelled using TRNSYS software. Then, energy demand of the building is obtained using measured temperatures (from CH0105) at the demo site.

The difference between energy demand values of pre- and post-intervention presents energy savings.

The buildings around Vilayetler Evi demo site is mostly consist of 5-floor apartments. A sample building is modelled in TRNSYS software as given in Fig. 1.

Figure 1. 3D model of the considered building.

The main characteristics of the building envelope are given in Table 1. Overall heat transfer coefficients (U) were determined based on “TS825-Thermal Insulation Requirements” standard. Indoor set point temperature is chosen as 22°C for both winter and summer.

Table 1. Main characteristics of the building envelope.

Envelope	Layers	Thickness (m)	U (W/m^2K)
External walls	Plaster, brick, insulation	0.41	0.238
Roof	Plaster, brick, insulation	0.24	0.236
Floor	Concrete, gypsum mortar, insulation	0.23	0.341

The mobile measurements in Vilayetler Evi parking lot was first taken in 2019 (ex-ante). Ex-post measurements have been taken on high-temperature days in the summer of 2020 and 2021. Green shady structures have not yet been covered by the ivies. Therefore, temperature decrease was encountered as around 1°C in 2021. The scenario for “the whole structure is fully covered” is simulated and a temperature decrease in shade is obtained as average 2°C (CH0105).

Using 2°C temperature drop, heating and cooling energy demand of the modelled building is calculated by the software. The buildings are heated by natural gas and cooling is provided by air-conditioners. Assuming an energy efficiency of 80% for natural gas heaters and a COP of 3 for air-conditioners, energy consumption of the building is calculated. Then, electricity consumption is converted to primary energy consumption using a conversion factor of 1.788 [1] and the results are given in Table 2.

Table 2. Annual primary heating, cooling and total energy consumption of the building (for 2°C temperature drop).

	Primary Energy Consumption		
	Heating (kWh/year)	**Cooling (kWh/year)**	**Total (kWh/year)**
Ex-ante	8473,40	52731,87	61205.27
Ex-post	8711,68	51705.80	60417,48
Change in energy consumption (%)	↑ 2.81	↓ 1.95	↓ 1.29

[1] https://webdosya.csb.gov.tr/db/meslekihizmetler/icerikler/elektrik-enerjisinin-birincil-enerji-ve-sera-gazi-salimi-katsayilari-agustos-2022den-sonra-20220825085911.pdf

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Table 2 indicates that for 2°C temperature drop, heating energy consumption increases by 2.81%, while cooling energy consumption decreases by 1.95%. The decrease in overall primary energy consumption is encountered as 1.29% since cooling energy consumption is approximately 3.5 times higher than heating energy consumption.

If the plants shed the leaves in winter, no temperature decrease would be encountered. That means no change in increase in energy consumption and CO_2 emissions.

In this study, we only concentrated on air temperature change. Relative humidity, solar irradiance and wind speed are the other parameters effect energy consumption of a buildings. Therefore, other parameters along with temperature should be taken into account to obtain more precise results.

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
No barriers detected.	

Economical barriers	How they have been addressed
No barriers detected.	

Social barriers	How they have been addressed
No barriers detected.	

Environmental (including COVID)	How they have been addressed
The ivies planted in the parking lots for shading have not yet covered the entire structure. Therefore, significant changes in the monitoring data could not be measured.	Modelling is used to predict the air temperature change in case the ivies to cover whole structure.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Since NBSs in demo sites do not have any building level interventions such as green roof and green façade. These interventions decrease overall heat transfer coefficient of the buildings which corresponds to a decrease in energy consumption. On the other hand, green shady structures and permeable pavements are implemented in the Izmir demo sites have no direct connection with buildings as green roofs and façades.

The projection of temperature drop measured/simulated in Vilayetler Evi demo site to the surrounding buildings at a large extend is only possible increasing the NBSs such as green shady structures, green covering shelters, cool pavements, shade and cooling trees.

Therefore, the impact cannot be evaluated as significant.

What was the impact? (positive/negative, significant/non-significant)?

Non-significant.

Other comments

1.3.8 CH0110 Carbon savings from reduced building energy consumption

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0110	Carbon savings from reduced building energy consumption	IZT
CITY	*RELATED NBS*	
IZMIR	Green shady structures, green covering shelters, cool pavements, shade and cooling trees	

Results and Discussion

Table of results

Primary energy consumption values taken from CH0109 are converted to amount of greenhouse gas emission using conversion factors, which are 0.202 tCO_2/MWh for natural gas and 0.484 tCO_2/MWh for electricity [1].

The amount of greenhouse gas emissions in kgCO2 is calculated and given in Table 1.

Table 1. Amount of annual greenhouse gas emissions of the building based on primary energy consumption.

	Greenhouse gas emissions ($kgCO_2$)		
	Heating	**Cooling**	**Total**
Ex-ante	1711.63	25522.22	27233.85
Ex-post	1759.76	25025.61	26785.37
Change in energy consumption (%)	↑ 2.81	↓ 1.95	↓ 1.65

[1] https://webdosya.csb.gov.tr/db/meslekihizmetler/icerikler/elektrik-enerjisinin-birincil-enerji-ve-sera-gazi-salimi-katsayilari-agustos-2022den-sonra-20220825085911.pdf

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

A 2.81% increase in CO_2 emissions is encountered based on increased energy consumption caused by a 2°C temperature reduction for natural gas heating. On the other hand, in cooling season the decrease in outdoor temperature resulted as a 1.95% decrease in CO_2 emissions. When the annual CO_2 emissions are evaluated, a 1.65% decrease is encountered.

If the plants shed the leaves in winter, no temperature decrease would be encountered. That means no change in increase in energy consumption and CO_2 emissions.

In this study, we only concentrated on air temperature change. Relative humidity, solar irradiance and wind speed are the other parameters effect energy consumption of a buildings. Therefore, other parameters along with temperature should be taken into account to obtain more precise results on energy and carbon savings.

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
No barriers detected.	

Economical barriers	How they have been addressed
No barriers detected.	

Social barriers	How they have been addressed
No barriers detected.	

Environmental (including COVID)	How they have been addressed
The ivies planted in the parking lots for shading have not yet covered the entire structure. Therefore, significant changes in the monitoring data could not be measured.	Modelling is used to predict the air temperature change in case the ivies to cover whole structure.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

As indicated in CH0109, NBSs in demo sites do not have any building level interventions such as green roof and green façade. Green shady structures and permeable pavements are implemented in the Izmir demo sites have no direct connection with buildings as green roofs and façades.

Temperature drop calculations for Vilayetler Evi demo site gave a 1.29% decrease in total primary energy consumption of the sample building. The projection of temperature decrease to the surrounding buildings at a large extend is only possible increasing the NBSs such as green shady structures, green covering shelters, cool pavements, shade and cooling trees.

Therefore, the impact on energy saving cannot be evaluated as significant. Simultaneously, carbon saving is also considered as insignificant.

What was the impact? (positive/negative, significant/non-significant)?

Non-significant.

1.3.9 CH0112 Global warning potential

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0112	GLOBAL WARNING POTENTIAL	EGE Soil
CITY	*RELATED NBS*	
IZM		

Results and Discussion

Table of results (summary, from Task 5.4)

The application of biochar to the soils appears to be one of the ways of atmospheric CO2 sequestration. In this process, carbon is separated from its rapid ecological cycle and participates in a much slower and more stable biochar cycle (Lehmann, 2007). The construction of a strategic pathway to utilize pyrolysis technology and biochar use in agriculture have been realised with potential and feasible utilization techniques.

Figure 1: Measurements

Table 1: Measurement dates

Treatment	Date
1st field experiment was conducted.	23.12.2020
1st GHGs measurement	30.12.2020
2nd GHGs measurement	06.01.2021
3rd GHGs measurement	20.01.2021
4th GHGs measurement	24.02.2021
Top dressing	13.03.2021
5th GHGs measurement	25.03.2021
6th GHGs measurement	21.04.2021
7th GHGs measurement	19.05.2021
8th GHGs measurement	16.06.2021
Harvest	17.06.2021

The sewage sludge used in the experiment was from the Çiğli Wastewater Treatment Plant of İzmir Metropolitan Municipality of Turkey, stabilized in anaerobic conditions and converted to granules of 90% dryness. Stabilized sewage sludge (SSS) and sewage sludge biochar (SSB) were incorporated into the experimental soil at a rate of 25 Mg ha^{-1} to the 0-15 cm soil depth. After incorporation, wheat seeds (250 kg ha^{-1}) were sown by hand and basal chemical fertilizer (500 kg ha^{-1}) were applied as a 15-15-15 fertilizer. The 15-15-15 fertilizer is defined by the NPK ratio (15-15-15), which means it has equal parts of Nitrogen, Phosphorous, and Potassium. Urea fertilizer applied as top-dressing (200 kg urea ha^{-1}).

The polyvinyl chloride (PVC) rings (20 cm diameter 10 cm high; 3410 cm^3) were inserted into the ground to a depth of 5 cm. Greenhouse gas (GHG) sampling occurred at specified time intervals (weekly for the first month, biweekly for the second month, and monthly thereafter, after organic materials incorporating) over 176 days. GASERA ONE PULSE (Photoacoustic Analyzer for measurement of CH_4, N_2O and CO_2) were used for the GHGs measurement.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

While the lowest methane value was 36.4 ppm for SSB treatment, the highest value occurred in SSS+CF soils (45.1 ppm). Although the methane emission of biochar-treated soils was closest to that of atmospheric air, methane emission of biochar-treated soils decreased below that in atmospheric air 4 months after the biochar was incorporated into the soil. The combined application of chemical fertilizers and biochar (SSB+CF) also showed low methane emissions.

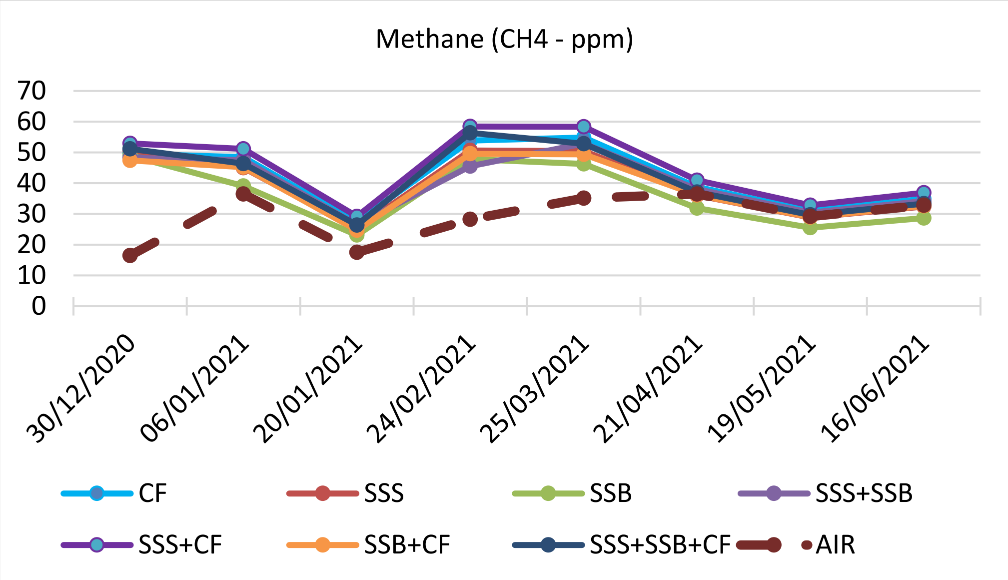


Figure 2: Methane change

In our field experiment in which 25 t/ha of organic material was applied, it was determined that the CO_2 concentration released to the atmosphere increased due to SSS applications. The sewage sludge, which is ready for agricultural use by the anaerobic stabilization method, caused an average of 26% more C-emissions than the biochar application.

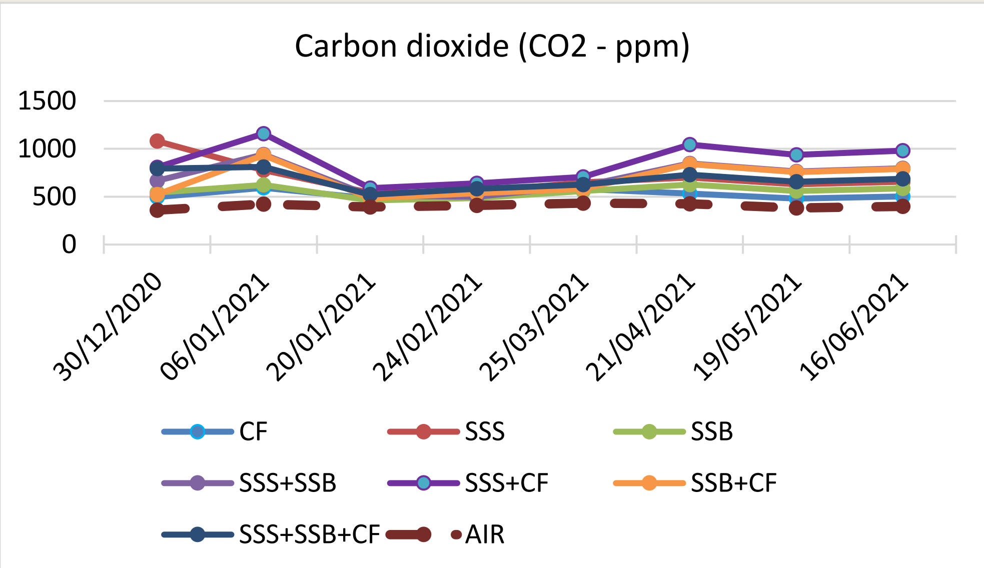


Figure 3: Carbon dioxide change (CO2 – ppm)

Since the physical conditions of the soil have a great effect on the N_2O release from the soil, we were able to reduce the N_2O emissions by 28% with biochar applications. The emission, which was 1120 ppb in SSS soils, decreased to 875 ppb due to SSB applications.

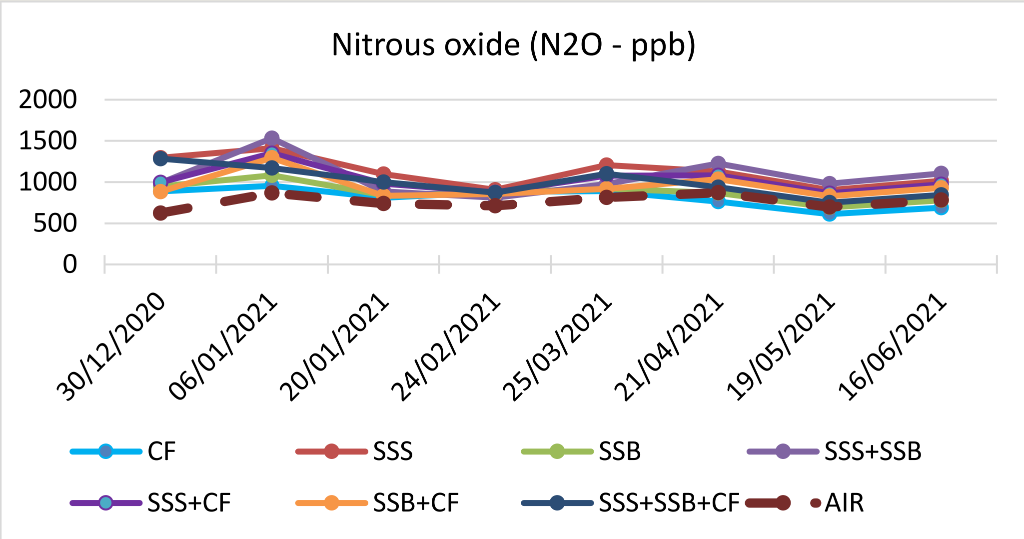


Figure 4: Nitrous Oxide (N2O – ppb)

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

In general, the use of organic wastes in agriculture by a consideration of certain conditions provides the opportunity to simultaneously increase soil productivity and potentially offer a more sustainable way of dealing with organic wastes. When organic wastes are thrown randomly, they cause a large amount of greenhouse gas emissions. In addition, our agricultural soils especially under the Mediterranean climatic condition need organic matter additions in terms of sustainable soil fertility.

Biochar (SSB) applications caused a 9% reduction in methane emissions from soil to the atmosphere, 21% in CO2 and 22% in N2O compared to sewage sludge (SSS) applications. It is thought that biochar had this effect because it has stable carbon and improves the physical and chemical properties of soils.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*

Economical barriers	How they have been addressed

Social barriers	How they have been addressed

Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
This KPI is related with Challenge 1: Climate Mitigation and Adaptation. CO_2, CH_4 and N_2O are the main greenhouse gases that cause climate change. The experiments done in the Farming Lab shows one of the possibilities to decrease GHG Emissions.

What was the impact? (positive/negative, significant/non-significant)?

1.3.10 CH0213 Runoff estimation of bioswales in Bioboulevard

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0213	RUNOFF ESTIMATION OF BIOSWALES IN BIOBOULEVARD	IZT , Ege

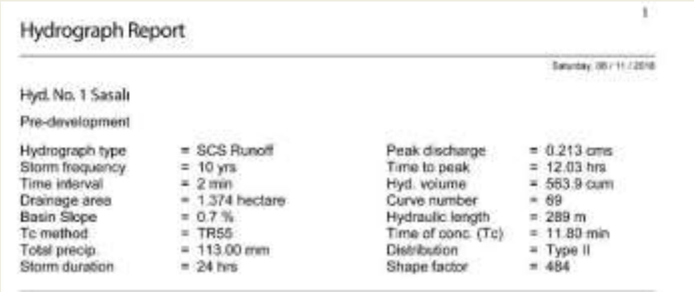
CITY	*RELATED NBS*
IZM	Bıo-boulevard, grassed swales, water retention pounds

Results and Discussion

Table of results (summary, from Task 5.4)

A GIS based analysis is made to predict runoff by using the most common method called The Runoff Curve Number (CN), developed for ungauged basins to calculate runoff from rainfall data by USDA NRCS (United States Department of Agriculture Natural Resources Conservation Service) formerly known as the Soil Conservation Service (SCS). The method is used worldwide to predict runoff based on the amount of impervious area, soil group, land cover type, hydrological condition, and antecedent runoff (USDA NRCS, 1986).

ArcMap 10.3 is the GIS software used in İzmir. Calculations for baseline values were carried out based on satellite images using GIS techniques. Land cover information is taken on site by visits. Noted down invasive *Eucalyptus* species and native herbaceous plant cover is the dominant vegetation covering app. 80% of the NBS area which is currently abandoned to its own natural dynamics. The needed soil information is provided by in-situ soil analysis. Precipitation values are estimated based on a 10-year return period with a 24-hour duration rainfall data for İzmir city.



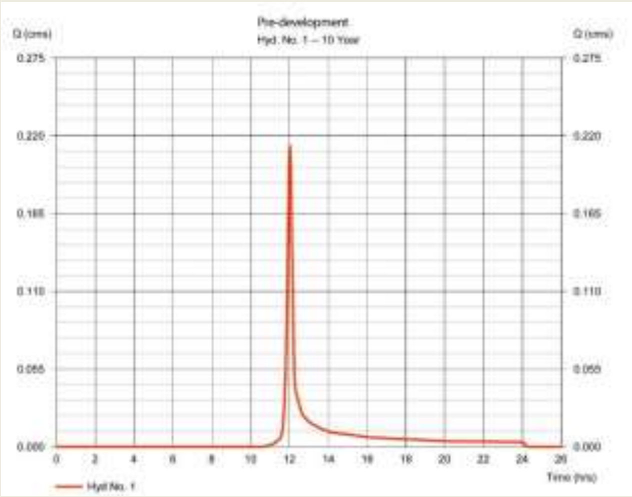
Hydrograph Report

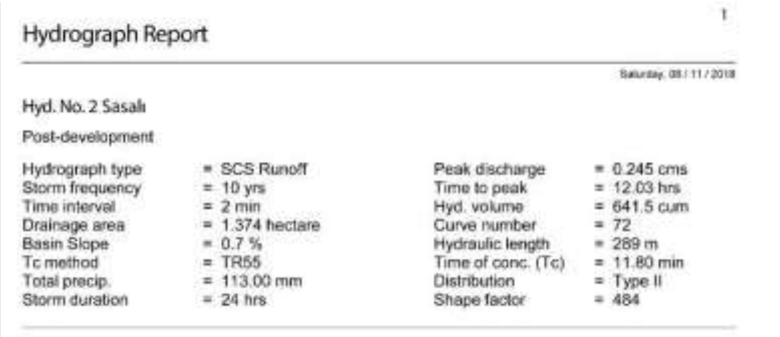
1

Hyd. No. 1 Sasalı

Pre-development

Hydrograph type	= SCS Runoff	Peak discharge	= 0.213 cms
Storm frequency	= 10 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 563.9 cum
Drainage area	= 1.374 hectare	Curve number	= 69
Basin Slope	= 0.7 %	Hydraulic length	= 289 m
Tc method	= TR55	Time of conc. (Tc)	= 11.80 min
Total precip.	= 113.00 mm	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484





Hydrograph Report

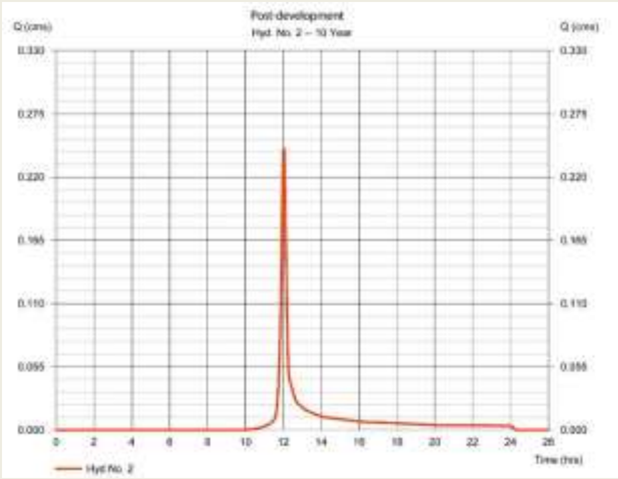
1

Saturday, 08 / 11 / 2018

Hyd. No. 2 Sasalı

Post-development

Hydrograph type	= SCS Runoff	Peak discharge	= 0.245 cms
Storm frequency	= 10 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 641.5 cum
Drainage area	= 1.374 hectare	Curve number	= 72
Basin Slope	= 0.7 %	Hydraulic length	= 289 m
Tc method	= TR55	Time of conc. (Tc)	= 11.80 min
Total precip.	= 113.00 mm	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

	Peak Discharge	Hyd. Volume
Baseline	0.213 cms	563,9 cum
Post Intervention	0.245 cms	641,5 cum

There is 15% increase on peak discharge and 13.7% increase on hyd. volume

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers	

Economical barriers	How they have been addressed

No barriers	
Social barriers	How they have been addressed
No barriers	
Environmental (including COVID)	How they have been addressed
No barriers	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

This KPI is calculated under Challenge 2: Water Management.

Grassed swales, water retention pounds were applied in a pilot area within the scope of the project. These applications are one of the first sustainable stormwater management practices applications in İzmir. Especially in recent years, the effects of climate change have been experienced more severely in the city of İzmir, and heavy and sudden rains have been experienced. When this practice becomes widespread, it will be effective in reducing the impact of floods that result in loss of life and property in the city.

To mention a big step taken regarding the spread of applications, İzmir Metropolitan Municipality has adopted a new approach to sustainable stormwater management in İzmir, inspired by the experiences of sustainable management of water, low-impact urbanization, water-focused urban design and sponge city concepts applied in other cities of the world. For this purpose, for the first time in Turkey, the "Water Resources Research and Application Center" within the scope of local governments became active in Izmir Metropolitan Municipality as of September 2021. The team of experienced engineers, landscape architects and city planners are dedicated to water-oriented planning of Izmir, effective management of existing water resources, and all water-related problems, especially flood and drought events, which increase in severity with the changing climate, both in the city center and in the rural areas. Currently, an incentive campaign has been launched for the establishment of 10000 raingardens and the establishment of rainwater harvest tanks in 5000 buildings throughout the city.

What was the impact? (positive/negative, significant/non-significant)?

When Sustainable stormwater management practices become widespread in the city, it will be effective in reducing the impact of floods in a positive and significant way. In addition, the return of precipitation water to the water cycle in the most environmentally friendly way with on-site solutions will undoubtedly be very positive for the ecosystem. It is certain that it will be effective in spreading the awareness of the citizens that water is a valuable resource and asset.

1.3.11 CH0403 Green space accessibility (m/min)

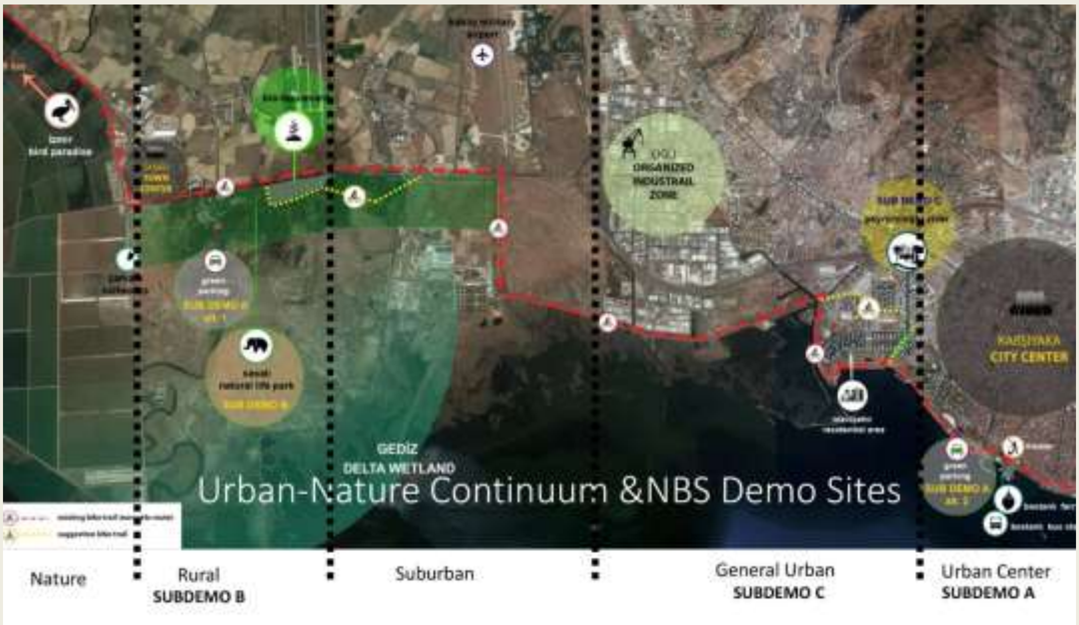
KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0403	GREEN SPACE ACCESSIBILITY (m/min)	
CITY	*RELATED NBS*	
IZMIR	IAc1, IAc2, IAc3, IAC4, IAc5, IAc8	

Results and Discussion

We accessed the Copernicus Land Monitoring Service (https://land.copernicus.eu/local/urban-atlas) and downloaded the 2018 release of the Izmir area. Urban Atlas is a polygon dataset created to monitor the land use alterations in densely inhabited Urban Zones (FUA's). We selected the two districts where the urban transformation has happened. We extracted the accessible green areas in the two neighbourhoods, then calculated, with a selection by location, all the residential plots 300 m closer to urban areas. We then summarized the population in the selection and transformed it into a percentage.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The following map shows the Izmir's demo areas. As can be seen, the areas of subdemo A, B, C, where several project actions have been implemented to increase green accessibility.



DISTRICTS	KPI INCREASE (%)	EXANTE	EXPOST
Mavisehir	4	96	100
Yali	0	100	100

Atakent
Bostanli
Sasali Center

Peynircioğlu Stream

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Green space accessibility is low for general public as they are insufficient comparing by population.	It is necessary to increase green areas and expand them by integrating with NBS throughout the whole city.

Economical barriers	How they have been addressed
-	-

Social barriers	How they have been addressed
In the construction of the parklets in subdemo A, the citizens reacted because the parking lot decreased.	By increasing the attractiveness and promotion of the use, the demand of the citizens can be ensured.

Environmental (including COVID)	How they have been addressed
Green spaces are insufficient for high population density.	It is necessary to increase green areas and expand them by integrating with NBS throughout the whole city.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

This KPI has contributd the challenge in a positive way, especially in areas with urbanization pressure.

What was the impact? (positive/negative, significant/non-significant)?

Green spaces support urban well-being by providing space for resting, relaxation, exercise and keeping air temperatures low. So, accessibility of green space has impacted to providing crucial aspect of a livable environment and human well-being.

1.3.12 CH0406 Recreational value

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0406	RECREATIONAL VALUE	
CITY	*RELATED NBS*	
IZMIR		

Results and Discussion

Table of results

Quantify the number of people participating in the recreational activities per year, related to any NBS, both recreational (number of visitors, number of recreational activities) or cultural value (number of cultural events, people involved, children in educational activities), expressed in (nº people/year).

Halk Park, which is the continuation of the Peynircioglu Stream, has 3 separate children's playgrounds for different age groups and 2 fitness areas for increasing public health. In addition, there is a "free platform" in the park where the public can freely express themselves, based on the idea that there should be public spaces that the citizens can express themselves in there.

It has been calculated using İnVEST Visitation: Recreation and Tourism software freely available at https://storage.googleapis.com/releases.naturalcapitalproject.org/invest-userguide/latest/recreation.html). The InVEST recreation model predicts the spread of person-days of recreation, based on the locations of natural habitats and other features that factor into people's decisions about where to recreate

The indicator PUD_AVG_Year has been calculated in two neighbourhoods (Yali and Mavisehir).

PUD_YR_AVG is the average photo-user-days per year (Photo User Days). This corresponds to the average PUD described in Wood et al. (2013).

N.B. for this indicator we have only one-time threshold (which is BEFORE the transformation happened). We can make an "estimation" of the change according to other indicator.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

4 parklet implementations were carried

Green corridor in Peynircioglu Stream

Green pavements around Peynircioğlu Stream

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed

Economical barriers	How they have been addressed

Social barriers	How they have been addressed
Lack of dissemination and communication activity.	Promotion of NBS needs to be increased.

Environmental (including COVID)	How they have been addressed

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

What was the impact? (positive/negative, significant/non-significant)?

Recreational value has impacted the visitors' perceptions of the environmental quality. It has been providing recreational ecosystem services are demanded by society. Recreational value as an environmental system has provided life support services for citizens.

1.3.13 CH0412 Pollinator species increase

KPI CODE	KPI NAME	PARTNER(S)
CH0412	POLLINATOR SPECIES INCREASE	EGE Landscape
CITY	*RELATED NBS*	
IZM	Green shady structure, urban carbon sink, green parklets and new green corridor	

Results and Discussion

Native and pollinator friendly plant species were preferred in the planting design in order to increase the number of pollinator species. It is intended that they can blossom in the season when the most pollinator species are active in the area. Furthermore, pollinator houses (10 in Peynircioğlu and 10 in Sasali) were installed around the pollinator friendly plants to attract more (Figure 1).

Figure 1. Pollinator modules

The observations were carried out in the sample areas of 10 x 10 m stable quadrats representing the relevant location and every month in each area for 6 months from April to September. Simultaneously, microclimatic variables (air temperature and wind speed) of the observation areas (using a data logger) were recorded as well.

In Peynircioğlu; pollinator species observed and recorded increased dramatically up to 357 % in the 1st monitoring period and 385 % in the 2nd monitoring period compared to baseline values (Table 1 and Figure 2).

In Sasalı; pollinator species increased up to 40 % in the 1st monitoring period and 30 % in the 2nd monitoring period compared to baseline values (Table 2 and Figure 2).

	Baseline	1st monitoring	2nd monitoring
Number of plant species	306	3966	3936
Number of pollinator species	7	25	27

Table 1: Pollinator species in Peynircioğlu

	Baseline	1st monitoring	2nd monitoring
Number of plant species	299	3936	3936
Number of pollinator species	20	28	26

Table 2: Pollinator species in Sasalı

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

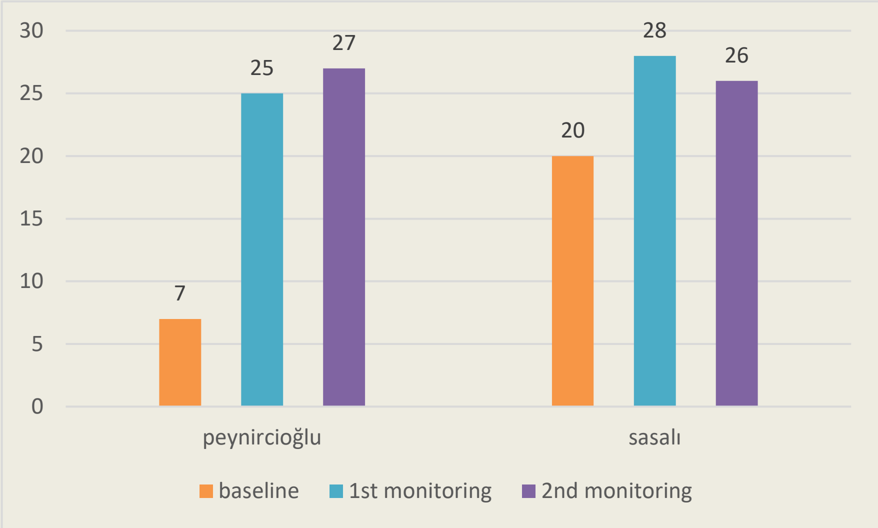


Figure 2. The number of pollinator species observed in Peynircioğlu and Sasalı

Based on the field observations in Peynircioğlu, the most favorite plants for the pollinators are Linden tree (*Tilia argentea*), Tree germander (*Teucricum fruticans*), Lavender (*Lavandula angustifolia and stoechas*), Sage (*Salvia microphylla*), Butterly bush (*Buddleja davidii*), Lilac (*Syringa vulgaris*), Judas tree (*Cercis siliquastrum*), Vitex (*Vitex agnus-castus*). Carpenter bees, flower flies, flower bees, butterflies, wasps increased dramatically in Peynircioğlu after the implementation. Honeybees stayed the same. This dramatic increase of pollinator species in Peynircioğlu In two years time showed that a successful pollinator friendly habitat was created. As the plants get older and mature and a sustainable habitat is achieved, it is expected to have more pollinator species (Figure 3).

In Sasali, Honeybees, flower bees, butterflies, wasps end carpenter bees increased. Lavender (*Lavandula angustifolia*), sage (*Salvia microphylla*), Butterly bush (*Buddleja davidii*), Lilac (*Syringa vulgaris*), Vitex (*Vitex agnus-castus*). Redroot pigweed (*Amaranthus retroflexsus*), (Rosemary (*Rosmarinus officinalis*) and Mallow (*Malva sylvestris*) seem to be the most favorable plants for the pollinator species.

Figure 3. Pollinator friendly plants

Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Local governments do mowing and weeding frequently which sometimes hinders the data collection process.	There was a good communication with the Parks and Gardens Dept who are in charge of maintenance of green areas.
Economical barriers	How they have been addressed
Field surveys require high time dedication and qualified personnel for the identification of species.	The frequency of data collection is monthly instead of weekly.
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Regarding the fact that In Peynircioğlu demo site, pollinator species increased dramatically up to 385 % (in the 2nd monitoring period) compared to baseline values, this KPI shows a significant impact on biodiversity crisis or decrease.

What was the impact? (positive/negative, significant/non-significant)?

Since the climate crisis and biodiversity decrease are the challenges that greatly affect each other, every action for biodiversity could create a direct positive impact on climate change adaptation. Increased biodiversity in the demo sites would help improving ecosystem health and climate resilience in the region. That is for sure that more pollinator friendly implementations are made, more biodiversity could be achieved. This leads to more resilient urban landscapes.

1.3.14 CH0502 Annual mean levels of fine PM2.5 particles

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	IZT-BIT
CITY	*RELATED NBS*	
IZM	Green shady structures, green covering shelter, parklets, urban garden biofilter, shade and cooling trees, grassed swales, new green corridor, green fences	

Results and Discussion

Table of results (summary, from Task 5.4)

Introduction

Fine particles ($PM_{2.5}$) are 2.5 micrometers in diameter or smaller, and can only be seen with an electron microscope. Fine particles are produced from all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

Air quality in Turkey is monitored by stationary Air Quality Monitoring (AQM) Stations, which were established in accordance with the Air Quality Control Regulation (AQCR), operated by the Ministry of Environment, Urbanization and Climate Change (MEUCC).

Background Data

PM2.5 values are collected by Cigli AQM station in 2019 and partially in 2020.

Figure 1: PM2.5 values

Table 1: PM2.5 values by Cigli AQM station

	Cigli 2019 (µg/m³)	Cigli 2020 (µg/m³)
January	2.413	-
February	2.449	-
March	2.346	-
April	9.674	-
May	9.4932	-
June	2.646	12.18
July	1.9752	13.562
August	5.452	11.692
September	7.838	11.34
October	7.838	11.583
November	7.793	16.069
December	7.826	33.454
Av.	5.645	15.697

Monitoring Data

Fixed stations

Figure 2: Vilayetler Evi Parking Lot

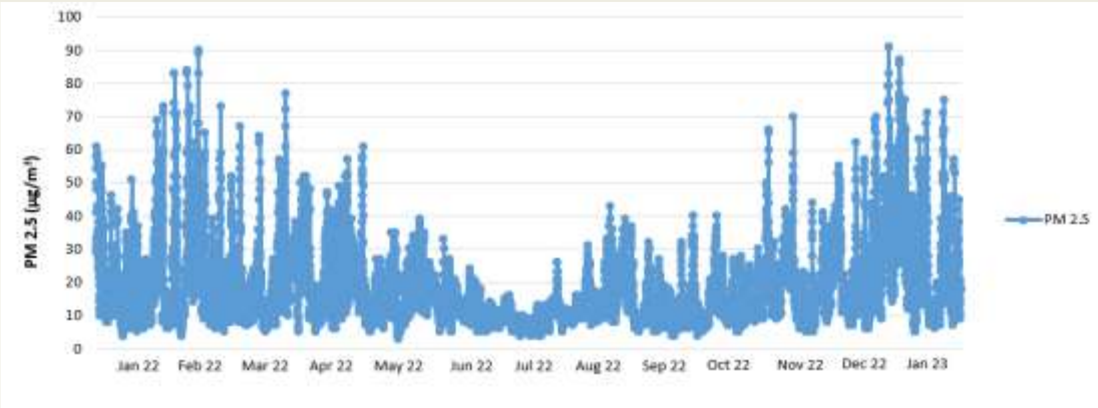


Figure 3: Vilayetler Evi Parking Lot (January 2022 - January 2023)

Figure 4: Sasali Natural Life Park Parking Lot

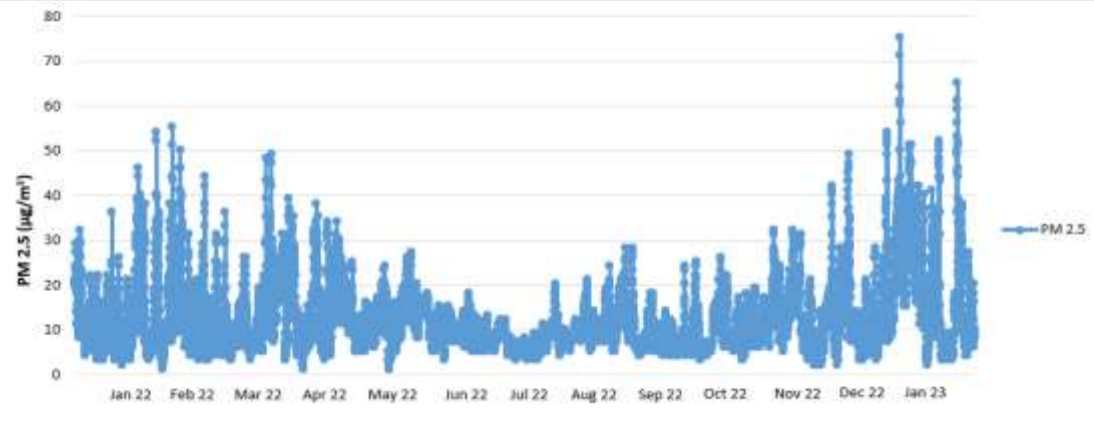


Figure 5: Sasali Natural Life Park Parking Lot (January 2022- January 2023)

Mobile Measurements

Figure 6: Fixed station at Vilayetler Evi Parking Lot (March 2022)

Figure 7: Mobile measurement device

Figure 8: Mobile measurement Control Point for Vilayetler Evi

Table 2: Mobile measurement data of PM 2.5

	Vilayetler Evi (µg/m³)	Control (µg/m³)
March 22	1.6	1.5
April 22	18.57	19.75
May 22	14.37	15
June 22	10.62	10.25
July 22	6.33	5.6
August 22	19.29	22.67
September 22	4.8	5.5
October 22	16.52	17.2
November 22	26.33	29.25
December 22	45.8	75.5
January 23	44.36	48.56
Av.	18.96	22.80

Figure 9: Mobile measurement Control Point for Sasali

Table 3: Mobile measurement data of PM 2.5

	Sasali (µg/m³)	Control (µg/m³)
March 22	11.1	9
April 22	15.46	12.25
May 22	8.53	9
June 22	11.29	6.12
July 22	10.22	8.2
August 22	16.93	18.33
September 22	4.7	4.7
October 22	9.87	10
November 22	16.8	14.14
December 22	56.3	50.6
January 23	46.43	38.17
Av.	18.87	16.41

Table 5: Fixed and mobile measurement data for 03.11.2022

March 11th, 2022	Vilayetler Evi			Sasalı		
	Intervention		Control	Intervention		Control
	Fixed	Mobile	Mobile	Fixed	Mobile	Mobile
T (°C)	6.0	10.0	11.6	8.0	11.3	9.2
RH (%)	42.8	35.0	33.0	38.0	34.9	36.1
PM 2.5 (µg/m³)	1.2	1.6	1.5	2.5	11.1	9.0

Figure 10: Growing Ivies at Vilayetler Evi (November 2022)

Table 6: Fixed and mobile measurement data for 01.23.2023

January 23rd, 2023	Vilayetler Evi			Sasalı		
	Intervention		Control	Intervention		Control
	Fixed	Mobile	Mobile	Fixed	Mobile	Mobile
T (°C)	16	20.84	20.43	20.5	23.41	24.76
RH (%)	64.25	49.98	50.04	49.73	47.16	44.84
PM 2.5 (µg/m³)	19.95	44.36	48.56	20.15	46.43	38.17

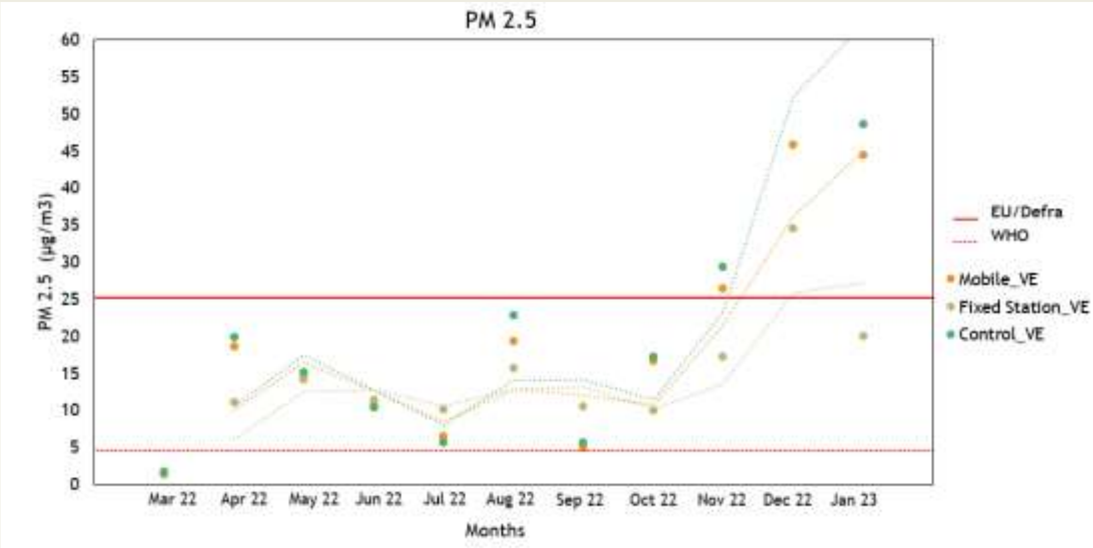


Figure 11: Comparison of the mobile measurement data at Vilayetler Evi (VE)(March 2022-January 2023).

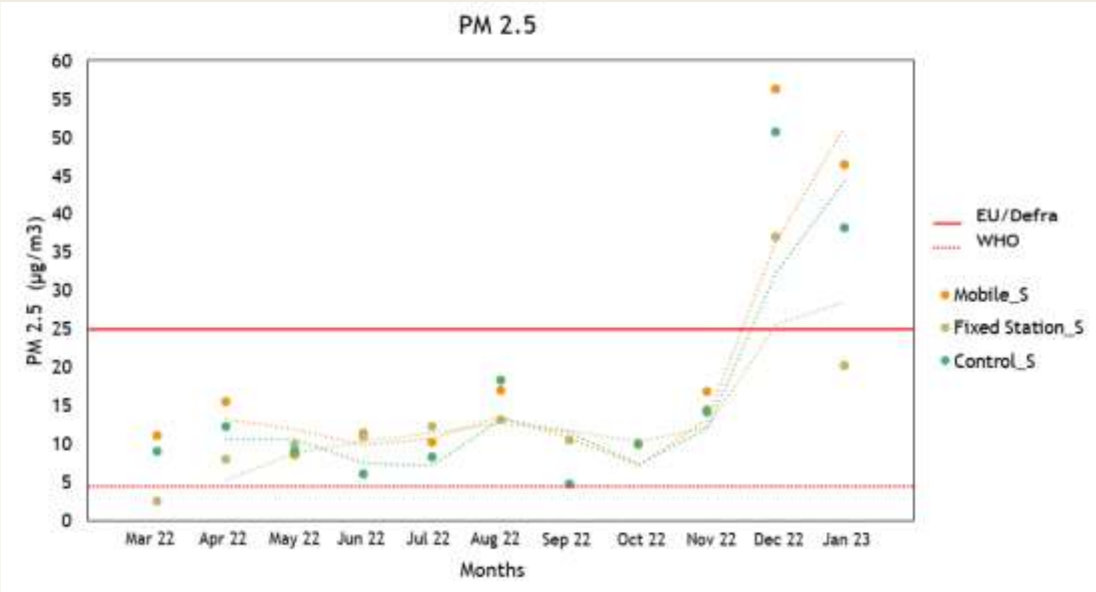


Figure 12: Comparison of the mobile measurement data at Sasali Natural Life Park (S) (March 2022-January 2023

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

In Cigli, PM2.5 values showed an increasing trend from 2019 to 2020 in summer, fall and winter seasons. Yearly average values are increased from 5.645 µg/m^3 to 15.697 µg/m^3. Fixed station measurements (av.) on the intervention sites are 13.21 µg/m^3 for Sasalı and 16.16 µg/m^3 for Vilayetler Evi. Trends indicate that in spring and fall, PM2.5 values are higher than other seasons. During the Covid-19 pandemic, all pollutants caused by traffic and industry were decreased. PM2.5 values of January-November 2022 indicate that the levels are already reached to pre-pandemic levels.

Subdemo A (Vilayetler Evi) is located in a heavily urbanized area with high population and traffic. It has been experiencing air pollution especially in winter months owing to fossil fuels. Although natural gas has been used for the heating, there are still neighborhoods in Karşıyaka and Çiğli districts that use solid fuels.

Additionally, in summer period, PM 2.5 values are decreased both for Subdemo A (Vilayetler Evi) and Subdemo B (Sasali). This is most likely because of wind speed during this season is lower than other periods. Other reason may be related the population of the city. During this period citizens go to vacation. However PM 2.5 values in most of the months are high with respect to the 'WHO' limit which is 5 µg/m^3 annualy mean.

Conclusions and recommendations.

People with heart or lung diseases, older adults and children are most likely to be affected by particle pollution exposure. Numerous scientific studies connect particle pollution exposure to a variety of health issues, including irritation of the eyes, nose and throat, coughing, chest tightness and shortness of breath, reduced lung function, irregular heartbeat, asthma attacks, heart attacks and premature death in people with heart or lung disease. Increasing the NBSs, number of trees will most likely reduce the impact of PM2.5 in the atmosphere to an extend while other activities causing the increase of PM2.5 continue to accelerate. There are a number of reasons the increasing of energy prices steers people to solid fuel, increasing traffic after pandemic and so on. At last glance, Subdemo A (Vilayetler Evi) and Subdemo B (Sasali) are still highly affected by the Industrial zone nearby, and also, prevailing wind direction carries the air pollutants from the Heavy Industrial Area at the north. However, despite that during the mobile measurement process, it was observed that when the wind is less, the growing ivies have a momentary positive effect on reducing the PM 2.5 values.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers.	

Economical barriers | How they have been addressed

No economic barriers.	
Social barriers	How they have been addressed
No social barriers	
Environmental (including COVID)	How they have been addressed
Because of the Covid-19 pandemic, purchase and installation of monitoring devices are postponed. One of the fixed stations was installed at the beginning of the lock down. However, data could not be collected. The ivies were planted to the parking lots for shading are not yet covered the whole construction.	We have started to collect data at January 2022 from fixed and mobile measurement devices at the interventions. The data for 2017-2021 are obtained from Air Quality Monitoring Stations operated by the Ministry of Environment and Urbanization (MEU). These stations have lack of PM2.5 and NO_2 data. We are expecting the ivies will cover the constructions in a larger extend, then we will observe the impact of the interventions on air pollution data.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Yes, there is a positive impact on the challenge.

What was the impact? (positive/negative, significant/non-significant)?

As mentioned in the conclusions section, the positive impact was that when the wind speed is low, the growing ivies have a momentary positive effect on reducing the PM 2.5 values.

1.3.15 CH0503 Annual mean levels of fine PM10 particles

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	IZT-BIT
CITY	*RELATED NBS*	

IZM	Green shady structures, green covering shelter, parklets, urban garden biofilter, shade and cooling trees, grassed swales, new green corridor, green fences

Results and Discussion

Table of results (summary, from Task 5.4)

Introduction

Same as CH0502. Same measurement devices are used.

Background Data

PM10 values are collected by Cigli and Karsiyaka AQM stations in 2021.

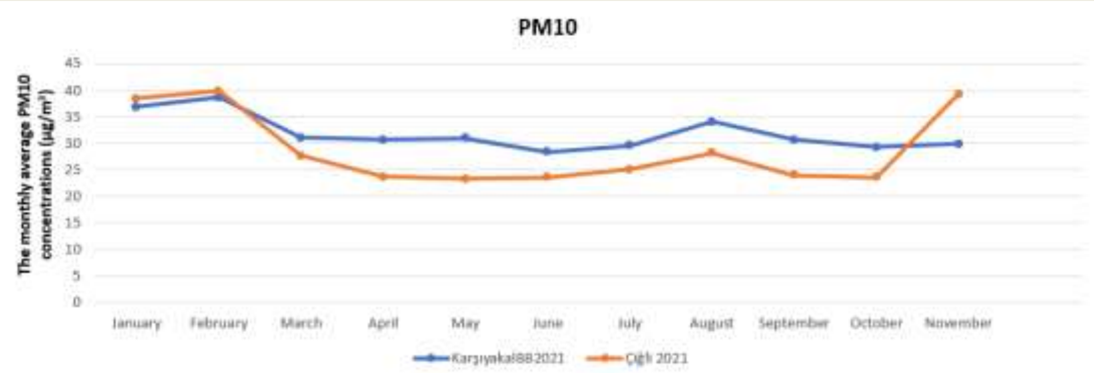


Figure 1: PM10 measurement for 2021 for Karşıyaka and Çigli

Table 1: PM 10 values by Karsiyaka and Cigli AQM station

	Karsiyaka 2021 (µg/m³)	Cigli 2021 (µg/m³)
January	36.87	38.49
February	38.64	39.83
March	31.06	27.74
April	30.64	23.69
May	30.99	23.27
June	28.41	23.63
July	29.62	25.07
August	34.02	28.23
September	30.71	24.0
October	29.26	23.58
November	29.87	39.29
Av.	31.82	28.81

Monitoring Data

Fixed stations

Figure 2: Vilayetler Evi Parking Lot

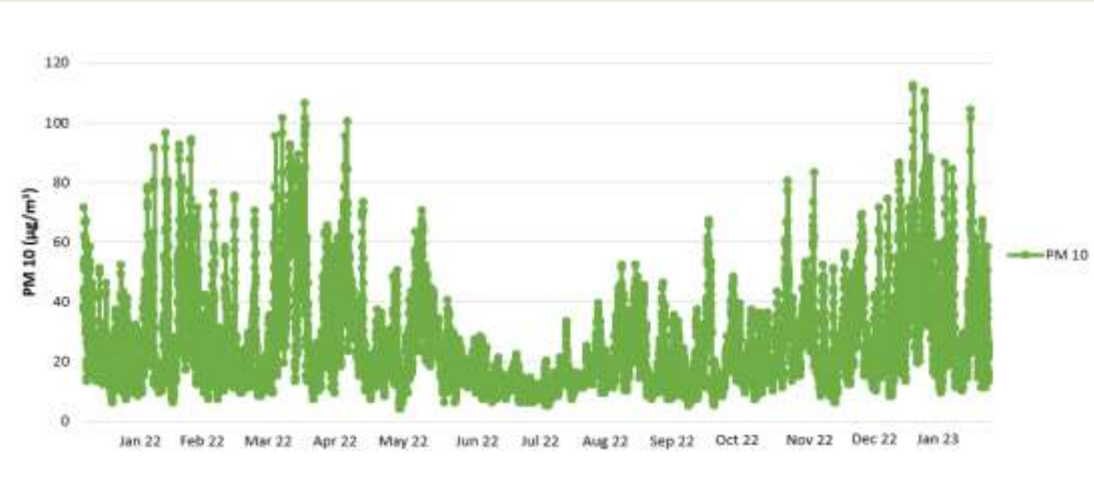


Figure 3: Vilayetler Evi Parking Lot (January 2022- January 2023)

Figure 4: Sasali Natural Life Park Parking Lot

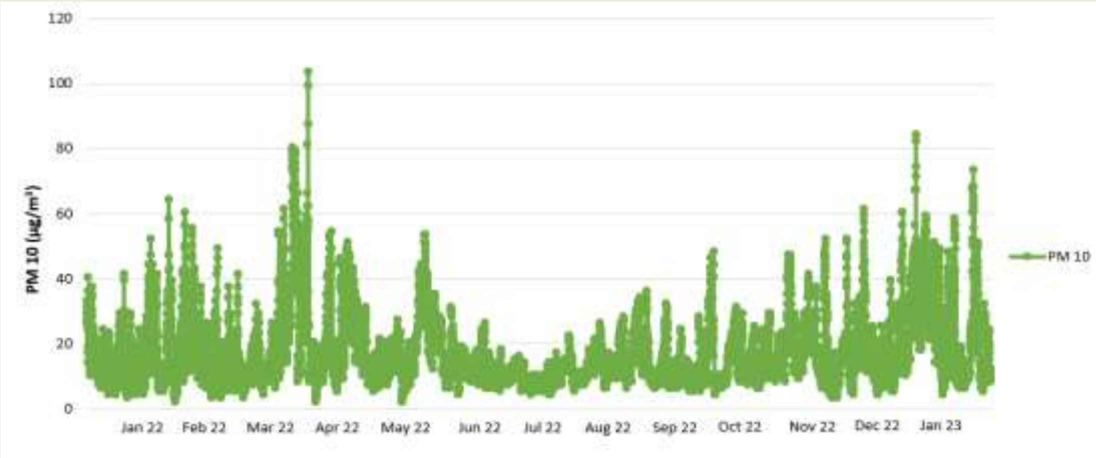


Figure 5: Sasali Natural Life Park Parking Lot (January 2022- January 2023)

Figure 6: Fixed station at Vilayetler Evi Parking Lot (March)

Figure 7: Mobile measurement device

Mobile Measurements

Figure 8: Mobile measurement Control Point for Vilayetler Evi

Figure 9: Mobile measurement Control Point for Sasali

Table 2: Mobile measurement data of PM 10

	Vilayetler Evi (µg/m³)	Control (µg/m³)
March 22	1.6	1.2
April 22	23.14	21.25
May 22	24.16	19
June 22	19.05	20.25
July 22	12.42	12
August 22	19	22
September 22	8.9	11
October 22	24.28	25.2
November 22	49.86	51.37
December 22	61.8	89.25
January 23	53.36	60.56
Av.	53.36	30.28

Table 3: Mobile measurement data of PM 10

	Sasali (µg/m³)	Control (µg/m³)
March 22	12.7	11.8
April 22	20.92	13.25
May 22	15.29	11
June 22	28.36	12
July 22	32.33	23
August 22	20	24.89
September 22	10.16	12
October 22	16.75	19.25
November 22	35.4	30.71
December 22	57.9	54.8
January 23	50.57	43.33
Av.	27.31	23.27

Table 4: Fixed and mobile measurement data for 03.11.2022

March 11th, 2022	Vilayetler Evi			Sasali		
	Intervention		Control	Intervention		Control
	Fixed	Mobile	Mobile	Fixed	Mobile	Mobile
T (°C)	6.0	10.0	11.6	8.0	11.3	9.2
RH (%)	42.8	35.0	33.0	38.0	34.9	36.1
PM 10 (μg/m³)	0	1.6	1.2	0.9	12.7	11.8

Figure 10: Growing Ivies at Vilayetler Evi (November)

Table 5: Fixed and mobile measurement data for 01.23.2023

January 23rd, 2023	Vilayetler Evi			Sasali		
	Intervention		Control	Intervention		Control
	Fixed	Mobile	Mobile	Fixed	Mobile	Mobile
T (°C)	16	20.84	20.43	20.5	23.41	24.76
RH (%)	64.25	49.98	50.04	49.73	47.16	44.84
PM 10 (μg/m³)	71.39	53.36	60.56	41.46	50.57	43.33

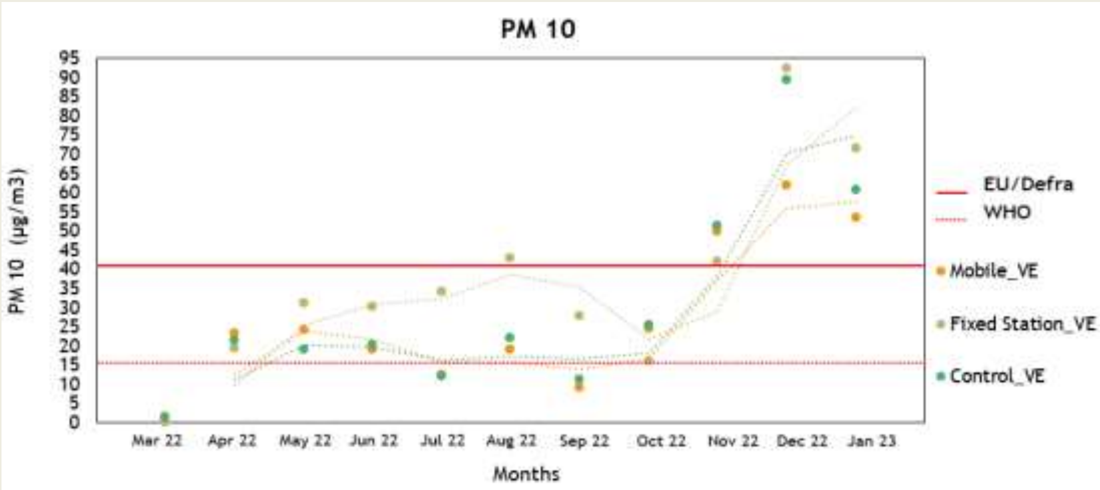


Figure 11: Comparison of the mobile measurement data at Vilayetler Evi (VE) (March 2022-January 2023).

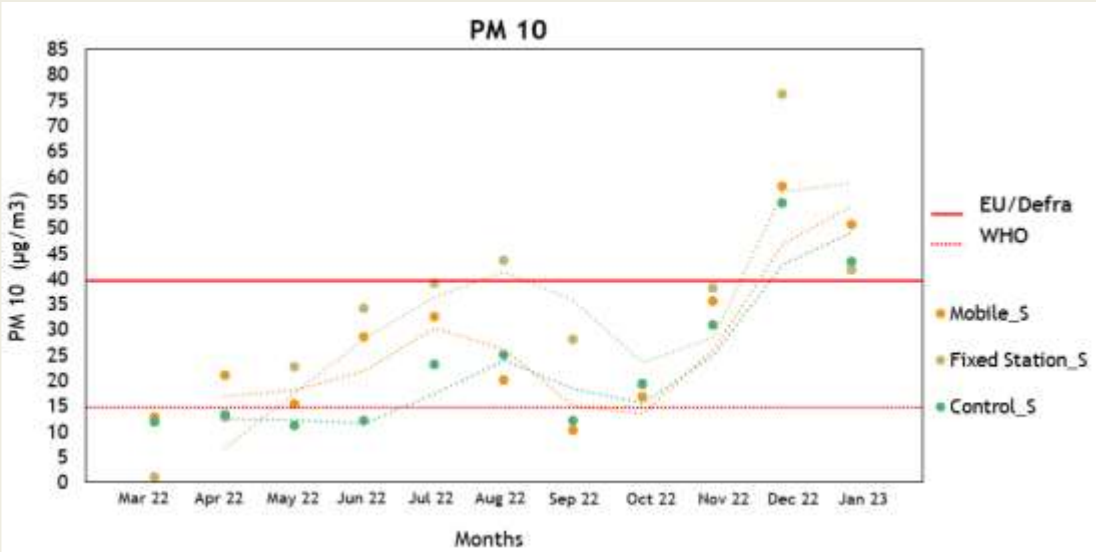


Figure 12: Comparison of the mobile measurement data at Sasali Natural Life Park (S) (March 2022- January 2023).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

When the PM10 graphs are examined, it is seen that the average value of November, December 2017 and January, February 2018 is 64.25 µg/m^3. This value decreased in the following winter months to 54.25 µg/m^3 for November-December 2018 and January-February 2019. Likewise, a decrease was observed for the 2020 and 2021 periods, and average values of 47.25 µg/m^3 and 48 µg/m^3 were measured, respectively. During the period of 16 March-31 May 2020 when the covid-19 measures were taken, there was a decrease in PM10 values as expected. Then, a sudden increase in PM10 values are observed in the second half of May in 2020. The reason of that would be the sudden relaxation of control measures after a lengthy lockdown within the city that resulted in increased human activity.

Fixed station measurements (av.) on the intervention sites are 21.74 µg/m^3 for Sasali and 29.02 µg/m^3 for Vilayetler Evi. The data in this period is still below the pre-pandemic levels.

Conclusions and recommendations.

At last glance, Subdemo A (Vilayetler Evi) and Subdemo B (Sasali) are still highly affected by the Industrial zone nearby, and also, prevailing wind direction carries the air pollutants from the Heavy Industrial Area at the north. However, despite that during the mobile measurement process, it was observed that when the wind is less, the growing ivies have a momentary positive effect on reducing the PM 10 values.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers.	
Economical barriers	How they have been addressed
No economic barriers	
Social barriers	How they have been addressed
No social barriers	
Environmental (including COVID)	How they have been addressed

Because of the Covid-19 pandemic, purchase and installation of monitoring devices are postponed. One of the fixed stations was installed at the beginning of the lock down. However, data could not be collected.	We have started to collect data at January 2022 from fixed and mobile measurement devices at the interventions. The data for 2017-2021 are obtained from Air Quality Monitoring Stations operated by the Ministry of Environment and Urbanization (MEU). These stations have lack of PM2.5 and NO_2 data.
The ivies were planted to the parking lots for shading are not yet covered the whole construction.	We are expecting the ivies will cover the constructions in a larger extend, then we will observe the impact of the interventions on air pollution data.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Same as CH0502. Yes, there is a positive impact on the challenge.

What was the impact? (positive/negative, significant/non-significant)?

As mentioned in the conclusions section of CH0502, the same applies to CH0503, the positive impact was that when the wind speed is low, the growing ivies have a momentary positive effect on reducing the PM 10 values.

1.3.16 CH0504 Emissions trends of NO2

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0504	EMMISIONS TRENDS of NO_2	IZT-BIT
CITY	*RELATED NBS*	
IZM	Green shady structures, green covering shelter, parklets, urban garden biofilter, shade and cooling trees, grassed swales, new green corridor, green fences	

Results and Discussion

Table of results (summary, from Task 5.4)

Introduction

Same as CH0502. Same measurement devices are used.

Background Data

NO_2 values are collected by only Cigli AQM station in 2018 and 2019.

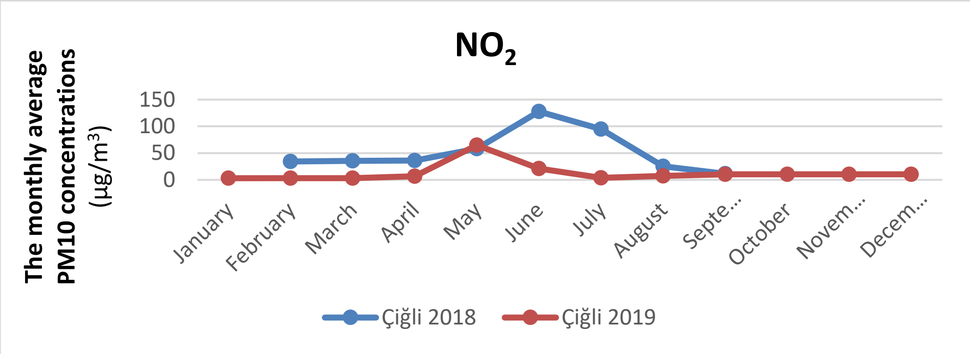


Figure 1: NO_2 values

Table 1: NO_2 values by Cigli AQM station

	Cigli 2018 (µg/m³)	Cigli 2019 (µg/m³)
January	-	3.008
February	34.327	3.02
March	35.265	3.016
April	36.164	6.71
May	58.484	64.795
June	127.609	20.925
July	95.023	3.8656
August	25.43	7.401
September	11.369	10.403
October	-	10.416
November	-	10.424
December	-	10.437
Av.	52.96	15.017

Monitoring Data

Fixed stations

Figure 2: Vilayetler Evi Parking Lot

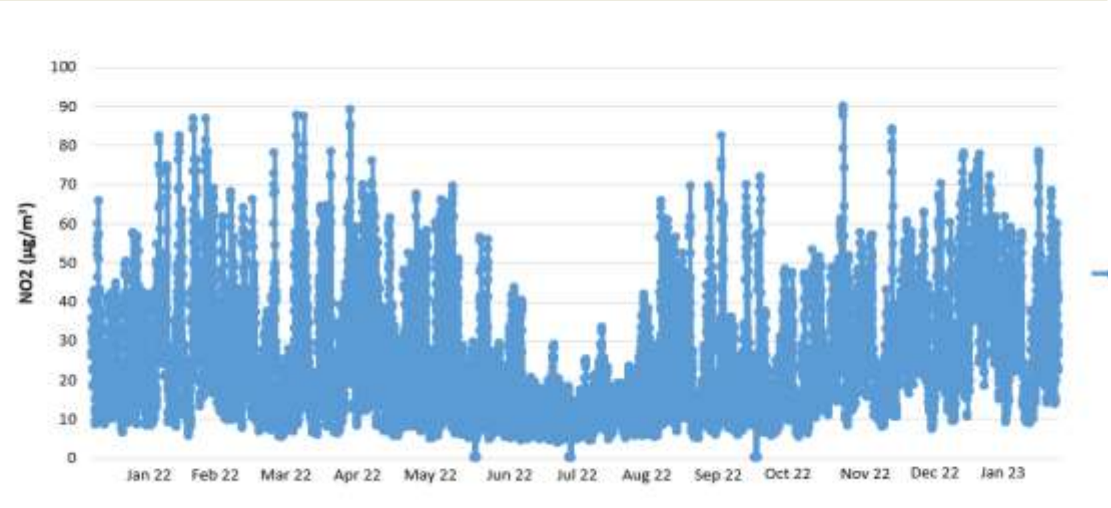


Figure 3: Vilayetler Evi Parking Lot (January 2022 – January 2023)

Figure 4: Sasali Natural Life Park Parking Lot

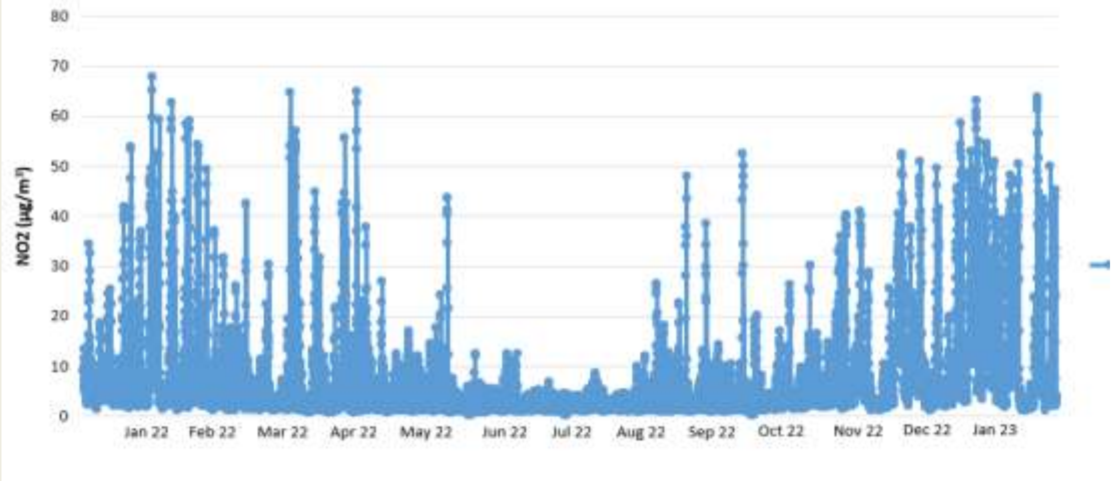


Figure 5: Sasali Natural Life Park Parking Lot (January 2022- January 2023)

Figure 6: Fixed station at Vilayetler Evi Parking Lot (March 2022)

Figure 7: Mobile measurement device

Mobile Measurements

Figure 8: Mobile measurement Control Point for Vilayetler Evi

Figure 9: Mobile measurement Control Point for Sasali

Table 2: Mobile measurement data of NO_2

	Vilayetler Evi ($\mu g/m^3$)	Control ($\mu g/m^3$)
March 22	99.6	114.7
April 22	31.82	48
May 22	42.45	72.5
June 22	36.31	38.4
July 22	15.83	38.4
August 22	31.76	64.44
September 22	10.12	43
October 22	27.2	36.75
November 22	44.25	43.71
December 22	94.37	100.33
January 23	111.36	128.33
Av.	49.55	66.23

Table 3: Mobile measurement data of NO_2

	Sasali ($\mu g/m^3$)	Control ($\mu g/m^3$)
March 22	110.9	97.8
April 22	42.31	52.57
May 22	19.12	32.5
June 22	25.85	10.25
July 22	21	3.2
August 22	31.89	44.33
September 22	63.7	54.25
October 22	54.15	55.4
November 22	42	45.55
December 22	53.37	83.2
January 23	104.14	105.6
Av.	51.67	56.06

March 11th, 2022	**Vilayetler Evi**			**Sasali**		
	Intervention		**Control**	**Intervention**		**Control**
	Fixed	**Mobile**	**Mobile**	**Fixed**	**Mobile**	**Mobile**
T (°C)	6.0	10.0	11.6	8.0	11.3	9.2
RH (%)	42.8	35.0	33.0	38.0	34.9	36.1
NO_2 ($\mu g/m^3$)	80.8	99.6	114.7	83.7	110.9	97.8

Table 4: Fixed and mobile measurement data for 03.11.2022

Figure 10: Growing Ivies at Vilayetler Evi (November 2022)

Table 5: Fixed and mobile measurement data for 01.23.2023

January 23rd, 2023	Vilayetler Evi			Sasali		
	Intervention		Control	Intervention		Contrc
	Fixed	Mobile	Mobile	Fixed	Mobile	Mobil
T (°C)	16	20.84	20.43	20.5	23.41	24.76
RH (%)	64.25	49.98	50.04	49.73	47.16	44.84
NO_2 (μg/m^3)	47.71	111.36	128.33	74.5	104.14	105.6

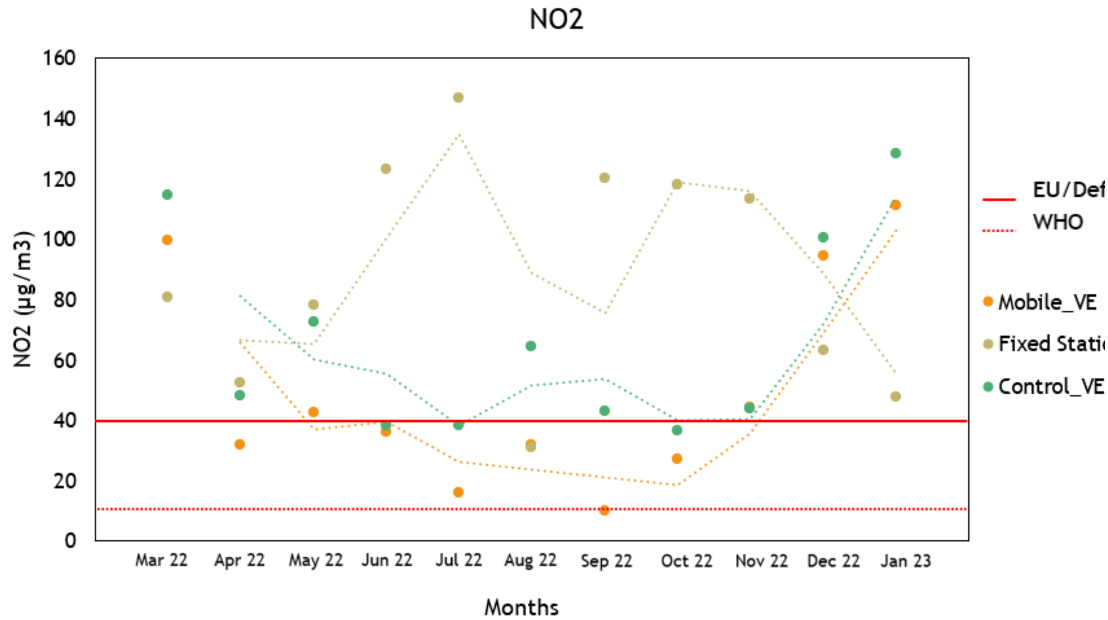


Figure 11: Comparison of the mobile measurement data at Vilayetler Evi (VE)(March 2022- January 2023).

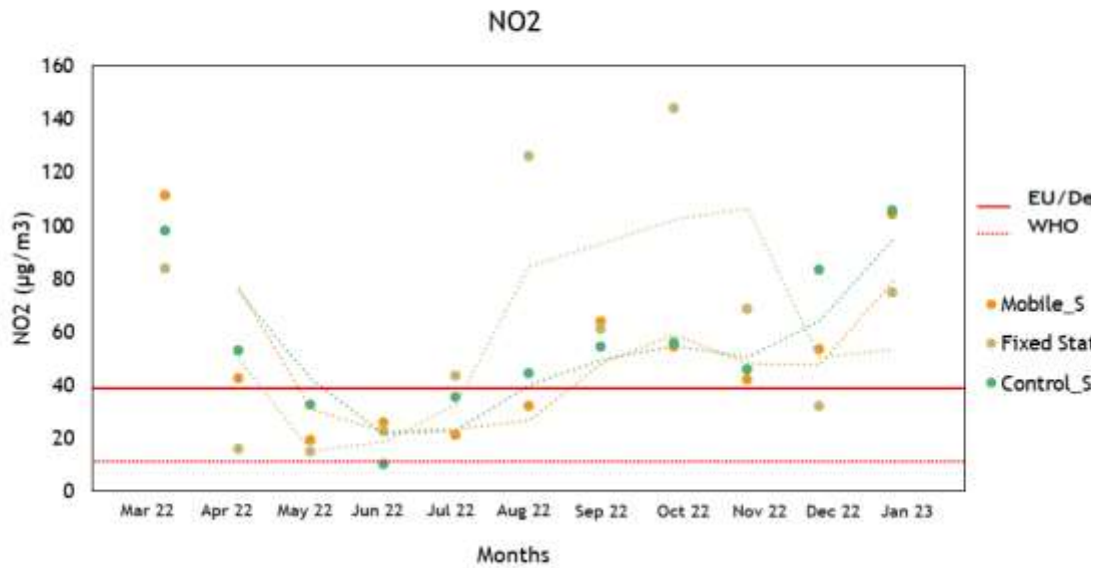


Figure 12: Comparison of the mobile measurement data at Sasali Natural Life Park (S) (March 2022- January 2023).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

In Cigli, NO_2 values are high in spring and summer months. Yearly average of 2018 is 52.96 µg/m^3 while 2019 value is 15.017 µg/m^3. Fixed station measurements (av.) on the intervention sites are 22.56 µg/m^3 for Sasalı and 48.88 µg/m^3 for Vilayetler Evi. Trends are increasing in spring period similar to historic data as can be seen mobile and fixed measurements in March 11th, 2022 (Mobile measurements: 99.6 µg/m^3 for Vilayetler Evi, 110.9 µg/m^3 for Sasalı).

Unlike CH0502, NO2 values passed both the EU/Defra and WHO limitations. Still, in summer months there is a drop in NO2 values similar to the reasons for CH0502 drop. It is observed that NO2 values are mostly less in Sasali than Vilayetler Evi data.

Conclusions and recommendations.

At last glance, Subdemo A (Vilayetler Evi) and Subdemo B (Sasali) are still highly affected by the Industrial zone nearby, and also, prevailing wind direction carries the air pollutants from the Heavy Industrial Area at the north. However, despite that during the mobile measurement process, it was observed that when the wind is less, the growing ivies have a momentary positive effect on reducing the NO_2 values.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers.	
Economical barriers	How they have been addressed
No economical barriers.	
Social barriers	How they have been addressed
No social barriers.	
Environmental (including COVID)	How they have been addressed
Same as CH0502.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

Same as CH0502.

What was the impact? (positive/negative, significant/non-significant)?

Same as CH0502.

1.3.17 CH0505 Emissions trends of SOx

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0505	EMMISIONS TRENDS of SOx	IZT-BIT
CITY	*RELATED NBS*	
IZM	Green shady structures, green covering shelter, parklets, urban garden biofilter, shade and cooling trees, grassed swales, new green corridor, green fences	

Results and Discussion

Table of results (summary, from Task 5.4)

Introduction

Same as CH0502. Same measurement devices are used.

Background Data

SO_2 values are collected by Cigli and Karsiyaka AQM stations in 2021.

Figure 1: SO_2 measurement for 2021 for Karsiyaka and Cigli

Table 1: SO_2 values by Karsiyaka and Cigli AQM station

	Karsiyaka 2021 (μg/m³)	Cigli 2021 (μg/m³)
January	5.54	12.48
February	8.46	6.40
March	8.16	11.72

April	5.38	12.69
May	4.35	13.43
June	4.13	13.22
July	5.82	11.19
August	8.52	13.55
September	7.53	13.38
October	8.19	10.50
November	8.32	9.48
Av.	6.76	11.64

Monitoring Data

Fixed stations

Figure 2: Vilayetler Evi Parking Lot

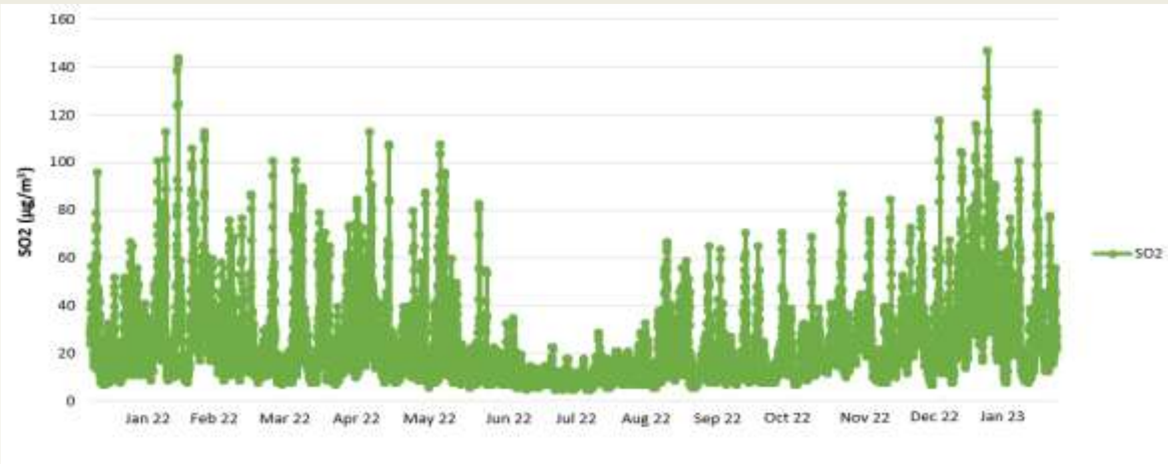


Figure 3: Vilayetler Evi Parking Lot (January 2022 – January 2023)

Figure 4: Sasali Natural Life Park Parking Lot

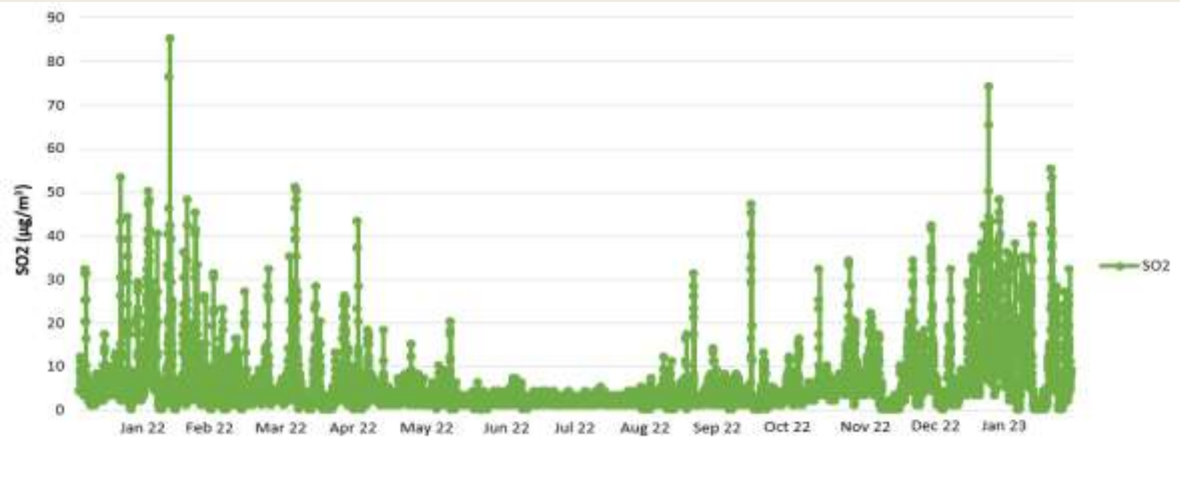


Figure 5: Sasali Natural Life Park Parking Lot (January 2022- January 2023)

Mobile Measurements

Figure 6: Fixed station at Vilayetler Evi Parking Lot (March)

Figure 7: Mobile measurement device

Table 2: Mobile measurement data of SO_2

Table 3: Mobile measurement data of SO_2

	Vilayetler Evi ($\mu g/m^3$)	Control ($\mu g/m^3$)
March 22	0	0
April 22	0	0
May 22	0	0
June 22	0	81.11
July 22	0	0
August 22	55.38	87.5
September 22	0	0
October 22	0	0
November 22	0	0
December 22	7.5	54
January 23	0	0
Av.	5.72	20.24

	Sasali ($\mu g/m^3$)	Control ($\mu g/m^3$)
March 22	13.1	13.1
April 22	0	0
May 22	0	0
June 22	0	3.75
July 22	0	12.5
August 22	1.11	140
September 22	12	61.67
October 22	5.71	0
November 22	0	0
December 22	96.25	0
January 23	0	0
Av.	11.65	21

Figure 8: Mobile measurement Control Point for Vilayetler Evi

Figure 9: Mobile measurement Control Point for Sasali

Figure 10: Growing Ivies at Vilayetler Evi (November)

Table 4: Fixed and mobile measurement data for 03.11.2022

January 23rd, 2023	Vilayetler Evi			Sasali		
	Intervention		Control	Intervention		Control
	Fixed	Mobile	Mobile	Fixed	Mobile	Mobile
T (°C)	16	20.84	20.43	20.5	23.41	24.76
RH (%)	64.25	49.98	50.04	49.73	47.16	44.84
SO_2 (µg/m^3)	11.42	0	0	7.5	0	0

Table 5: Fixed and mobile measurement data for 01.23.2023

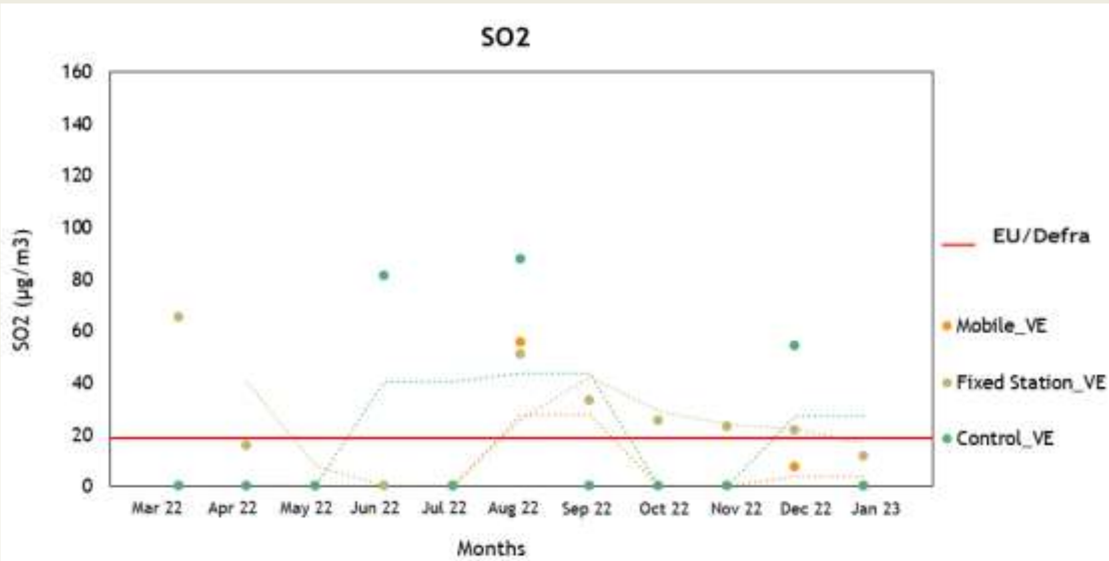


Figure 11: Comparison of the mobile measurement data at Vilayetler Evi (VE) (March 2022 - January 2023).

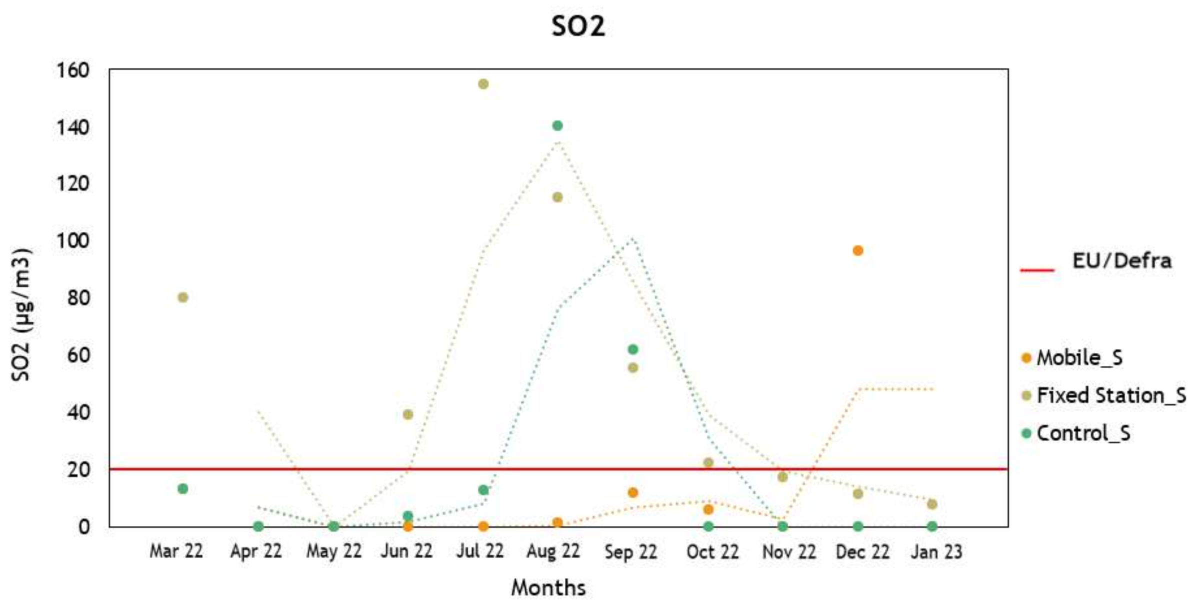


Figure 12: Comparison of the mobile measurement data at Sasali Natural Life Park (S) (March 2022 - January 2023).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The daily mean SO_2 graphs (2017-2021) reflects that SO_2 concentrations show fluctuations on a yearly basis. The highest decrease in SO_2 values is encountered in 2020. As a result of the measures taken within the scope of the pandemic in 2020, a serious decrease in SO_2 value recorded between March 16-May 31, 2020. In the following normalization period (June 1-30, 2020), decreasing trend was carried out.

Fixed station measurements (av.) on the intervention sites between January-March 2022 are 41.92 µg/m^3 for Sasali and 36.68 µg/m^3 for Vilayetler Evi. The data in this period is much higher than the pre-pandemic levels.

Conclusions and recommendations.

At last glance, Subdemo A (Vilayetler Evi) and Subdemo B (Sasali) are still highly affected by the Industrial zone nearby, and also, prevailing wind direction carries the air pollutants from the Heavy Industrial Area at the north. However, despite that during the mobile measurement process, it was observed that when the wind is less, the growing ivies have a momentary positive effect on reducing the SO_2 values.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers.	
Economical barriers	How they have been addressed
No economical barriers.	
Social barriers	How they have been addressed
No social barriers.	
Environmental (including COVID)	How they have been addressed
Same as CH0502.	Same as CH0502.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
Same as CH0502.
What was the impact? (positive/negative, significant/non-significant)?
Same as CH0502.

1.3.18 CH0508 Pollutant removed by vegetation

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0508	POLLUTANT REMOVED BY VEGETATION	EGE Landscape
CITY	*RELATED NBS*	
IZM	Green parklets, urban carbon sink: planting new trees, green fences, green walls, shade and cooling trees	

Results and Discussion

Air pollutant removal capacity of trees and shrubs, such as carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM2,5 and 10) and sulphur dioxide (SO_2) was estimated based on dry deposition model of I-tree Eco v6. The structure information of plants including height, diameters of breast height and crown size is collected by measuring every single plant in the field for the baseline and monitoring calculations.

In Peynircioğlu, the air pollution removal capacity of plants increased up to 65% in the 1st monitoring period and 75 % in the 2nd monitoring period compared to baseline value (Table 1 and Figure 1).

On the contrary, after implementation in Sasalı, air pollutant removal capacity of plants decreased almost 50 % (Table 2 and Figure 2). But that was something very well expected because large grown trees in the demo site had to be replaced by the young ones. Thus, only one monitoring was carried out in Sasali because pollutant removal capacity of these large canopy trees is not replaceable easily in a couple of years. It is expected that this ecosystem service of the plants will be increasing over time as they grow.

	Baseline	First monitoring	Second monitoring
Number of plant species	306	3,966	3,936
Pollutant removed	51,51 kg/year	85,37 kg/year	90,15 kg/year

Table 1: Pollutant removal rate by vegetation in Peynircioğlu

	Baseline	First monitoring
Number of plant species	299	3,936
Pollutant removed	33,81 kg/year	16,83 kg/year

Table 1: Pollutant removal rate by vegetation in Sasalı

Figure 1: Large canopy trees of Peynircioğlu (left) and young plants of Sasalı (right)

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The main pollutants removed by trees are O_3 and PM10 in Peynircioğlu (Figure 3). It is obvious that after the intervention, pollutants removed by trees increased significantly because of increased number of plants and canopy cover in the 2nd monitoring.

In Sasalı, high amount of O_3, PM10, and NO_2 was absorbed by the plants (Figure 4). Before the implementation, pollutants were removed mainly by large eucalyptus trees (*Eucalyptus cameldulensis*) that were dominant in the area. After the implementation, mainly Strawberry tree (*Arbutus unedo*), Linden tree (*Tilia tomentosa*), Goat willow (*Salix caprea*) and other species provide contribution to this service.

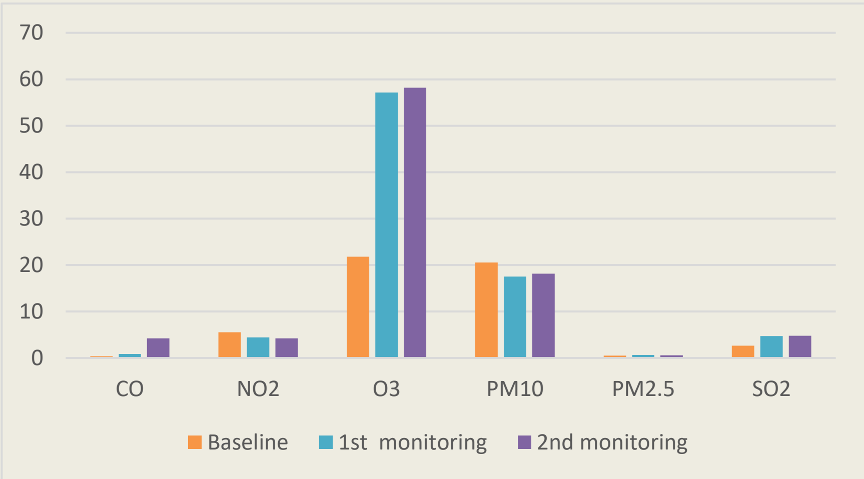


Figure 3: Pollutant removed by plants in Peynircioğlu

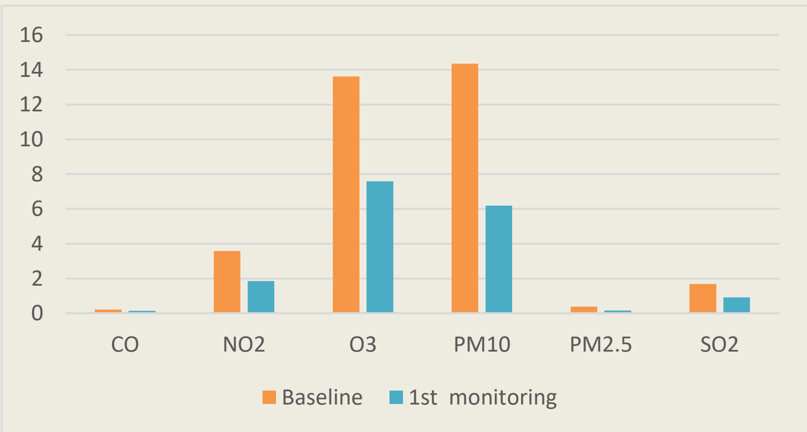


Figure 4: Pollutant removed by plants in Sasalı.

Conclusions and recommendations

It is vital that proper maintenance is required to keep the pollutant removal levels increasing over time. Canopy cover should not be trimmed at all unless it is completely dried. Death plants should be renewed immediately with large ones.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

This KPI creates a significant impact on the air pollution challenge. Planting new trees and increasing canopy cover definitely enhance the air purification functions of urban green areas. There are a number of studies that verifies this impact. Therefore, many cities try to increase the number of plants and canopy cover all over the city in order to combat air pollution as well as providing other ecosystem services.

Pollutant removal capacity of Sasalı decreased noticeably compared to baseline values because in the 1st monitoring. That decrease can be explained with removal of large old grown trees in the site. In the future, with sustainable maintenance measures, it is possible to see some increases for this service. But it may take a while to reach the level of pre-implementation.

What was the impact? (positive/negative, significant/non-significant)?

In Peynircioğlu, it is obvious that the impact of KPI was very positive.

In Sasalı, on the other hand, the impact of KPI was already quite negative in 1st monitoring. Loss of large canopy trees in the site could be compensated at least over a five years of period with sustainable maintenance measures as the new plants grow.

1.3.19 CH0601 Green space quantity (m/min)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0601	GREEN SPACE QUANTITY (m/min)	
CITY	*RELATED NBS*	
IZMIR		

Results and Discussion

Table of results (summary, from Task 5.4)

	KPI_CH0601
EXANTE (m)	
EXPOST (m)	
KPI INCREASE (%)	

Average distance from houses to the nearest Green Infrastructure (m).

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The following maps shows 1st Mavisehir, 2nd Yali neighbourhoods' boundry. The green space quantity has been increased from %16 to %17 in Mavisehir, from %9 to %10 in Yali neighbourhood.

Copernicus ONDA DIAS service has been accessed ,(https://www.onda-dias.eu/cms/) created an IZTECH user profile and downloaded the tile MSIL2A of 6th June 2021. We then processed the single bands and created a raster multiband made by band 4, band 3, band 2, and infrared band 8. We applied a supervised classification sampling and auto-produced a Land Use Land Cover for Izmir (10 meters ground resolution). We then calculated the green space as the quantity of permeable spaces in the two selected neighborhoods of the project area.

Measured on a postprocessed LULC by supervised classification sampling method on Sentinel L2A-downloaded image (06 June 2021). Extraction of green areas and calculation of the % of green areas per neighbourhood.

Figure 6: From 16% to 17% (Mavisehir Neighborhood)

Figure 7: From 9% to 10% (Yali Neighborhood)

DISTRICTS	KPI INCREASE (%)	EXANTE	EXPOST
Mavisehir	%1	16	17
Yali	%1	9	10

Examples of green spaces: 26 trees planted around car park and parklets

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*

As the rate of urbanization is very high, it is difficult to expand the quantity of green space in the whole city.	Green space quantity could be increased them by integrating with NBS throughout the whole city.
Economical barriers	How they have been addressed
-	
Social barriers	How they have been addressed
NBS implementation in the neighborhoods with high density may be seen as useless by the society.	The role of NBS in reducing the effects of climate change should be explained to the society.
Environmental (including COVID)	How they have been addressed
-	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
What was the impact? (positive/negative, significant/non-significant)?
Increased green space has been providing to creation of environments that support active lifestyles and improve access to exercise opportunities significantly for citizens. Besides that, has significantly reduced greenhouse gas emission and the risk of floods and overflows, especially around the Peynircioglu Stream.

1.3.20 CH0702 Citizen perception

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0702	CITIZEN PERCEPTION	
CITY	*RELATED NBS*	
IZMIR	IAc23, IAc24, IAc25. IAc26, IAc27 and IAc28	

Results and Discussion

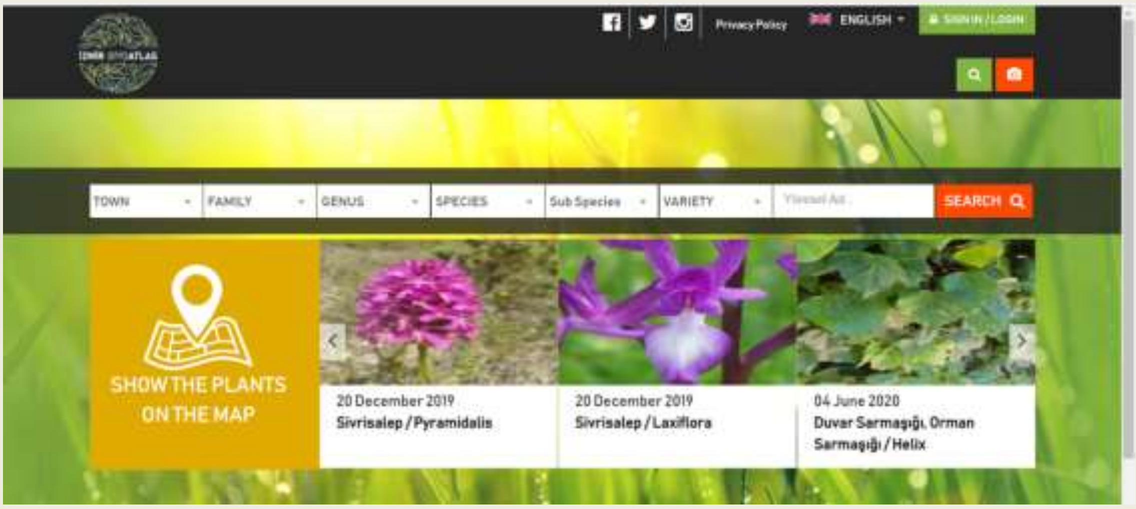
Table of results (summary, from Task 5.4)

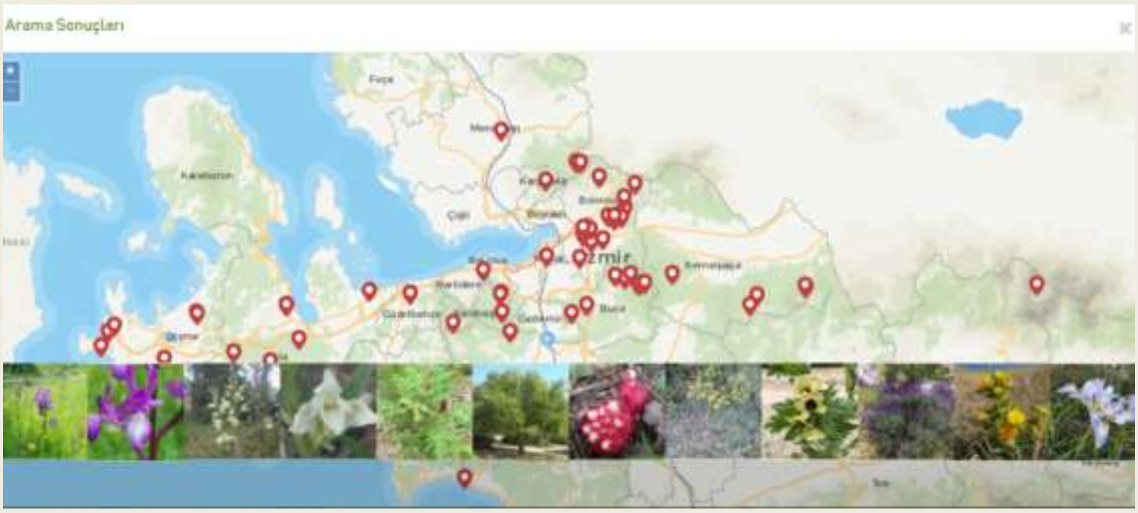
- Nature Based Solutions Training
- Basic Ecology and Biogeography
- Ecology and Economy Relationship
- Nature Based Solutions

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

The bioatlas website has been introduced to citizens. The photos of plants captured by citizens are uploaded to the system (it is a must to be a member of the site). There are some rules regarding the light, the angle of the photos taken, etc. The location of the plant also need to be stated. Academics who are experts send the detailed information about the plant.

http://www.izmirbiyoatlas.org





Conclusions and recommendations.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	How they have been addressed
No barriers	

Economical barriers	How they have been addressed
No barriers	

Social barriers	How they have been addressed
Inability to reach all users in the demo site.	Dissemination and communication activities should be increased

Environmental (including COVID)	How they have been addressed
No barriers	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

What was the impact? (positive/negative, significant/non-significant)?
As the flood and overflow risk decreased through the NBSs implemented around the Peynircioglu stream, the approach of the citizens to the NBS implementations developed positively. In addition, the creation of a digital platform which is "Biz İzmir" that includes some of the NBS implementations facilitates the work of city wide users. In particular, the users can record type of plant or obtain information about existing listed plants in "Bioatlas" application related to increasing biodiversity.

1.3.21 CH0704 Urban farming activities

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0704	URBAN FARMİNG ACTIVITIES	EGE Soil
CITY	*RELATED NBS*	
IZM		

Results and Discussion

Table of results (summary, from Task 5.4)

Climate-smart greenhouse can be defined as an approach for transforming and reorienting agricultural development under the new realities of climate change. Climate smart soil and agriculture will be practice in a greenhouse and on field together. This NBS employs greenhouse facilities to illustrate the effects of climate change on urban green vegetation used in urban green areas and farming (for both urban and peri-urban areas). This practice will help to select adequate vegetal species for urban farming and to establish community practices and new social forms of organization.

Figure 1: Climate smart greenhouse

Climate smart greenhouse includes 3 production & demonstration parts and it is located in the eastern part of the Sasalı Natural Life Park. There is also an open field agriculture that demonstrates on effects of changed climate condition on soils and plants (162 sqm) and a seminar room designed for educative propose for students and visitors (162 sqm).

Studies are being done within the greenhouses to demonstrate producing agricultural crop continuously under changed climate condition. In another 162 sqm of the greenhouse there is a parabolic solar heating system and also use of solar energy for lightening.

There is also a vertical planting system implemented (Figure 2) we plan to get 17 times more product from the unit area.

Figure 2: Vertical farming system

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

One of the studies on urban farming is about agricultural production on high-level salty soils at field conditions. For this purpose, a spatial planting technique has been developed. According to this technique, high ridge planting pads 70 cm high from the ground are prepared for planting seedlings.

Figure 3: Production under salty conditions

Baseline measurements are made in sections such as high ridge planting and data are obtained periodically. In other sections, measurement data will begin to be obtained as each section is completed.

Fruit trees are sensitive to salinity and cannot grow in salty soils. After these processes, soil samples were taken both from the top of the high ridges and the areas between this row (ground). Soil samples were taken from 9 points separately in July and October to see the effect of climate on soil salinity. It was observed that the salinity (EC) was minimally increased in the high ridge (HR) samples while rising in the soils taken from the ground (GR).

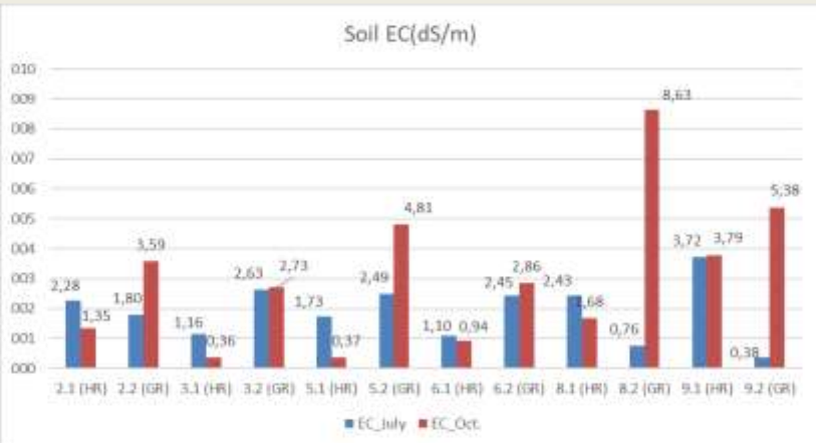


Figure 4: Seasonal changes in soil salinity in the study area (HR: High ridge, GR : Ground

When the analysis results of the samples made from the surface of the soil between the rows without any treatment were examined, it was seen that the salinity (EC) values increased in all samples from July to October due to evaporation. This result shows that if the winter precipitation is insufficient to wash the soils, there will be salt accumulation in the soils and it will not be possible to grow plants. For this reason, it has been determined that the high ridge planting technique that we suggested and implemented was successful. In addition, the results of this effect will be better understood when followed for many years (Figure 5). The pomegranate and quin trees developed quite well and started to bear fruit (Figure 5, 6).

Figure 5: Fruits grown so far

In order to protect both agricultural production and urban green spaces, we need to identify both planting techniques and plants types that are resistant to salinity and increasing drought.

Figure 6: Tamarix plant that survived the salty soil

Conclusions and recommendations.

The aim is to show three different ways in this field, which was constructed in order to raise awareness about the effects of climate change and measures to be taken. First, we aimed for an answer to the problem of being unable to cultivate due to the salinization of the soil, which is our most important natural resource. As a result of planting on the high ridge, it can be seen that the rate of increase in soil salinity slows down and decreases in some areas, so fruit trees can continue their development. This technique can provide the continuity of food production in agricultural areas can be ensured in the coming years. It is anticipated that this development will be even more successful with the integration with the developing smart agriculture technologies. Of course, it should be noted that it is necessary to ensure the continuity of practices and studies on this subject.

In the coming decades, vertical farming systems will become widespread in order to increase food production and to produce even in inefficient or unsuitable areas. Therefore, it is successfully demonstrated both soilless horizontal and vertical farming techniques in order to demonstrate these examples in the field and ensure their widespread use. Thanks to these new systems, it was possible to show that it is possible to get more of the product to be taken from the unit area in a shorter time. In particular, the way to ensure the transfer of knowledge successfully is to show the results with real applications.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Lack of qualified technical local personnel in the production and use of new technologies.	Problems were tried to be solved by finding personnel who would provide support from different locations.
Economical barriers	How they have been addressed
No economic barriers.	The greenhouse belongs to the Municipality and the relevant departments will keep the facility to continue the training activities.
Social barriers	How they have been addressed
No social barrier	All visitors had positive feedbacks regarding the area.
Environmental (including COVID)	How they have been addressed
During the COVID period, there were problems with the lack of timely implementation of some applications and the supply and transportation of the materials to be applied.	The problems were solved by repeating the applications.

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

The KPI is among Challenge 7 Participatory Planning and Governance. The results of the experiments made in the field gives a lot of feedback and information about urban farming and all these experiences are shared with students from different majors and farmers. The good practices can be used by other stakeholders.

What was the impact? (positive/negative, significant/non-significant)?

As mentioned before, explaining theoretical knowledge to people does not actually guarantee learnedness. Therefore, as a result of practices demonstrations in such an area, it was observed that increasing this level of knowledge and awareness was more successful. On the negative side, it can be said that there are many people who will benefit from this field, but it takes a long time for them to see these applications due to the high demand.

1.3.22 CH0706 Energy savings

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0706	ENERGY SAVINGS	EGE
CITY	*RELATED NBS*	
IZM	URBAN FARMING ACTIVITIES – Energy Savings	

Results and Discussion

This section of the Greenhouse includes some applications aimed at reducing energy from the national electricity network. The heating of this part of the greenhouse will be provided by parabolic solar energy. For this purpose, isolated water tanks that store heat during daytime hours will be used for night heating purposes. The use of Parabolic (concave) type Solar Collector is aimed at the heating of 200 sqm size greenhouses. In the parabolic type solar collectors, 0.5 kW/h thermal power is obtained from 1 sqm reflective surface area.

The total reflectance of 6 Parabolic Type Solar Collectors planned to be used in the system mirror area is 24 sqm.

The hourly thermal power to be obtained from the 24 sqm mirror surface is 12 kW/h. Average of the system to be installed based on the daily 7-hour sun exposure data. In this case; energy gains of 7 hours x 12 kW / h = 84 kW / h will be provided and it means annually; 30,240 kW / h of energy will be saved.

The required thermal power for the 200 sqm greenhouse to be heated is 24 kW/h. The operating principle of the system the thermal energy stored in the daytime will be used for heating the greenhouse for 3 hours at night. The total amount of energy consumed per night in heating is 3 x 24 kW h = 72 kW/h.

Additional, photovoltaic solar energy system (battery) will be use lightening needs of the greenhouse.

Figure 1: Parabolic solar collectors and photovoltaic solar panels

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Table 1: Electricity production

Reflective surface Area m^2	kW/h m^2	Total kW/daily	Months 2022	Total kW/month
24	12	84	July	2.520
24	12	84	August	2.520
24	12	84	September	2.520
24	12	84	October	2.520
	12	84	November	2.520
	---	---	December	Continue
Total	60	420		12.600

Conclusions and recommendations.

The parabolic test practice was arranged to operate under steady conditions. This is essential to measure the data for the determination of the useful heat gain given in equation parameters which are needed for the analysis. Outdoor tests were performed in the midday hours on clear days when the beam radiation was high and the incidence conditions were almost the same.

Parabolic trough solar collector is a proven technology for heat and electricity generation but its usage in city applications has not matured completely, yet. In this project, the sample performance tests of the special hand-made parabolic collector were performed to characterize it under the climate conditions of Izmir. This parabolic solar collector can also be used in future studies.

As a result of the study, it has been understood that the use of parabolic solar panels in cities with long sunshine durations such as Izmir will be successful and can be used within nature-based solutions to reduce carbon emissions.

Regarding the monitoring process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
Although it is not a major challenge, the cleaning and maintenance of parabolic systems and the lack of experts in parabolic systems can be a problem in solving specific problems.	The establishment that will ensure the continuity of the system must employ an expert for this job.
Economical barriers	How they have been addressed
No economic barriers	-
Social barriers	How they have been addressed
The system is built in a publicly owned greenhouse so social acceptance was not an issue. It also draws the attention of the people who visited the area for training activities.	-
Environmental (including COVID)	How they have been addressed
.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?

This KPI is among Urban Farming Activities Challenge. Parabolic solar collector attracts the attention of visitors. Demonstrating this system serves as an important precursor for its dissemination.

What was the impact? (positive/negative, significant/non-significant)?

While the amount of energy obtained is important, it is also important that no carbon emissions for this. It has become widespread to obtain energy from the photovoltaic solar panel system. Its use for lighting purposes in greenhouses also has started to become widespread. However, fossil fuels or electricity are still used for heating. The parabolic system saves energy by storing the heat during the daytime and using it for heating during the day or night. The use of the parabolic system in greenhouse heating is not known in Turkey. The case study made in this project will contribute positively to teaching and dissemination for both urban and rural farming systems.

Other comments

Optional: Any other relevant comments that you would like to include.

As it is known, the use of fossil fuels increases carbon emissions. Since the water stored in the dams decreases due to climate change and recent droughts and can only meet the drinking water need, electricity production from hydroelectric systems should be abandoned. Energy is needed for lighting and heating in the greenhouse during the production season. In this project, instead of using the energy produced from fossil fuels or hydroelectric power plants, it is planned to obtain the energy needed from renewable sources with nature-based solutions.

1.3.23 CH0707 Water savings

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0707	WATER SAVINGS	EGE
CITY	*RELATED NBS*	
IZM	URBAN FARMING ACTIVITIES – Water Savings	

Results and Discussion

Depending on the changing climatic conditions, temperature and evaporation increase, while there is a decrease in water resources. In addition to these, the salinity rate in water and soil increases. Under these conditions, it is getting harder and harder to farm in the field. Greenhouse, which uses less water than field agriculture, is an important alternative for uninterrupted food production. Treated water is needed for agricultural production in the greenhouse. It is planned to harvest water from the roof of the greenhouse in order to save both water and obtain clean water for hydroponic-type productions. For this purpose, the rain falling on the roof is collected and stored by a gutter system.

Figure 1: Collecting and transferring rainwater from the roof of the greenhouse to the tank

Figure 2: Rainwater Storage

Discussion of results: comment on all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other relevant material if necessary: maps, graphs, photos, etc.

Harvested Water from monthly rain between November 2021- January 2022 can be seen in table below.

Table 1: Water harvested

Roof area m^2	Monthly rain (mm)	Months 2021-2022
596,7	92	November 2021
596,7	146.8	December 2021
596,7	136.9	January 2022
596,7	102.9	February 2022
596,7	80.3	March 2022
596,7	60.4	April 2022
596,7	56.5	May 2022
596,7	37.4	June 2022
596,7	----	July
596,7	----	August
596,7	11.6	September
596,7	34.3	October
596,7	76.5	November
Total	**835.4**	**Total Rain (mm)**

HW =Roof Area (m^2) x RLC x FSC x Total Rain (mm)

HW = 596.7 (m^2) x 0.8 x 0.9 x 0.8534 (m)

HW = 358.91 m^3

Glossary

HW = Harvested Water (mm)

RLC = Roof Layer Coefficient (Roof layer coefficient is 0,8 according to German DIN1989).

FSC = Filtering System Coefficient (filtering system coefficient is 0,9 according to German DIN1989).

Total Rain (mm) = TR (From meteorological observation)

Explanations of the calculations used for water harvesting are given below.

The size of the roof collecting area is the calculated base area of the greenhouse (plus the roof overhang), independent of the roof shape and roof slope. If only one side of the roof of the greenhouse is used as a collecting area, only the corresponding base area will be taken into consideration. In the case of other areas, the base area upon which there is rainfall will be used as an estimate.

Yield Coefficient

The position, slant, orientation, and composition of the collecting area are to be taken into consideration in the determination of the yield coefficient. The value 0,8 can be used as a planning basis for the slant and composition of the collecting area.

Filter Systems

The manufacturer information with regard to the usable rainwater volume flow is to be taken into consideration for hydraulic-action filter systems that are used in the reservoir supply line.

Note: A hydraulic filter efficiency of 0.9 is achieved as a rule with filter systems that are maintained on a regular basis.

Conclusions and recommendations.

Rainwater harvesting is an innovative alternative water supply approach commonly used. Rainwater harvesting captures, diverts, and stores rainwater for later use. Implementing rainwater harvesting is beneficial because it reduces demand on the existing water supply, and reduces run-off, and contamination of surface water.

Rainwater can be used for nearly any purpose that requires water. If groundwater is used for soilless (hydroponic) agriculture in the greenhouse, the water must be purified. For this purpose, additional chemicals and energy should be used. No treatment is required for rainwater. Rainwater is used for soilless agriculture within the scope of the project. These include landscape use, stormwater control, wildlife and livestock watering, indoor use, and fire protection. In the project, the water obtained as a result of rainwater harvesting was used to support the irrigation needs in agricultural productions.

A rainwater harvesting system can range in size and complexity. All systems have basic components, which include a catchment surface, conveyance system, storage, distribution, and treatment.

Regarding the monitoring process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers	

Economical barriers	How they have been addressed

No economic barriers	-
Social barriers	How they have been addressed
The system is built in a publicly owned greenhouse so social acceptance was not an issue. IT also draws the attention of the people who visited the area for training activities.	-
Environmental (including COVID)	How they have been addressed
The construction of the greenhouse is one of the last implementations made within the project due to COVID and other reasons. The collection of water and monitoring started relatively late.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
This KPI is among Urban Farming Activities Challenge. Farming/agriculture consumes more than 70% of the water in Turkey. As it is expected to have water stress in the near future due to increasing population, consumption patterns, different industries increasing use as well as climate change, the competition among sectors is expected to increase (clean water, industry, energy, tourism, etc.). The use of harvested water in the greenhouses is one of the first good practices in the country and can be used especially in areas where there are a lot of greenhouses (the Aegean and Mediterranean Regions to be specific).
What was the impact? (positive/negative, significant/non-significant)?
Demonstrating to farmers, citizens, and also municipal personnel how to obtain water without or less the need for existing water resources and treatment through rain harvesting has had a significant and positive impact. The amount of collected rainwater may increase depending on the amount of rain and the storage capacity. Demonstrating and teaching rain harvesting is important for dissemination so that urban landscape areas and urban agriculture will be less affected by water and soil salinization in the future.

1.3.24 CH0802 Green intelligence awareness (m/min)

KPI CODE	*KPI NAME*	*PARTNER(S)*
CH0802	GREEN INTELLIGENCE AWARENESS (m/min)	
CITY	*RELATED NBS*	
IZMIR		

Results and Discussion

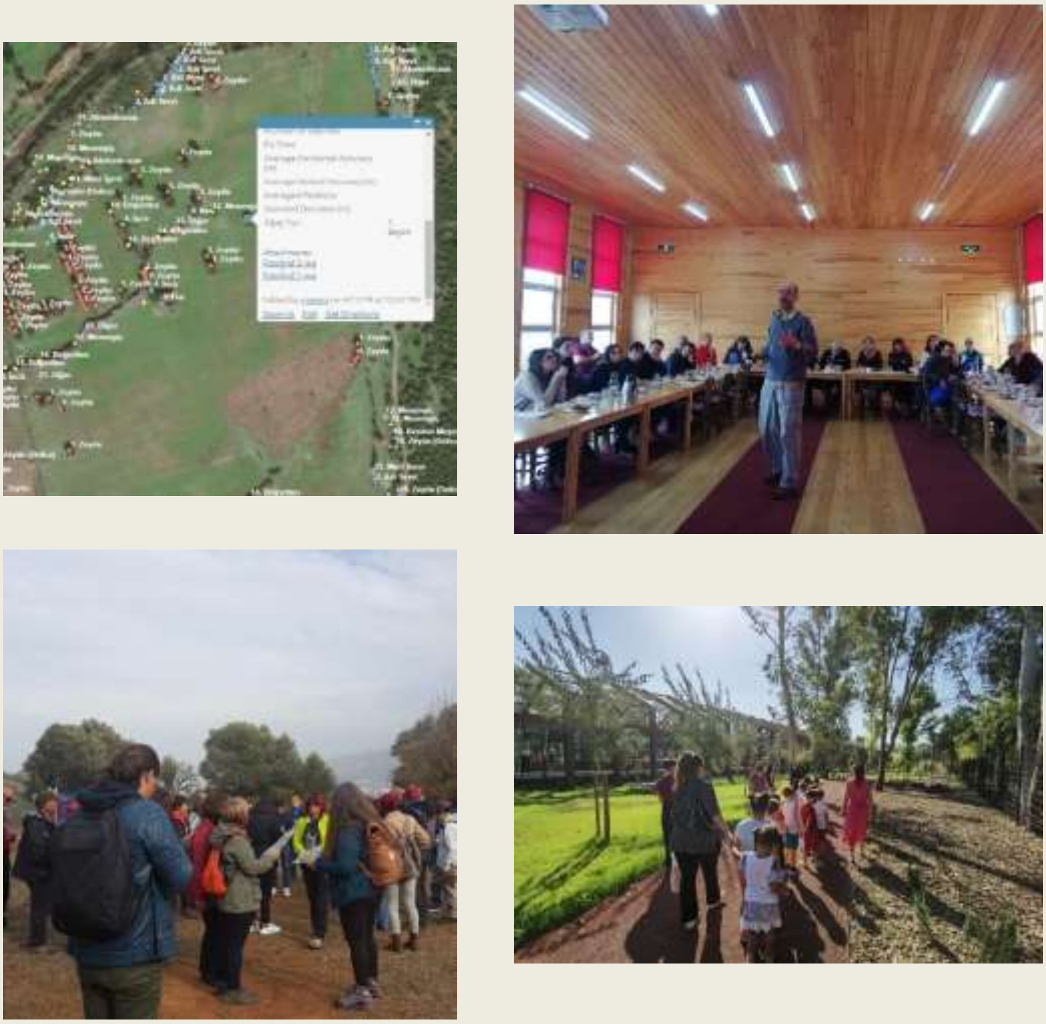
Table of results (summary, from Task 5.4)

Some of the training activities and visits to Agriculture Center and Sasalı Area.

- Çiğli Municipality Agricultural Services Directorate (about 30 people)
- Political groups and Artists (about 100 people)
- Chamber of Landscape Architects İzmir Branch, (about 30 people)
- Izmir Efes Rotary Club and Efes Rotaract clubs (about 50 people)
- Yaşar University Vocational School of Food Technologies (about 100 people)
- 20 different primary school student groups of about 20 each came. (about 400 people)
- Gediz delta UNESCO workshop (about 100 people)
- Antalya Metropolitan Municipality Agricultural Services Department Agricultural Structures and Irrigation Branch (about 30 people)
- Technical Workshop on "Back to Our Nature" as part of the "Economics Congress of the Second Century" (about 100 participants)
- Bilkent University Parks and Gardens Department Students (about 50 people)
- Employees of Izmir Metropolitan Municipality Department of Studies and Projects (about 100 people)
- AIPH coordination team (about 10 people) within the scope of Expo 2026 Project
- Manisa Celal Bayar University Landscape Architecture Students (about 150 students)
- Ege University Landscape Architecture and Agricultural Engineering Soil Department Students (about 200 People)

In total approximately 1350 academics, local government representatives, students, international institutions.

Discussion of results: comment all relevant information to put in context the results from the table: Local considerations, trends, evolution, differences between NBSs, etc. Include other *relevant material if necessary: maps, graphs, photos, etc.*



Citizen science activity on biodiversity in Izmir (November 2018)

Conclusions and recommendations.

(300 words max.) Please, answer to the questions.

Regarding the monitorization process

Barriers encountered during the monitoring of this KPI and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers	
Economical barriers	How they have been addressed
No barriers	
Social barriers	How they have been addressed

Frequent change of the department heads after the elections affected the process	the Agriculture Center will continue to be active after the project number of activities are expected to accelerate.
Environmental (including COVID)	How they have been addressed
Pause in work of council because of covid 19.	

Regarding the results of the KPI(s)

Is there a significant impact on the challenge?
What was the impact? (positive/negative, significant/non-significant)?
The negative effects of climate change were understood by the students who attended the special trainings and activities, provided at the established agricultural center. Increasing temperatures, drought, decreasing rainfall, changes in soil chemistry, negative effects of living creature in Izmir habitats were simulated in the "laboratory of the future" and the awareness of students has been raised.

2 Final NBS Catalogue

2.1 Valladolid

2.1.1 Vac01 New Green Cycle Line

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0401 CH0402 CH0405 CH0407 CH0408 CH0410 CH0602 CH0702 CH0902 CH0903	New Green Cycle Line	VAL
CITY	*DATE OF IMPLEMENTATION*	
VAL	May 2022	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

The new cycle line contributes to the promotion of the most efficient transport modes, the reduction of energy consumption, the improvement of the accessibility and security levels and the improvement of the quality of life of citizens. It will help to connect current existing cycle lanes with new cycle lanes, in order to increase connectivity, sustainable transport but also for biodiversity, using sustainable permeable materials that reduce the heat island effect.

Different KPIs of the following topics were selected to calculate: green space management, urban regeneration, participatory planning and governance and public health and well-being.

The most interesting result is how Vac01 has increased the accessibility to Green Space to population by cycling. Over the total of the city, it has meant an increase of 9.6% of linear metres of new cycle lanes with respect to the existing one.

It is sure that the elderly people life quality and citizen perception have improved, but the methodology based on app mobile data didn´t get enough data due to the low participation of citizens. The calculation of the walking and cycling increase have the same problem, even if the app allows to register the mobility behaviour of users, they don´t want to share these data. Regarding crime reduction thanks to NBS, it is not a KPI easy to calculate.

In order to evaluate the sustainability of the intervention, 29 aspects divided into three categories have been scored:1) Impact on ecosystem 2) Construction and operation 3) Impact on society

NBS	Ecosystem	Construction/operatio	Society	Score	Category
VAc1 New green cycle lane and re-naturir	6,7	13,3	26,7	47	Good

The results show that the intervention is "good" in terms of sustainability.

Urban regeneration challenge:

Benefits for interventions: 46.70/100 is the score reached of permeable parking taking into account different criteria of different topics: improvement by NBS type, the sustainability KPI and the functionality of the interventions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Connection problems between the different existing bike lanes along the green corridor.	Working together the mobility department to solve them
Economical barriers	How they have been addressed
URBAN GreenUP budget insufficient.	Municipal funding has been increased.
Social barriers	How they have been addressed
Not identified.	

Environmental (including COVID)	How they have been addressed
Due to the COVID the implementation was delayed.	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Maintenance and cleaning are essential factors for the correct use of dirt cycle tracks, avoiding insecurity for the cyclist. Rabbit dug holes in the dirt cycle	Planning and surveillance

Economical barriers	How they have been addressed
The European project does not finance maintenance.	the Valladolid City Council finances all maintenance actions.

Social barriers	How they have been addressed
Non-acceptance of the reduction of parking spaces, width of sidewalks or roads for implementing new bike lanes. Low utilization of the mobile app, so little reliable data to evaluate citizen's behaviour and perception.	Educational campaigns promoting sustainable mobility

Environmental (including COVID)	How they have been addressed
The lack of rain and drought complicate the growth of the plants.	Manual irrigation alternatives

2.1.2 Vac02, Vac03, Vac04, Vac05 Arboreal interventions

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0101 CH0102 CH0203 CH0206 CH0211 CH0212 CH0403 CH0405 CH0407 CH0408 CH0502 CH0503	Arboreal interventions VAc2 Planting 1,000 trees, VAc3 Tree shady places (500 trees), VAc4 Shade	VAL

CH0504CH0507 CH0514 CH0602 CH0702 CH0801	and cooling trees (600 trees), VAc5 Re-naturing parking trees (250)	
CITY	*DATE OF IMPLEMENTATION*	
VAL	2020 (25%), 2021 (>60%), 2022 (15%)	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

None of the KPIs defined to the URBAN GreenUP project represents uniquely the arboreal interventions (new trees planted in urban and peri-urban areas).

There have been planted almost 1400 new trees in urban and peri-urban areas from 43 different tree species, increasing biodiversity. Most of the planted trees have been from the *Pinus*, *Acer* and *Populus* genders.

Trees species	nº trees	%
Pinus	360	15%
Acer	344	14%
Populus	294	12%
Cedrus	142	6%
Juglans	137	6%
Quercus	118	5%
Celtis	116	5%
Fraxinus	105	4%
Tilia	82	3%
Sophora	73	3%
Koeleuteria	68	3%
Platanus	68	3%
Amigdalus	65	3%

Trees species	nº trees	%
Gleditsia	65	3%
Carpinus	59	2%
Betula	50	2%
Robinia	43	2%
Ulmus	42	2%
Liguidambar	40	2%
Zelkova	40	2%
Hacer	30	1%
Ailanthus	25	1%
Liriodendro	20	1%
Pyrus	5	0%
TOTAL TREES	**2.391**	**100%**

New trees remove carbon dioxide (CH01), intercept rainfall (CH02), increase the green areas connectivity, improve the citizen perception on green areas (CH04), increase green areas

sustainability, reduces air pollution (CH05), improves citizen perception (CH07) and can mean vandalism (CH08).

Conclusions and recommendations.

Regarding the implementation process

Technical barriers	*How they have been addressed*
Tree planting is done with young individuals. It requires specialized machinery.	Provide garden means
Economical barriers	How they have been addressed
Buying trees is cheap. Planting trees and installing irrigation and protection systems is expensive.	Financing of everything necessary with municipal own means.
Social barriers	How they have been addressed
The trees have the "not in my backyard" effect – we all love trees, specially the big ones, but they prevent good views from the windows, they raise the pavement of the sidewalks, the dirty the cars…	Do not cut down the trees and give them the value they deserve as part of the city
Environmental (including COVID)	How they have been addressed
Trees plantation depends highly of the period of the year (autumn campaign is better for plantation). Lack of rain and lack of water affects directly	Treepits and trees planted in green areas (parks) have automatic irrigation systems.

Regarding the operation process

Technical barriers	*How they have been addressed*
Trees on the road require maintenance: pruning and watering	Provide a municipal garden maintenance system
Economical barriers	How they have been addressed
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed

Accept citizen complaints, especially when the trees already produce some effect such as dirt, sidewalks, reducing visibility, etc.	The gardening policy of the Valladolid City Council is to respect the trees in the urban framework (streets included) and to plant new trees and green areas in all the streets and squares that are redeveloped.
Environmental (including COVID)	How they have been addressed
It is not a barrier: precisely during the COVID closure, the citizens gave more value to nature and green areas.	

Other comments

Trees are essential in cities. The benefits outweigh the drawbacks (citizen complaints, raised sidewalks, need for maintenance, etc.)

2.1.3 Vac06 Green resting areas

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0203 CH0206 CH0401 CH0403 CH0404 CH0405 CH0407 CH0408 CH0602 CH0702 CH0801 CH0902 CH0903	Vac6 Green resting areas	VAL/CAR
CITY	*DATE OF IMPLEMENTATION*	
VAL	April 2022	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Green resting areas are green spaces projected for social passive recreation (resting, relaxation, observing nature, social contact). The development of green resting areas plays a central role in policies related to health, nature conservation and spatial planning.

3 Green resting areas has been installed along the Green Corridor.

NBS Locations
Green Corridor

Green resting areas can be monitored with all the KPIs related to trees and green surface. It is expected that the entire surface of the pergola will be covered with deciduous climbing ivy, at least in spring and summer. Likewise, there are new trees planted nearby. New vegetation of the green resting areas **remove carbon dioxide** (CH01), increase the green areas connectivity, improve the citizen perception on green areas (CH04), increase green areas sustainability (CH05), improves citizen perception (CH07) and can mean vandalism (CH08).

These NbS have been provided with smart soils and filter soils, which contribute positively to improving the water absorption capacity of the soil and increasing the amount of rainwater intercepted. This in turn contributes to reducing the water purification needs of the city. However, it has not been possible to quantitatively estimate the impact as there is no data on the associated KPIs.

Regarding the **distribution of green spaces** in the city, the neighbourhoods where these rest areas have been installed have seen an increase in the ratio of m2 of green spaces per inhabitant after the installation of the NBS of the URBAN GreenUP project. The figures for these neighbourhoods are shown in the following table. The impact has been particularly significant in the Pilarica district, with the greatest increase in green area compared to the baseline situation.

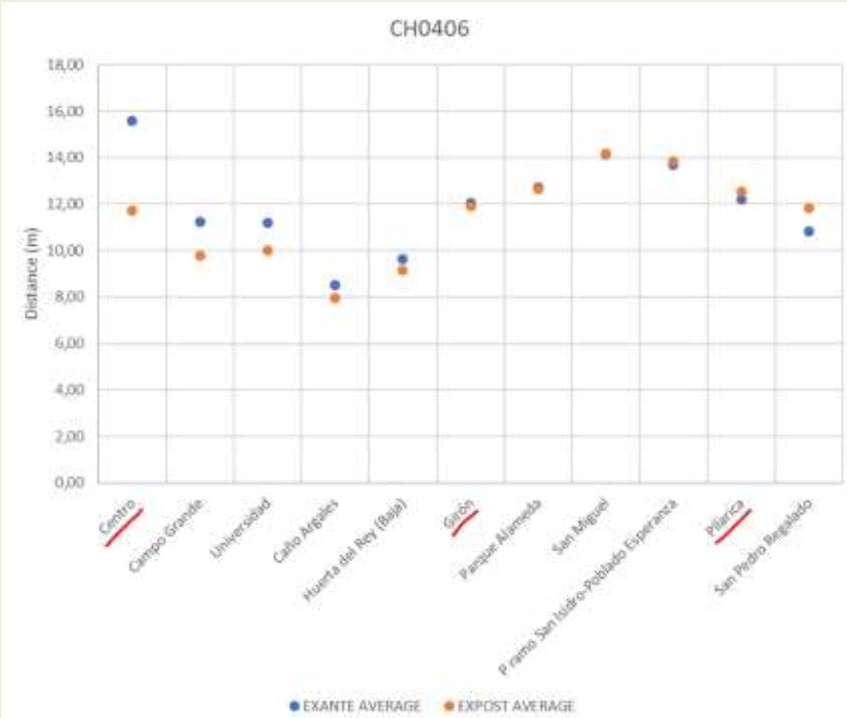
CH0401 Green Space Distribution (m2/capita)			
DISTRICTS	BASELINE	POST-INTERVENTION	INC (%)
Girón	124.96	125.38	<1%
Centro	19.75	19.86	<1%
Pilarica	13.09	21.56	64%

In terms of **improved accessibility**, the neighbourhoods where green resting areas have been installed have also improved in this indicator. The effect is particularly significant in the case of the Centro district, mainly due to two factors: the number of NBS installed and the high population density in this area.

CH0403 Green Space Accessibility (m-min)			
DISTRICTS	BASELINE	POST-INTERVENTION	INC (%)
Girón	48.06	48.06	<-0%
Centro	102.88	51.22	-38.7%
Pilarica	75.99	75.03	-1.4%

However, the green resting areas per se have not generated a significant impact on these indicators, as they have been installed in the context of pre-existing green areas.

Regarding the **connectivity between green infrastructures**, in the 3 districts the distance between green infrastructures has decreased, so the impact has been positive. In this case, the Centro district has once again benefited the most from the actions. In Pilarica and Girón the impact has been less significant.



Regarding the sustainability degree, this action has been evaluated as Good level.

		Ex-post						
Name	NBS	Ecosystem	Construction/ operation	Society	Score	Category	Implementation date	
Resting areas	VAc6 Installation of 3 Green Resting areas	13,3	16,7	26,7	57	Good	abril-22	M59

According to other KPIs, we highlight the fact that street furniture is vandalized with scratches or breaks (benches, wooden pergola, bicycle racks, insect hotel), monitored by *CH0801- Crime reduction*.

On the other hand, since the *VAc6-Green resting areas* are located along the Green Corridor, they positively affect the indicators *CH0902 Walking Area Increase* and *CH0903 Cycling Area Increase*, automatically monitored with the URBAN GreenUP mobile app (location services). However, this impact could not be evaluated either, as no conclusive data was obtained through the mobile application.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Difficulties in installing a public drinking water source in suburban areas where the water supply is not nearby.	Not installing a drinking water source in all areas.
Economical barriers	*How they have been addressed*
The largest investment in the construction is the irrigation system.	Take advantage of the existing irrigation system nearby
Social barriers	*How they have been addressed*
These green infrastructures are to be used by citizens for rest, sports and leisure activities.	

Environmental (including COVID)	*How they have been addressed*
None	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
None	
Economical barriers	*How they have been addressed*
Unforeseen maintenance cost (furniture items)	Unexpected investment with own means
Social barriers	*How they have been addressed*
Vandalism in street furniture. The citizens want to see the green pergola covered with ivy grown shortly after planting.	Public street and furniture cleaning service Increase other types of plants, such as shrubs, or tree planting.
Environmental (including COVID)	*How they have been addressed*
If the plants do not have irrigation they can dry out, due to the drought, high temperatures and not enough rain.	Install an automatic irrigation system

2.1.4 Vac7 Urban carbon sink (Santos-Pilarica)

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0101 CH0102 CH0203 CH0205 CH0206 CH0401 CH0405 CH0407 CH0408 CH0410 CH0602 CH0702 CH0801 CH0902 CH0903	Vac7 Urban carbon sink (Santos-Pilarica)	CAR/VAL
CITY	*DATE OF IMPLEMENTATION*	
VAL	March 2022	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

The Urban Carbon Sink (UCS) is conceived as an urban forest in which species have been selected mainly for their ability to fix carbon. Therefore, it is a nature-based solution for the over-accumulation of carbon dioxide in cities' atmosphere. This NBS is proposed to compensate the emissions of this greenhouse gas, capturing it in the form of biomass.

The Urban Carbon Sink is located in the eastern part of the municipality of Valladolid, in the neighbourhood known as Los Santos-Pilarica. Specifically, the plot is located in Sector 50 of the urbanizable land known as "Los Santos 2" with a plan definitively approved for its development (BOCyL, 27th June 2006). It limits to the south with the bed of the river Esgueva and to the east with the Outer Round VA-20. North and West are adjacent to other plots of similar characteristics.

The urban carbon sink forest is completed with other NbS such as: one *Green resting area* (VAc6) with an insect hotel, and various *Natural pollinator modules* (Vac21).

CH01 Climate mitigation & adaptation: *CH0101+CH0102 Carbon removal*: Urban carbon sinks are designed to retain carbon dioxide from the atmosphere, among other uses. This NbS impacts on carbon sequestration capacity (indicators CH0101 and CH0102). Carbon sequestration is due to the species selection and number of trees. *Pinus pinaster*, *Populus nigra* and *Celtis australis* were planted in the urban carbon sink.

Trees matrix	Species	Plants/Ha	Trees #
Higrophylus trees	*Populus nigra, Populus alba*	150	166
Fruit trees	*Sorbus domestica, Prunis dulcis, Prunus spinosa, Crateaegus monogna, other*	250	144
Transitional mixed trees	*Celtus australis, Ulmus minor "resista", Fraxinus angustifolia, Jugalns regia*	250	126
Forest trees	*Pinus pinea, Querqus faginea, Querqus ilex, Juniperus thrurifera, Pinus pinaster*	800	1553
			1989

Theoretically, the implementation of this NbS has been estimated to increase CO2 fixation by 211%. The action implemented has led to a change in land use, from an agricultural use to a green area use. Although the existing agricultural cover was already fixing atmospheric carbon prior to the URBAN GreenUP action, has increased significantly thanks to the plantation of almost 2000 new trees. Moreover, this impact increases over time. This urban forest will be maintained for 30 years in Valladolid, as it is being labeled to the Ministry of Environment as "Carbon fixation project" at national level.

These NbS have been provided with **smart soils**, which contribute positively to improving the water absorption capacity of the soil and increasing the amount of rainwater intercepted. This in turn contributes to reducing the water treatment needs of the city. However, it has not been possible to quantitatively estimate the impact as there is no data on the associated KPIs.

Regarding the **distribution of green spaces** in the city, this action has contributed significantly to increase in the ratio of m2 of green spaces per inhabitant. In the case of Pilarica District, it has increased a 64% the ratio of m2 green spaces/inhabitant, from 13.09 m2 to 21.56 m2 per inhabitant.

In terms of improved accessibility, Pilarica district has also improved in this indicator.

CH0403 Green Space Accessibility (m-min)			
DISTRICTS	BASELINE	POST-INTERVENTION	INC (%)
Pilarica	75.99	75.03	-1.4%

Regarding the **connectivity between green infrastructures**, in Pilarica District the distance between green infrastructures has decreased, so the impact has been positive.

CH0410 Pollinator Species Increase: The presence of **pollinators** has significantly increased due to the increasing area of green NbS, specially the species with flowers.

		Butterflies	Flies	Beetles	Bees	Others	Average
UCS	2020	2,67	4,89	0,78	1,64	0,92	**9,97**
	2021	4,1875	3,00	0,28	2,19	1,47	**9,66**

Regarding the sustainability degree, this action has been evaluated as **Very Good level**.

		Ex-post						
Name	NBS	Ecosystem	Construction/ operation	Society	Score	Category	Implementation date	
Urban carbon sink	VAc7 Urban Carbon Sink	26,7	16,7	23,3	67	Very good	abril-22	M59

On the other hand, since the *VAc7-Urban carbon sink* is located in the East of the Green Corridor, it positively affects the indicators *CH0902 Walking Area Increase* and *CH0903 Cycling Area Increase*, automatically monitored with the URBAN GreenUP mobile app (location services). However, this impact could not be evaluated either, as no conclusive data was obtained through the mobile application.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Tree planting is done with young individuals. It requires specialized machinery.	Provide garden means

Economical barriers	*How they have been addressed*
Buying trees is cheap. Planting trees and installing irrigation and protection systems is expensive.	Financing of everything necessary with municipal own means.

Social barriers	*How they have been addressed*
Forest tree planting has a replacement rate of 30%. Citizens perceive it as poor maintenance	Dead trees replacement

Environmental (including COVID)	*How they have been addressed*

The trees and vegetation in green areas were freer during the Covid confinement	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Difficult access for maintenance	Use of hand tools and light machinery
Economical barriers	*How they have been addressed*
Need for a specific budget for the maintenance of the carbon sink. Powers not included in maintenance contracts for green areas.	Use of additional economic means.
Social barriers	*How they have been addressed*
Acts of vandalism on furniture items (signs, canopy)	Service of urban cleaning
Environmental (including COVID)	*How they have been addressed*
The severe drought of 2023 has affected the survival of trees. Young trees die without being able to capture water from the water table.	Replanting of the carbon sink.

Other comments

Trees in urban forests must be able to survive on their own, even more so when they have a nearby water source (river and surface water table).

2.1.5 Vac09 SUDs for re-naturing parking

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0201 CH0202 CH0207 CH0208 CH0209 CH0408 CH0602	SUDs for re-naturing parking	VAL/CEN
CITY	*DATE OF IMPLEMENTATION*	
VAL	April 2023	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Sustainable drainage systems act in the management of urban runoff. They allow regulating strong rain flows and, therefore, improve the municipal sewage systems, reduce the amount of water that reaches the treatment plants; reduce the impact of overflows and protect from the effects of flooding.

A water retention pond has been built on a roundabout. In this case, two sewers have been installed on the road next to the roundabout that collect water from rain that comes down from the highest area of the street and channels it inside of the roundabout. A small excavation has been made in the roundabout, and when the water enters it on rainy days, a small pond is formed that little by little empties, as the water infiltrates directly into the ground. Thus, the large puddles that were produced in this the road and were dangerous are avoided. On the other hand, the existing trees have been maintained and the roundabout has been revegetated.

Water management challenge:

5 KPI regarding water management challenge were establish to quantify the effect of these interventions. The mandatory analysis and tests of the ground and rain statistics were made because the methodology uses theoretical data allowing calculating the KPIs even without finalising the works. Nevertheless, it has not been possible to obtain these KPIs due to the lack of qualified technical personnel in the entity responsible of them.

Green space management challenge

Green Areas sustainability:

In order to evaluate the sustainability of the intervention, 29 aspects divided into three categories have been scored:

1) Impact on ecosystem: the ecological context where a project is placed and developed.

2) Construction and operation: the impact of the execution of the works to implement the NBS and the impact through the life due to the use.

3) Impact on society: improvement of the quality of the community life.

NBS	Ecosystem	Construction/ operation	Society	Score	Category
VAc9 SUDs for re-naturing parking	26,7	16,7	6,7	50	Good

The results show that the intervention is "good" in terms of sustainability.

<u>Urban regeneration challenge:</u>

Benefits for interventions: 56.67/100 is the score reached of permeable parking taking into account different criteria of different topics: improvement by NBS type, the sustainability KPI and the functionality of the interventions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Existing trees in the roundabout	Integrate the trees in the design
Economical barriers	How they have been addressed
Not identified.	
Social barriers	How they have been addressed
Not identified.	
Environmental (including COVID)	How they have been addressed
Due to the COVID the implementation was delayed.	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Not identified.	
Economical barriers	How they have been addressed
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
Vandalism: people steal plants	Educational activities Plants reposition
Environmental (including COVID)	How they have been addressed
The lack of rain and drought complicate the growth of the plants.	Manual watering would be an option, but it is very important to evaluate also if this is sustainable.

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

Sustainable urban drainage systems are very useful and easy to build in parks and gardens, but it is very complicated in consolidated urban areas and roads.

2.1.6 Vac10 Rain gardens

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0201 CH0202 CH0207 CH0208 CH0209 CH0408 CH0602	Rain gardens	VAL/CEN
CITY	*DATE OF IMPLEMENTATION*	
VAL	April 2023	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Sustainable drainage systems act in the management of urban runoff. They allow regulating strong rain flows and, therefore, improve the municipal sewage systems, reduce the amount of water that reaches the treatment plants; reduce the impact of overflows and protect from the effects of flooding.

A rain garden has been built in the west area of Valladolid, to manage the rain water in a parking area withourt sewage system: the rainwater from the parking area crosses the discontinuous curb and falls into a ditch filled with gravel and permeable materials that, through different sections arranged in stages, infiltrates the water into the ground avoiding puddles.

Water management challenge:

5 KPI regarding water management challenge were establish to quantify the effect of these interventions. The mandatory analysis and tests of the ground and rain statistics were made because the methodology uses theoretical data allowing calculating the KPIs even without finalising the works. Nevertheless, it has not been possible to obtain these KPIs due to the lack of qualified technical personnel in the entity responsible of them.

Green space management challenge

Green Areas sustainability:

In order to evaluate the sustainability of the intervention, 29 aspects divided into three categories have been scored:

1) Impact on ecosystem: the ecological context where a project is placed and developed.

2) Construction and operation: the impact of the execution of the works to implement the NBS and the impact through the life due to the use.

3) Impact on society: improvement of the quality of the community life.

NBS	Ecosystem	Construction/ operation	Society	Score	Category
VAc10 Rain gardens	26,7	16,7	6,7	50	Good

The results show that the intervention is "good" in terms of sustainability.

Urban regeneration challenge:

Benefits for interventions: 56.67/100 is the score reached of permeable parking taking into account different criteria of different topics: improvement by NBS type, the sustainability KPI and the functionality of the interventions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Kerbs around parking areas are mandatory according to municipal normative, but they don´t allows water going out.	Kerbs are discontinuos to allow water going out across them.
Economical barriers	How they have been addressed
Not identified.	
Social barriers	How they have been addressed
Not identified.	
Environmental (including COVID)	How they have been addressed
Due to the COVID the implementation was delayed.	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Not identified.	
Economical barriers	How they have been addressed

The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
Vandalism: some people remove stones and kick the kerbs.	Educational activities
Environmental (including COVID)	How they have been addressed
The lack of rain and drought complicate the growth of the plants.	Manual watering would be an option, but it is very important to evaluate also if this is sustainable.

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

Rain gardens are a very good solution to manage rainwater, but the implementation in roads and pavement areas are not easy. However, in green areas and parks are very easy to implement. The operation and maintenance is also very simple.

The advantages regarding heat island effect and rain water management are considerable, so it is a NBS with a high potential.

2.1.7 VAc11 Green parking pavements

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0201 CH0202 CH0207 CH0208 CH0209 CH0408 CH0602	VAc11 Green parking pavements	VAL
CITY	*DATE OF IMPLEMENTATION*	
VAL	April 2023	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Sustainable drainage systems act in the management of urban runoff. They allow regulating strong rain flows and, therefore, improve the municipal sewage systems, reduce the amount of water that reaches the treatment plants; reduce the impact of overflows and protect from the effects of flooding.

A green permeable parking has been built in the west area of Valladolid where before an unpaved parking area existed. In this way, the stability of the ground is improved and the formation of puddles and mud is avoided, without having to asphalt the ground and allowing plants to grow. Permeable pavements allow the earth to breathe and prevent its overheating, reducing the heat island effect in cities.


Water management challenge:

5 KPI regarding water management challenge were establish to quantify the effect of these interventions. The mandatory analysis and tests of the ground and rain statistics were made because the methodology uses theoretical data allowing calculating the KPIs even without finalising the works. Nevertheless, it has not been possible to obtain these KPIs due to the lack of qualified technical personnel in the entity responsible of them.

Green space management challenge

Green Areas sustainability:

In order to evaluate the sustainability of the intervention, 29 aspects divided into three categories have been scored:

1) Impact on ecosystem: the ecological context where a project is placed and developed.

2) Construction and operation: the impact of the execution of the works to implement the NBS and the impact through the life due to the use.

3) Impact on society: improvement of the quality of the community life.

NBS	Ecosystem	Construction/operation	Society	Score	Category
VAc14 Green Parking Pavements	20,0	16,7	10,0	47	Good

The results show that the intervention is "good" in terms of sustainability.

Urban regeneration challenge:

Benefits for interventions: 52.22/100 is the score reached of permeable parking taking into account different criteria of different topics: improvement by NBS type, the sustainability KPI and the functionality of the interventions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Not identified.	
Economical barriers	How they have been addressed
Not identified.	
Social barriers	How they have been addressed
Not identified.	
Environmental (including COVID)	How they have been addressed
Due to the COVID the implementation was delayed.	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The pavement does not resist big weights, it is not for trucks parking.	A vertical traffic sign marks he prohibition of entry for heavy-duty vehicles.
Economical barriers	How they have been addressed

The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
Not identified.	
Environmental (including COVID)	How they have been addressed
The lack of rain and drought complicate the growth of the plants.	Manual watering would be an option, but it is very important to evaluate also if this is sustainable.

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

Green permeable park lots are very easy to implement and are not expensive. The operation and maintenance is also very simple.

The advantages regarding heat island effect and rain water management are considerable, so it is a NBS with a high potential.

2.1.8 Vac15 Cycle pedestrian green-paths

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0402 CH0405 CH0407 CH0408 CH0410 CH0602 CH0702 CH0902 CH0903	Cycle pedestrian green-paths	VAL
CITY	*DATE OF IMPLEMENTATION*	
VAL	May 2023	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

This intervention includes green pavements in a special structure with filter properties. Those green pavements leave small gaps filled with smart soil and with specific creeping grass species with a short growing and minimum maintenance.

These features will allow manage the water runoff and it could serve in the cycle-pedestrian areas to reduce cycle speed in specific urban sections with many pedestrians. These sections of pavements will indicate slow velocity zones in street crosses, pedestrian stops, etc.

In order to evaluate the sustainability of the intervention, 29 aspects divided into three categories have been scored:1) Impact on ecosystem 2) Construction and operation 3) Impact on society

NBS	Ecosystem	Construction/operatio	Society	Score	Category
VAc15 Cycle-pedestrian green paths	13,3	6,7	23,3	43	Good

The results show that the intervention is “good” in terms of sustainability.

<u>Urban regeneration challenge:</u>

Benefits for interventions: 43/100 is the score reached of permeable parking taking into account different criteria of different topics: improvement by NBS type, the sustainability KPI and the functionality of the interventions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
In many urban places direct water infiltration to the ground is not possible due to the existance of underground systems, like water pipes, electrical wires, ductos, etc	Construction of drainage systems that derives the water to the city rainwater collectors or to the sewage system will be necessary
Economical barriers	How they have been addressed
Not identified.	
Social barriers	How they have been addressed
Cycle lanes are also used by scooters and skaters, and the uneven surface of the green-paths is a problem for them.	The construction solution has been changed in the most frequent places for skaters.
Environmental (including COVID)	How they have been addressed
Due to the COVID the implementation was delayed.	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Maintenance and cleaning are essential factors for the correct use of cycle tracks, avoiding insecurity for the cyclist.	Planning and surveillance
Economical barriers	How they have been addressed
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
Some citizens: Non-acceptance of uneven surfaces to reduce the speed	Educational activities

Environmental (including COVID)	How they have been addressed
Due to the COVID the implementation was delayed.	

2.1.9 Vac16, Vac17, Vac18 Smarts soils as substrate

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0201; CH0207; CH0208; CH0209; CH0211; CH0514	Smarts soils as substrate: VAc16 Smarts soils as substrate for cycle-pedestrian green paths, pollinators mod. & green shady struct (A). VAc17 Smarts soils as substrate for green singular infrastructure (SubDemo B). VAc18 Smarts soils as substrate in Wastewater plant zone (SubDemo C)	VAL / CAR
CITY	*DATE OF IMPLEMENTATION*	
VAL	Supply in May 2020, December 2020 and March 2023	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Smart soils is an special substrate composed of by-products of the agricultural industry (90%) (vegetable waste) and with added biocarbon (10%), which increases the retention of air pollutants.

The supply of smart soil has been contracted to a regional company (EMUPA), that is located close to the city of Valladolid, which supplies different types of substrate for the municipal Parks and Gardens Area (green areas).

Smart soil storage in the EMUPA facilities

VAc16	Smarts soils as substrate for *Vac2- Trees*; *Vac15- Cycle-pedestrian green paths* & *Vac19- Pollinators mod.*(A)	Expected m3
VAc2	Planting 1,000 trees	180
VAc15	Cycle-pedestrian green paths	180
VAc19	Natural pollinator's modules	18
VAc16	*Smarts soils as substrate for VAc15, VAc19 & VAc6 (A)*	378

VAc17	Smarts soils as substrate for GI (B) *VAc6*, Vac20, Vac29	m3
VAc6	Installation of 3 Green Resting areas	20
VAc20	Compacted Pollinator's modules	20
VAc17		40

VAc18	Smarts soils as substrate (C.)	m3
VAc14	Green Parking Pavements	200
VAc5	Re-naturing parking trees (250)	40
VAc6	Installation of 3 Green Resting areas	20
VAc21	Natural pollinator's modules (6)	45
VAc7	Urban Carbon Sink	240
VAc6	Installation of 3 Green Resting areas	20
VAc18		565

VAc18 Smarts soils as substrate in Wastewater plant zone (C.): As the NWTP were not implemented in Valladolid, this Vac18 was defined to be implemented with the Stormwater Treatment Systems (SUDs Vac9, Vac10, Vac14: rain garden, detention pond and green filtering parking pavement)

Unfortunately, there is no KPI indicator that has been specifically calculated to monitor the effectiveness of smart land in the interventions carried out. Only CARTIF laboratory experiences on the formulation of this type of substrates are available since the initial of the URBAN GreenUP project.

However, the amount of soil added in each NBS is detailed below.

There have been made three supplies to the EMUPA provider.

EMUPA Smart soil	Smart soil (m3)	NbS
C1. S1 – Supply Parks and Gardens	245	Vac2, Vac5 Tree planting
C1. S2 - Supply Parks and Gardens	245	Vac2, Vac5 Tree planting
C1. S3 – Supply Green Corridor (on works)	665	Vac6 (resting areas), Vac7 (carbon sink), Vac15 (Cycle-pedestrian green paths), Vac19, Vac20, Vac21 (pollinators mod.)
	1.155 m^3	EMUPA

Smart soil as substrate in the carbon sink (VAc7)

One extra supply of Smart soil has ben made as part of the implementation works for the SUDs (Stormwater treatment systems) in march 2023.

	Smart soil (m3)	NbS
C2. Execution of SUDS	210 m^3	VAc14 Green Parking Pavements

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
▪ It is not easy to find "biochar" to get the composition of the Smart Soil.	▪ Schedule the supply with time in advance, so that the biochar can be bought and brought to Valladolid.
▪ Large volumes of soil require a large storage area.	▪ The soil was stored in the municipal nursery (Renedo) and in the supplier's own facilities. ▪ Soil application by experts, ensuring it does not mix into lower soil layers (buried)

▪ Smart soil has to be added only to the topsoil, or we will be burying the biochar. ▪The smart floor was supplied by a local provider but was applied on a construction site (Green Corridor)	▪Coordination between actors: The supplier and the site manager, to transport and extend the soil when necessary.
Economical barriers	How they have been addressed
Smart Soil is not cheap, compared to the traditional organic substrate for green areas	Financing of between €30-35/m3 with European funds
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
It is difficult to monitor the real effectiveness of this type of innovative solutions	
Economical barriers	*How they have been addressed*
Does not need maintenance	
Social barriers	*How they have been addressed*
Physically, the existence of this innovative soil is not appreciated, so it is difficult to communicate.	The writing of explanatory texts should be increased to disseminate the benefits of smart soil.
Environmental (including COVID)	*How they have been addressed*

2.1.10 VAc19, VAc21 Natural pollinator's modules

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0108; CH0401; CH0405; CH0408; CH0410; CH0602; CH0902; CH0903	VAc19/21_Natural pollinator's modules	CARTIF
CITY	*DATE OF IMPLEMENTATION*	
VALLADOLID	May 2022	VALL

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Natural Pollinator's Modules (NPM) are located on the city's green spaces, either on the outskirts or in the city centre. Their installation increases the connectivity and distribution of the existing urban green areas, supporting the rest of the green infrastructures that have been implemented. They also have a high visual impact since they are frequented areas for walking and outdoor activities. 21 NPM has been installed along the Green Corridor.

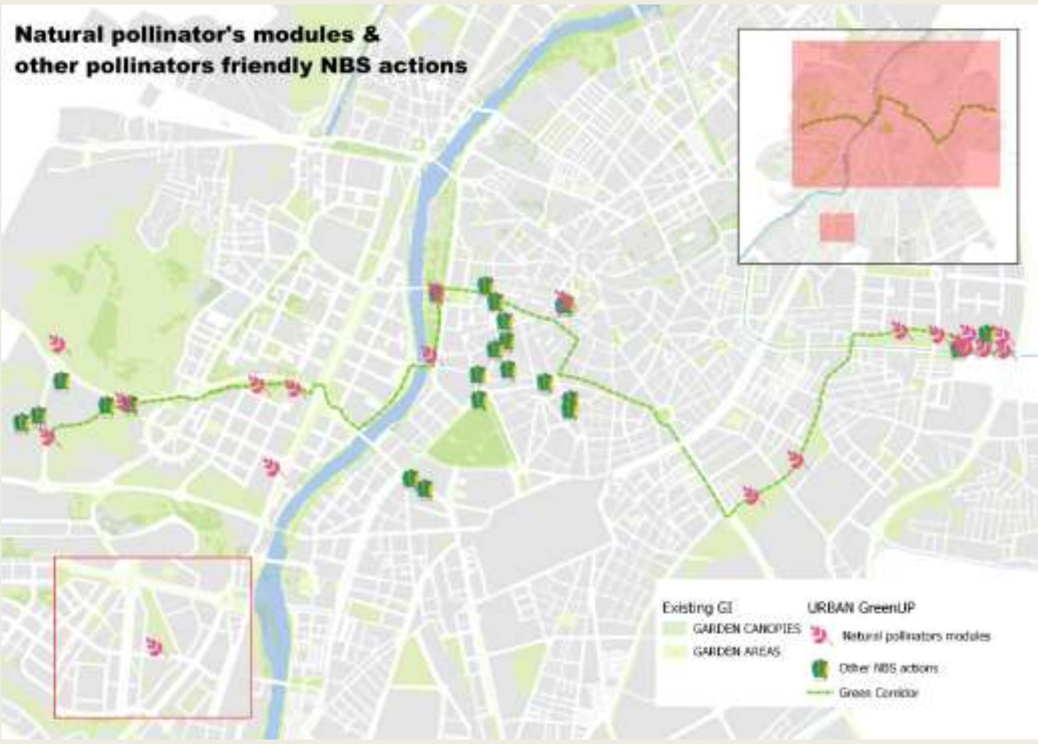


Figure 2.1. NPM location in the existing green urban areas, in relation to the Green Corridor line and other NBS actions.

Figure 2. NPM installed along the green Corridor

In terms of temperature decrease (CH0105) and heatwave risk (CH0108) where the CPMs have been installed, there hasn´t been a relevant impact due to the small size and amount of the modules.

Regarding the distribution of green spaces in the city, the neighbourhoods where these pollinators modules have been installed have seen an increase in the ratio of m2 of green spaces per inhabitant after the installation of the NBS of the URBAN GreenUP project. The figures for these neighbourhoods are shown in the following table. The impact has been particularly significant in the Pilarica district, with the greatest increase in green area compared to the baseline situation.

CH0401 Green Space Distribution (m2/capita)			
DISTRICTS	BASELINE	POST-INTERVENTION	INC (%)
Girón	124.96	125.38	<1%
Centro	19.75	19.86	<1%
Pilarica	13.09	21.56	64%

In terms of improved accessibility, the neighbourhoods where the natural pollinator's modules have been installed have also improved in this indicator. The effect is particularly significant in the case of the Centro district, mainly due to two factors: the number of NBS installed and the high population density in this area.

CH0403 Green Space Accessibility (m-min)			
DISTRICTS	BASELINE	POST-INTERVENTION	INC (%)
Girón	48.06	48.06	<-0%
Centro	102.88	51.22	-38.7%
Pilarica	75.99	75.03	-1.4%

However, the natural pollinator's modules per se have not generated a significant impact on these indicators, as they have been installed in the context of pre-existing green areas.

This NbS significantly impacts in pollinator species increase (CH01410) in urban areas by providing year-round flowers, shelter and watering places. The implementation of green infrastructure in 2021 already had a significant impact on several points of the city: Urban Carbon Sink (UCS); Natural Wastewater Plant (NWP); Orchards Parque Alameda (OPA); the City Centre (CCR).

It is expected that from 2022 with the implementation of the modules the impact will increase thanks to the development of vegetation that attracts pollinators.

		Butterflies	Flies	Beetles	Bees	Others	Average
UCS	2020	2,67	4,89	0,78	1,64	0,92	**9,97**
	2021	4,1875	3,00	0,28	2,19	1,47	**9,66**
NWP	2020	1,47	2,13	0,07	0,20	2,20	**3,87**
	2021	0,48	2,78	0,40	0,93	1,58	**4,58**
OPA	2020	0,48	1,81	1,71	1,38	1,10	**5,38**
	2021	1,25	3,57	0,30	4,14	1,39	**9,27**
CCR	2020	0,21	0,57	0,10	0,37	0,28	**1,25**
	2021	0,16	1,80	0,09	1,28	0,74	**3,33**

Figure 2.3. Summary of the average values according sampling area and type of pollinator

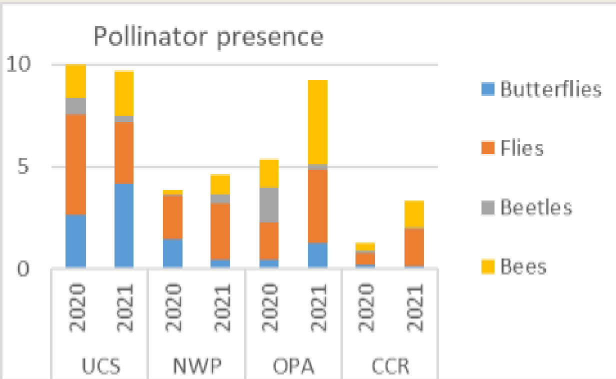


Figure 2.4. Pollinator presence average per year

On the other hand, the impact that these actions have had on the increase in walking and cycling could not be evaluated, as no conclusive data was obtained through the mobile application (CH0902 and CH0903).

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
1. Location Natural Pollinator's Modules (NPM) location may have some trees and/or bushes that can obstacle their installation. **2. Species selection** Some of the selected plant species were annual, which implies their annual replacement and therefore an increase in the maintenance costs. Also, some of them were difficult to find in the garden centres of the city. Also, some plants can be susceptible to developing diseases. Plant groups have to provide food for pollinators throughout the year, covering different times of flowering. **3. Hydric requirements** Some plants need plenty of water for their growth and development. It is needed continuous presence of water for the development of the bushes and flowers and to provide freshwater for pollinators and birds. **4. Planting time** The planting has been done in mid-May, with high temperatures, making it difficult for the roots to settle and increasing the susceptibility of the plants to heat and drought.	**1. Location** The existing species previous to the installation of the modules will be maintained, adding the smart soil and the new pollinator-friendly species. **2. Species selection** A final plant selection was made so that besides being pollinator-friendly, the correct size, native, antiallergic and with low hydric requirements, they also had to be easy to find in garden centres and of low maintenance. The plants that did not fit these requirements were dismissed, as well as those that are susceptible to developing diseases and included in the invasive species list. The plant group have been selected to secure different times of flowering to provide food for pollinators throughout the year. **3. Hydric requirements** Each pollinator module has to have a connection for irrigation and provide freshwater for pollinators and birds. In addition to being able to collect rainwater. **4. Planting time** It is recommended to do the planting on October-November or March-April when there are mid temperatures to facilitate the settlement of the roots in the new location.
Economical barriers	How they have been addressed
In relation to the selection of species, the implementation of plants with high maintenance, water requirements, annual replacement... implies a higher economic cost.	Selecting those species adapted to the climate of Valladolid and not very demanding in terms of water requirements.
Social barriers	How they have been addressed
Citizen lack of awareness about the operation and benefits of pollinator modules	Awareness campaigns have been carried out on social networks (e.g. during the bee day);

can lead to their rejection and/or fear of the presence of pollinators. High exposure of the modules to vandalism and deterioration due to the play of children/adults.	engagement campaigns e.g. workshops of insect hotels construction. One possibility is to change the name to “Flower module” to avoid initial rejection.
Environmental (including COVID)	How they have been addressed
Not applicable	Not applicable

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Not identified	
Economical barriers	How they have been addressed
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
Vandalism (graffiti and plants thefts). Non-acceptance of pollinators (for example insects and bees) in the city	Educational activities
Environmental (including COVID)	How they have been addressed
The lack of rain and drought complicate the growth of the plants.	Increasing the frecuency of irrigation systems, but it is important to take into account if it is sustainable. Plants replacement.

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

Not sustainable materials have been used to build the NPM as cement, complicating on some occasions the optimal development of the plants.

2.1.11 Vac20 Compacted pollinator's modules

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0108; CH0401; CH0405; CH0408; CH0410; CH0902; CH0903	Vac20_Compacted pollinator's modules	CARTIF
CITY	*DATE OF IMPLEMENTATION*	
VAL	May 2022	VAL

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

<u>Compact Pollinator's Modules</u> (CPM) are located in grey urban areas, with little vegetation and highly paved where gardens cannot be installed. Their installation increases the connectivity and distribution of the existing urban green areas, supporting the rest of the green infrastructures that have been implemented. 13 CPM units has been installed along the Green Corridor.

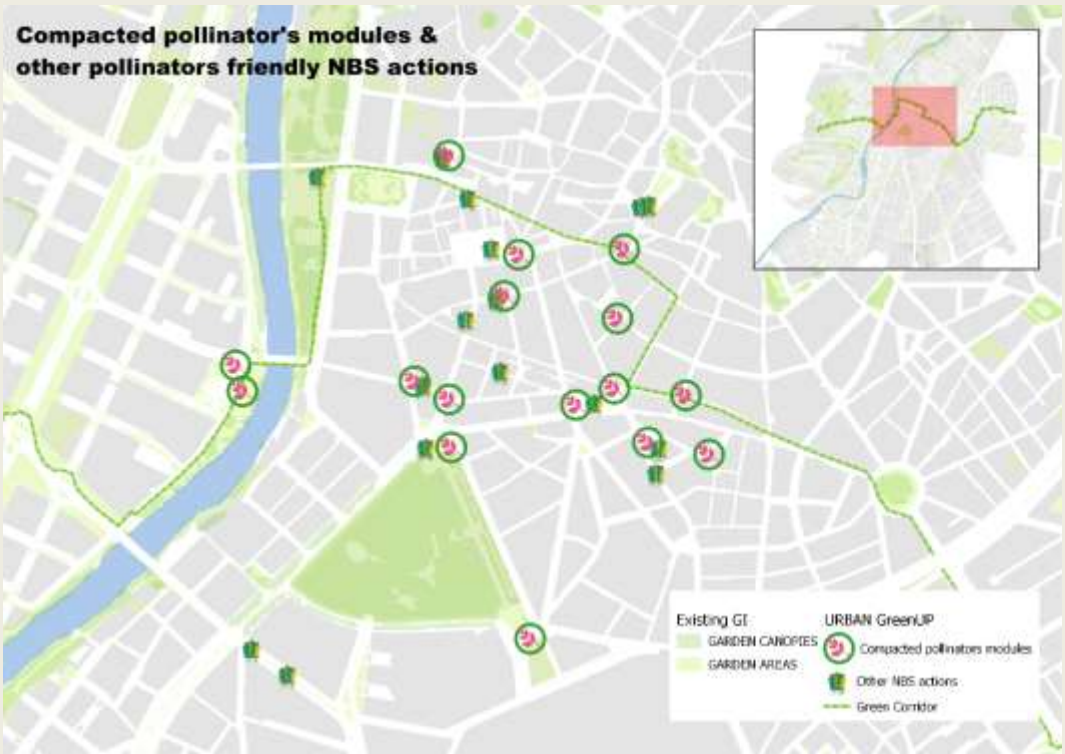


Figure 2.5. CPM location in the city centre in relation to the Green Corridor line and other NBS actions

Figure 6. CPM installed along the green Corridor

In terms of temperature decrease (CH0105) and heatwave risk (CH0108) where the CPMs have been installed, there hasn´t been a relevant impact due to the small size and amount of the modules.

Regarding the distribution of green spaces in the city, the neighbourhoods where these pollinators modules have been installed have seen an increase in the ratio of m2 of green spaces per inhabitant after the installation of the NBS of the URBAN GreenUP project. However, in Centro District the impact has not been high, as the surface of the NbS installed are low.

CH0401 Green Space Distribution (m2/capita)			
DISTRICTS	BASELINE	POST-INTERVENTION	INC (%)
Centro	19.75	19.86	<1%

In terms of improved accessibility, the neighbourhoods where green resting areas have been installed have also improved in this indicator. The effect is particularly significant in the case of the Centro district, mainly due to two factors: the number of NBS installed and the high population density in this area.

CH0403 Green Space Accessibility (m-min)			
DISTRICTS	BASELINE	POST-INTERVENTION	INC (%)
Centro	102.88	51.22	-38.7%

This NbS significantly impacts in pollinator species increase (CH01410) in urban areas by providing year-round flowers, shelter and watering places. The implementation of green infrastructure in 2021 already had a significant impact on the City Centre (CCR). It is expected that from 2022 with the implementation of the modules the impact will increase thanks to the development of vegetation that attracts pollinators.

		Butterflies	Flies	Beetles	Bees	Others	Average
CCR	2020	0,21	0,57	0,10	0,37	0,28	**1,25**
	2021	0,16	1,80	0,09	1,28	0,74	**3,33**

Figure 2.7. Summary of the average values in the City Centre according type of pollinator

On the other hand, the impact that these actions have had on the increase in walking and cycling could not be evaluated, as no conclusive data was obtained through the mobile application (CH0902 and CH0903).

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
5. Location The Compacted Pollinator's modules have to meet a series of requirements to be implemented in urban areas, in terms of aesthetic issues and good visibility of the modules and regarding their compatibility with the urban furniture, street functionality, pedestrian mobility and accessibility, temporal activities and stands of the street. **6. Size** Compacted pollinator's modules have little area available (4 m^2) for planting. **7. Species selection** Some of the selected plant species were annual, which implies their annual replacement and therefore an increase in the maintenance costs. Also, some of them were difficult to find in the garden centres of the city. Also, some plants were susceptible to developing diseases. Plant groups have to provide food for pollinators throughout the year, covering different times of flowering. Finally, some plants need different types of soil and treatments, in addition to the possibility of rejection between plants. **8. Hydric requirements** Some plants need plenty of water for their growth and development. It is needed continuous presence of water for the development of the bushes and flowers and	**1. Location** A specific study of each location was carried out to identify the possible impediments for the module's implementation. Several preliminary works were carried out to set up the area for the installation of the module, e.g. movement of planters or urban furniture. The modules that were incompatible with the initial location were relocated to a new one. **2. Size** Large-size trees and bushes were dismissed, selecting small-sized species that can leave space for other species and generate a diverse plant group. **3. Species selection** A final plant selection was made, so that besides being pollinator-friendly, the correct size, native, antiallergic and with low hydric requirements, they also had to be easy to find in garden centres and of low maintenance. The plants that did not fit these requirements were dismissed, as well as those that were susceptible to develop diseases and included in the invasive species list. Several plant groups have been created with different times of flowering to provide food for pollinators throughout the year. These plant groups also have similar soil and treatment needs, avoiding interactions

to provide freshwater for pollinators and birds. **9. Planting time** The planting has been done in end-May, with high temperatures, making it difficult for the roots to settle and increasing the susceptibility of the plants to heat and drought.	between plants, being able to be maintained individually and also form a floristic group. **4. Hydric requirements** Each pollinator module has to have a connection for irrigation and provide freshwater for pollinators and birds. **5. Planting time** It is recommended doing the planting on October-November or March-April, when there are mid temperatures to facilitate the settlement of the roots in the new location.
Economical barriers	How they have been addressed
In relation to the selection of species, the implementation of plants with high maintenance, water requirements, annual replacement... implies a higher economic cost.	Selecting those species adapted to the climate of Valladolid and not very demanding in terms of water requirements.
Social barriers	How they have been addressed
Citizen lack of awareness about the operation and benefits of pollinator modules can lead to their rejection and/or fear of the presence of pollinators. High exposure of the modules to vandalism and deterioration due to the play of children/adults.	Awareness campaigns have been carried out on social networks (e.g. during the bee day); engagement campaigns e.g. workshops of insect hotels construction. One possibility is to change the name to “Flower module” to avoid initial rejection. CPM are mobile and can be multifunctional; they can be used as access control for events, to prevent vehicles from entering, among other uses.
Environmental (including COVID)	How they have been addressed
Not applicable	Not applicable

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*

The manual irrigation of potted plants is not easy in some streets	Planning
Economical barriers	How they have been addressed
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
Vandalism (graffiti and plants thefts). Non-acceptance of pollinators (for example insects and bees) in the city	Educational activities
Environmental (including COVID)	How they have been addressed
The lack of rain and drought complicate the growth of the plants.	Manual watering would be an option, but it is very important to evaluate also if this is sustainable. Plants replacement

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

The pots are made of polyethene to meet the needs of strength and lightness but come into conflict with the sustainability of the solution. Many empty planters in the city could be reused or planters that only have seasonal plants could be converted to permanent planting, making them more sustainable and economical; recycled wood or damaged rubbish bins can be used for the new modules.

2.1.12 VAc22, VAc23 Green noise barriers

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0401; CH0403; CH0404; CH0408; CH0411; CH0703; CH0801; CH0901; CH1002	VAc22-23-Green noise barriers	SGR
CITY	*DATE OF*	

	IMPLEMENTATION	
VAL	4th March 2022 (M58)	

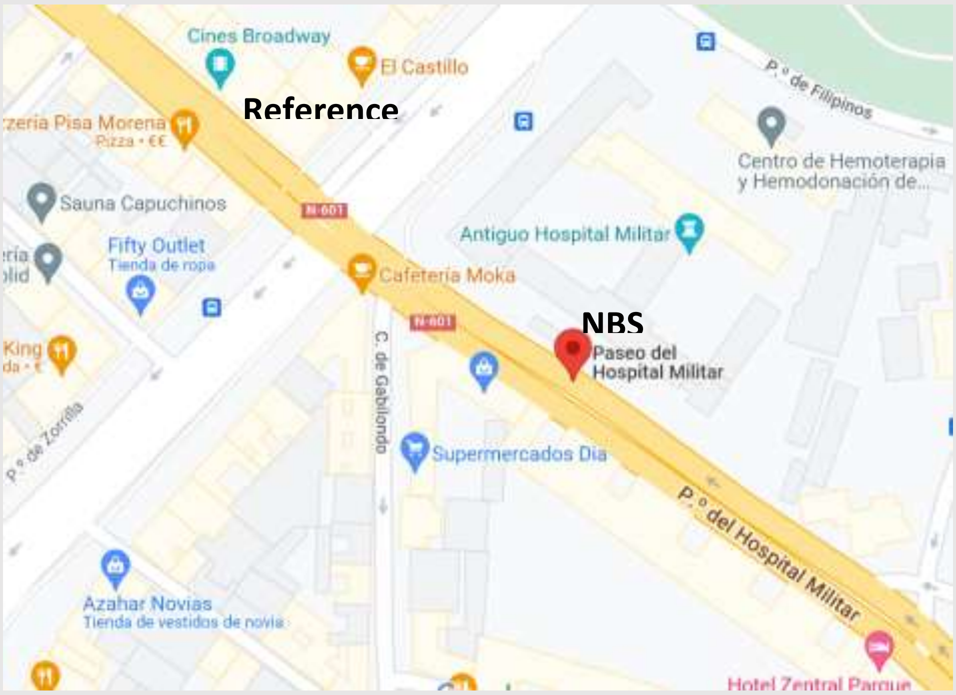
- ***Results and Discussion***

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

This intervention seeks to minimize the traffic noise that arrives to the homes in a zone of the city through a solution that also re-naturalizes the area.

The green sound barriers manage to introduce large vegetable surfaces without occupying large urban spaces. In this specific intervention we have used precast insulation panels that have been naturalized through an innovative vertical garden system. Vegetable surfaces are able to reduce noise thanks to the absorption of the substrate and the reflection of its leaves.

Noise reduction with this NBS is focused mainly in the effect of the traffic. So, noise monitoring is highly affected by the traffic conditions. Reference site has been selected in the same street at around 250m far from NBS intervention site. However, there is a cross street in the middle and it affects to the traffic distribution.



Current results do not show relevant impacts on noise reduction by the green noise barriers but data collected show a high variability. Regarding noise reduction, the impact was neglectable.

NBS Assessment. NBS site and reference site.	13/01/2022		18/03/2022		10/05/2022	
	Max.	Av.	Max.	Av.	Max.	Av.
Paseo del Hospital Militar, 34 (Ref.)	99,7	62,1	102	68,6	101	69,9
Paseo del Hospital Militar, 31 (NBS)	91,9	57,8	100,8	69,6	101,7	68,4
Difference	7,8	4,3	1,2	-1	-0,7	1,5

Regarding Green Areas Sustainability the result is Good, the score reached is 47.

For the Citizen perception KPI, the NBS has a bad score, an average rate of 3.2 (from 1-10).

Regarding the job creation KPI, 16 workers were needed.

- ***Conclusions and recommendations.***

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
It was difficult to find a location where the barriers could be placed. There was no electricity connection available for the remote control. Some of the traffic signs highs were lower than the barriers.	An area with vegetation between traffic lanes was chosen, so that a residual space was used, and with the need to reduce decibels. A solar panel was installed for the remote control. The traffic signs were raised.
Economical barriers	How they have been addressed
The budget was quite limited and it was not possible to reach the minimum length necessary for them to be effective.	The design was used in such a way that sections with and without vegetation were alternated, maximizing the length of the barriers.
Social barriers	How they have been addressed
At first, the citizens did not understand the need for the intervention and complained about the traffic restrictions due to the works.	Explanatory panels were placed to publicize the benefits of the NBS.
Environmental (including COVID)	How they have been addressed
No barriers detected.	No barriers detected.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	No barriers detected.
Economical barriers	How they have been addressed

The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
Vandalism (graffiti and plants thefts).	Education and awareness activities
Environmental (including COVID)	How they have been addressed
No barriers detected.	No barriers detected.

2.1.13 VAc24 Vertical mobile garden

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0108; CH0403; CH0404; CH0408; CH0410; CH0411; CH0703; CH0801	VAc24 Vertical mobile garden	SGR
CITY	*DATE OF IMPLEMENTATION*	
VAL	8th May 2020 (M36)	

- ***Results and Discussion***

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

A vertical mobile garden is a constructive system that allows to plant in vertical self-supporting structures. They are NBSs non static, they can be moved from their location so they can bring nature to many different places of the city. They also introduce resting areas where the citizens can seat, and even innovative solutions like solar energy powered fans that refreshes the users in summer.
We can differentiate two types of vertical mobile gardens: the first type are NBSs that need a water supply and drainage system, and the second type are NBSs that don't need any connection.


The main objective of these NBSs was to improve the connectivity between the different interventions along the city, and it has been achieved as the results of CH0402, Green Space Distribution, is good. It would be necessary to implement more of these small interventions to improve the results, but the impact of the NBSs done is positive.

Regarding Green Areas Sustainability the result is Bad, the score reached is 33.

For the Citizen perception KPI, the results are divided between the different interventions (from 1 to 10):

Letters Valladolid	Portugalete Sq	Santiago St	Santiago St
6.2	5.6	5.6	5.9

We can consider them positive.
The letters of Valladolid have become one of the most known interventions of the project URBAN GreenUP, publicizing the project to all the citizens.

- ***Conclusions and recommendations.***

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The anchors to the pavement intended to support the small gardens could not be installed due to municipal regulations.	They were placed in sets of 2 and 3 pieces so that they had enough weight to not need to be anchored to the ground.
The evacuation of the water in Plaza Zorrilla couldn't achieve the general network.	We perforated the slab and evacuate the water though the parking under the square.

Economical barriers	How they have been addressed
The cost of the vertical mobile garderns was higher than expected	Municipal funding has been increased.

Social barriers	How they have been addressed
Not identified	

Environmental (including COVID)	How they have been addressed
No barriers detected.	No barriers detected.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	No barriers detected.

Economical barriers	How they have been addressed
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.

Social barriers	How they have been addressed
Vandalism (graffiti and plants thefts).	Education and awareness activities

Environmental (including COVID)	How they have been addressed
No barriers detected.	No barriers detected.

2.1.14 VAc25 Green Facade

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0108; CH0109; CH0110; CH0401; CH0403; CH0404; CH0408; CH0410; CH0411; CH0501; CH0703; CH0801; CH1001; CH1002	VAc25 Green Facade	SGR
CITY	*DATE OF IMPLEMENTATION*	
VAL	30th June 2020 (M37)	

- ***Results and Discussion***

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

A Green façade is a constructive system that allows to plant vegetable species in the entire vertical surface of a façade. The structure that supports this system is affixed to the façade. On this structure are placed different layers and a substrate in which the plants grow.

Green facades are NBSs that introduce nature directly in the skin of the buildings, being a strong NBSs to naturalize the built environment. These kind of interventions has also a strong impact on the citizens as they are very visual icons in the city.

The design of this vertical garden is conditioned by the existing façade. The current façade has a very marked geometry of hexagons, and it has been decided to integrate this NBS into the building with the same geometry.

One of the objectives of this intervention was to achieve a collaboration between private and public sectors. It was a very positive project to get a win-win situation, where all the partners involved get very good results.

Green facades can function as an acoustic solution to dampen the noise from outside and increase the sense of peace and quiet, and also can protect your walls from direct solar radiation providing thermal insulation. Buildings covered with green absorb less heat during the day and lose less heat at night helping to protect them from the frigid winter temperatures. When combined with high-quality insulation, a green facade can improve the energy efficiency and lower the heating and cooling loads. A green facade can also provide needed habitat for several urban creatures, including birds, butterflies, spiders, and other insects. They can also improve the citizen health through more direct contact with the natural world in the places we inhabit. The plants used by a green facade can improve the air quality around, because they have the ability to capture fine particulate matter released by cars, factories, and other common pollutants of urban air. Plants can even capture fine particulate matter such as metals like lead and cadmium and move them into the soil and out of the air that we breathe. Because plants cause evaporation and transpiration, they also play an important role in lowering the summer temperatures around the buildings we live in, thus, reducing the urban heat island effect.

The irrigation included a re-circulation system to collect the leftover water. It was necessary to find a place in the interior of the building to allocate the installations. The species planted were selected to maximize the absorption of pollutants and minimize the water consumption.

Some KPIs were defined in order to measure all the explained benefits, but the results don´t show important impacts. The effect of the installed façade is not appreciable with the sensors installed because the green surface is not enough big to have a big impact in the quality of the air or biodiversity of the city area.

So, discussing about the obtained results, this NBS has not significant impact on the temperature reduction in the area. It could be due to the fact the vertical garden is installed quite high (around 7 m high of the lower part) from the floor where people are (and thermometers too).

Temperture reduction (ºC)	VALUE	UNITS	Year
Ex-ante (2019)	-1,45	ºC	
Ex-post (2020)	-1,44	ºC	
Ex-post (2021)	-1,29	ºC	
CH0105	**11**	**%**	**2021**

This NBS has not significant impact on the heatwave risk in the area. Anyway, it is difficult to assess the impact because data in different year differs quite a lot.

Heatwave risk reduction (%)	VALUE	UNITS	Year
Ex-ante (2019)	45 / 79%	Days /%	
Ex-post (2020)	50 / 100%	Days /%	
Ex-post (2021)	50 / 94%	Days /%	
CH0108	**+15**	**%**	**2021**

Regarding Green Areas Sustainability the result is Good, the score reached is 60.

Regarding energy saving we don’t have enough data to assure a significant energy reduction due to the NBS implementation. In one hand, the relative size of the NBS compared to the total building envelope, building complexity may have influenced thermal methodology approach. On the other hand, energy consumption approach may have been affected by many factors like: COVID lockdown, energy saving measures in lightning, changes in electricity provider, etc.

Regarding Annual levels of fine particles, $PM_{2,5}$ and PM_{10} the assessment of this KPI shows that this NBS has a positive influence in the PM2,5 and PM10 city background levels. The reference location also with city background levels is close to the NBS intervention site. The impact is Positive, significant.

For the Citizen perception KPI, the result is 6.2 that is very positive.

Regarding the job creation KPI, 10 workers were needed.

- ***Conclusions and recommendations.***

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The structural capacity of the façade was unknown.	It was decided to anchor the garden to a new substructure, that was also anchored to the building's slab. An agreement was reached with El Corte Inglés so that they took charge of this substructure, and the City Council of the rest of the garden.
Economical barriers	How they have been addressed
URBAN GreenUP budget insufficient.	El Corte Inglés and the Valladolid City council also financed the NBS implementation.
Social barriers	How they have been addressed
No barriers detected.	No barriers detected.
Environmental (including COVID)	How they have been addressed
The planned installation date of the garden coincided with the beginning of the lock down due to the pandemic.	The works had to be delayed until the sanitary measures allowed the works.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The pigeons eat some of the plants of the garden.	An ultrasound inhibitor was installed.
Economical barriers	How they have been addressed

The European project does not finance maintenance.	El Corte Ingles company was responsible of the green façade maintenance, thanks to an agreement between the Valladolid City Council
Social barriers	How they have been addressed
No barriers detected.	No barriers detected.
Environmental (including COVID)	How they have been addressed
No barriers detected.	No barriers detected.

2.1.15 VAc26 Electrowetland

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0206, CH0207, CH0208 (old:CH0211; CH0212; CH0213)	Vac 26. Electrowetland	LEITAT
CITY	*DATE OF IMPLEMENTATION*	
VALLADOLID	July 2021	

Results and Discussion

Table of results of each Challenge scoring that applies to this NBS. The final output is a final scoring for each Challenge.

An Electrowetland is a natural wastewater treatment system that generates electricity from the oxidation of the organic matter. It is based on a conventional Horizontal Subsurface Flow Constructed Wetland (HSSF CW) in which electrodes are introduced. Therefore, it consists on a planted and permanently flooded gravel basin in which wastewater flows horizontally from one side to the other of the system crossing the electrode layer.

Electrodes implementation and the electrical connection stablished through them stimulate the development of an exoelectrogenic biofilm able to transfer the electrons resulting from the degradation of the organic matter to an external circuit thus generating electricity. Wastewater treatment efficiency is also improved resulting in lower wetland surface requirements when compared to conventional wetlands.

To date, very few Electrowetland pilot-scale experiences have been reported and therefore, the design specifications stablished in this project constitute a proposal based on the conclusions obtained in the lab-scale experiments already published.

Images of the Electrowetland in winter (left) and late spring- beginning of summer (right)

The impact has been particularly significant in terms of organic matter (COD and BOD) and total suspended solids (TSS).

COD: CH0206

EX ANTE		EX POST					
2020 (Jan-May) M36	**Baseline tot**	**2021**	**2022 (Jan-May) M60**	**2022 (Jun-Dec)**	**2022 tot**	**2023 (Jan-May) M72**	**Post Tota**
73,60	73,60	6,94	4,52	2,95	3,56	1,13	3,88

BOD:CH0207

EX ANTE		EX POST					
2020 (Jan-May) M36	**Baseline tot**	**2021**	**2022 (Jan-May) M60**	**2022 (Jun-Dec)**	**2022 tot**	**2023 (Jan-May) M72**	**Post Tota**
25,71	25,71	4,16	2,01	0,78	1,29	0,15	1,87

TSS:CH0208

EX ANTE		EX POST					
2020 (Jan-May) M36	**Baseline tot**	**2021**	**2022 (Jan-May) M60**	**2022 (Jun-Dec)**	**2022 tot**	**2023 (Jan-May) M72**	**Post Tota**
7,36	7,36	1,24	1,01	0,98	0,97	0,19	0,80

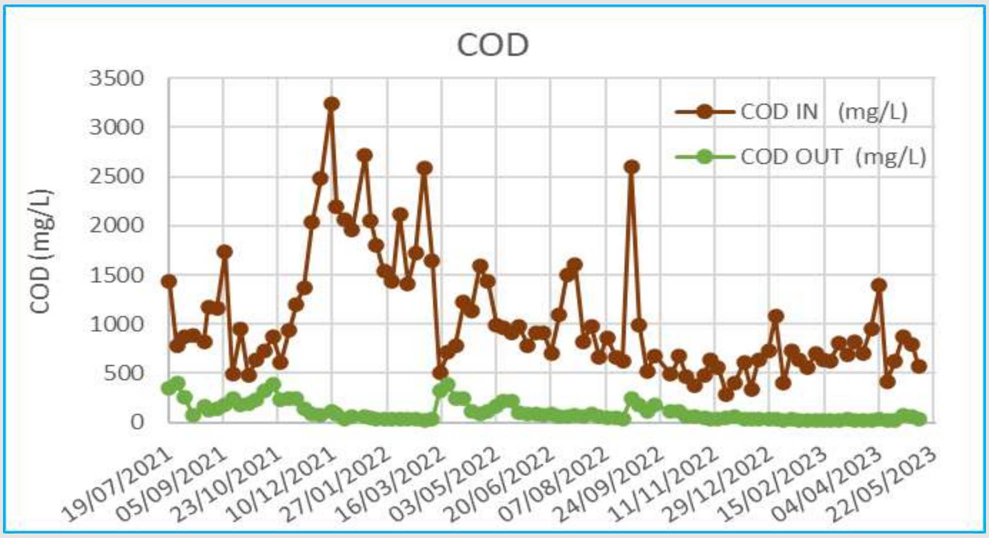
Results are expressed in kg NUTRIENT/year

Challenge	KPI	Weight	Results
CH0206	-94.73*	3.8	359.96
CH0207	-92.73*	3.8	352.36
CH0208	-89.17*	3.8	338.85

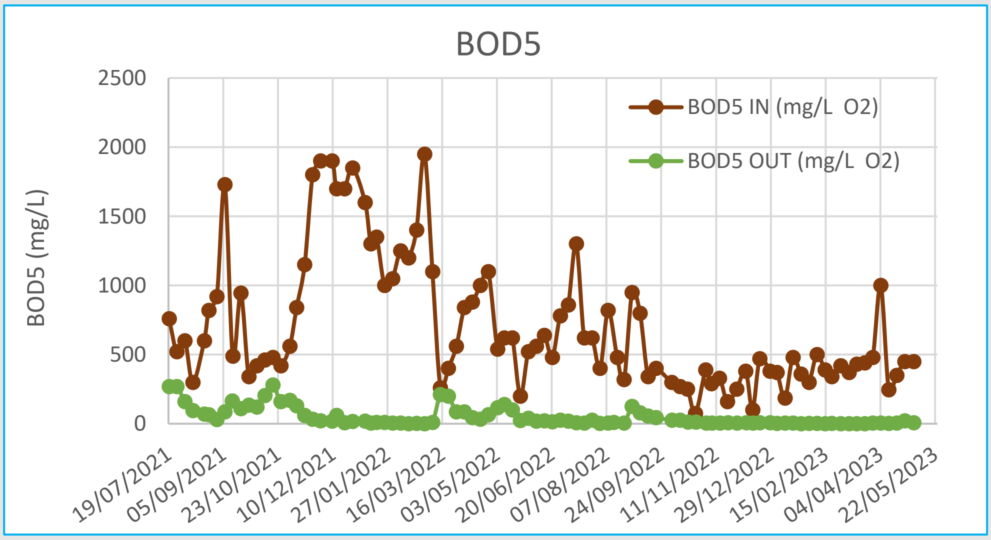
*Negative result due to a removal efficiency. To calculate result, the absolute value has been taken.

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

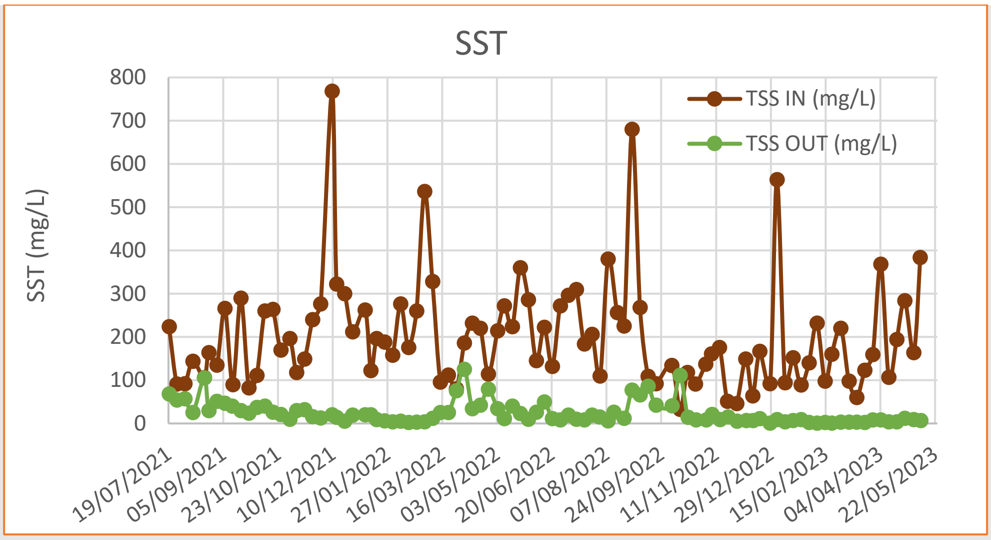
Evolution of COD degradation is being shown on the right, from the beginning of the implementation of electrowetland until now. We can see that COD was reduced by an average of 89%.



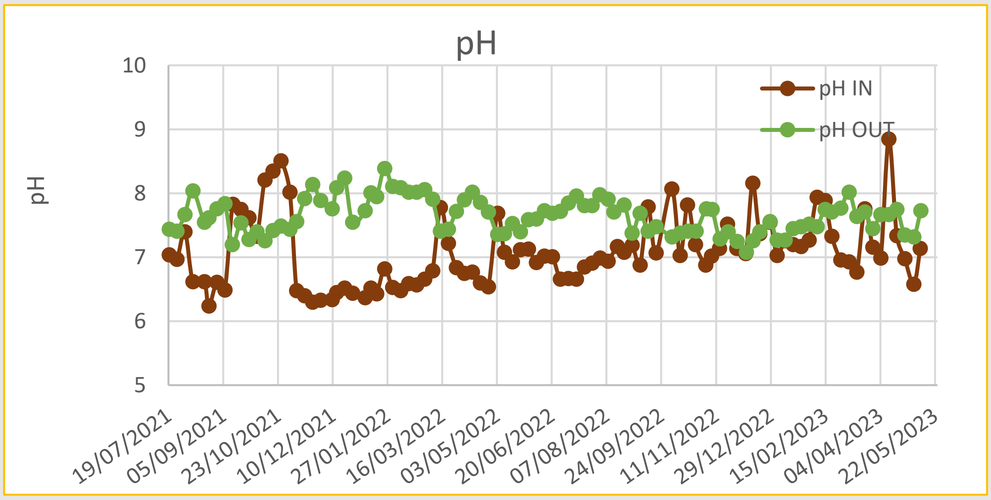
Evolution of BOD degradation is being shown on the left, from the beginning of the installation of electrowetland until now. BOD was reduced by 90.4%.

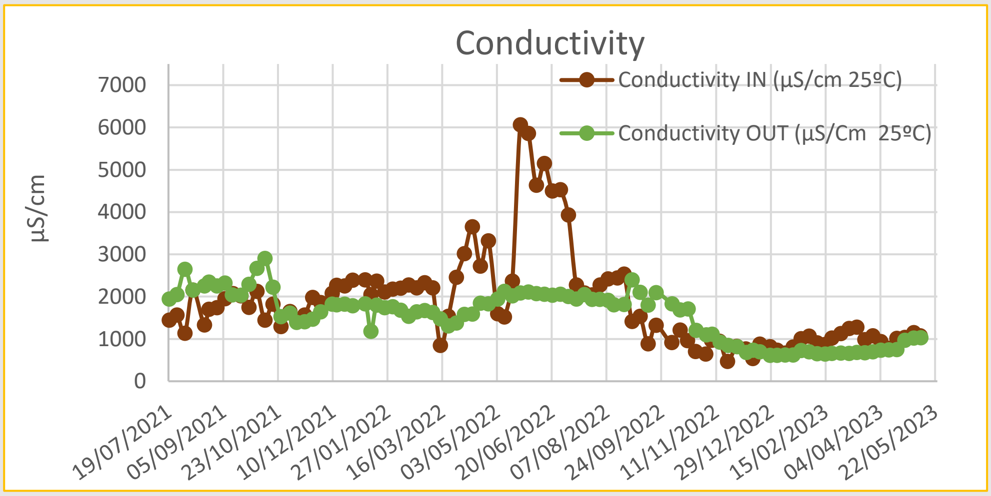


Evolution of SST reduction is being shown on the left, from the beginning of the installation of electrowetland until now. Total suspended Solids were reduced by 81%.

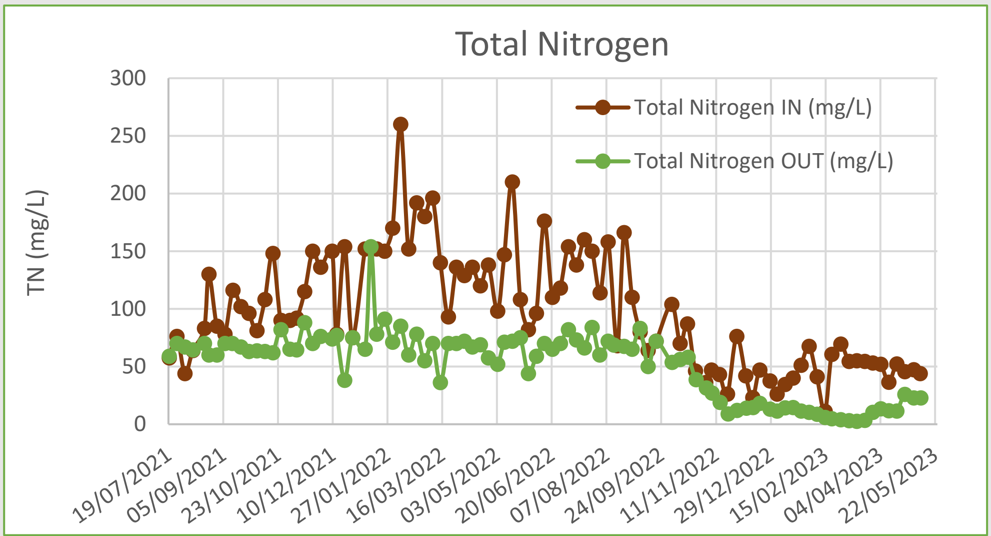


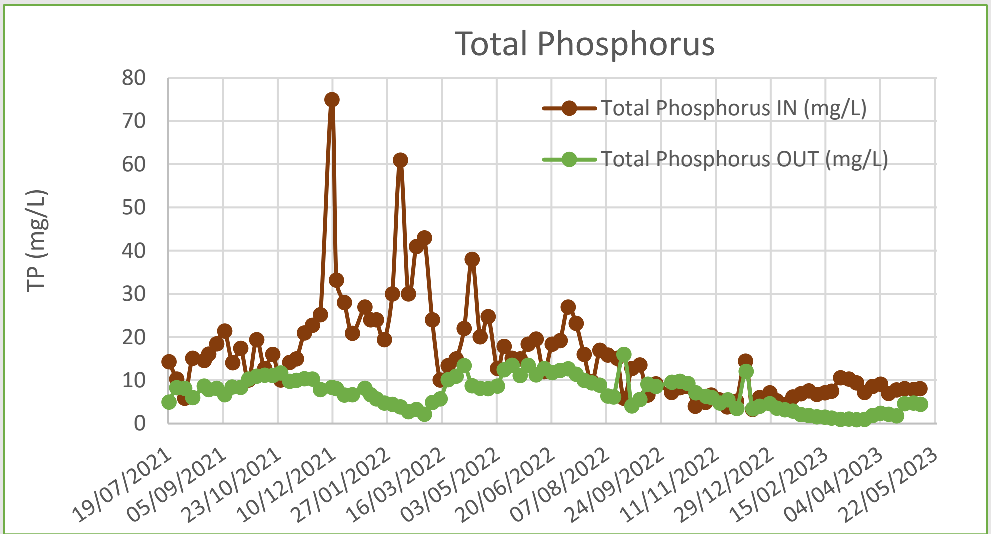
A part from the KPI, other parameters were monitorized (nutrients, pH and conductivity). Evolution of pH and Conductivity is being shown above. There is a tendency to stabilize pH and conductivity in the electrowetland effluent over time.





Evolution of nitrogen and Phosphorus reduction is being shown on the left, from the beginning of the installation of electrowetland until now. There is a removal of 45% of N and 41% of P probably due to plant or bacterial immovilization in the rhizosphere.





Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Delay from the company in charge of the construction of the Electrowetland caused by band leaks	Construction company fixed the problem.

Economical barriers	How they have been addressed
LEITAT had to carry with costs that weren´t contemplated in the project.	We accorded with Cartif a possible solution where we had some budget to subcontracting during the year extension.

Social barriers	How they have been addressed
Not identified.	Not identified.

Environmental (including COVID)	How they have been addressed
Due to the COVID situation, the implementation of the electrowetland intervention was delayed a few months.	The construction started as soon as the situation allowed.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Sampling frequency and maintenance of the electrowetland.	We had to modify the subcontract with the company in charge of maintenance of the electrowetland.

Economical barriers	How they have been addressed
Not identified.	Not identified.

Social barriers	How they have been addressed
Not identified.	Not identified.

Environmental (including COVID)	How they have been addressed
Not identified.	Not identified.

2.1.16 VAc27 Green Covering Shelter

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0108; CH0401; CH0403; CH0404; CH0408; CH0410; CH0411; CH0501; CH0703; CH0801; CH1001; CH1002; CH1003	VAc27 Green Covering Shelter	SGR

CITY	*DATE OF IMPLEMENTATION*
VAL	24th February 2020 (M33)

- ***Results and Discussion***

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

A Green covering shelter is a very light type of green roof. This type of green roof has a very light and thin substrate to avoid that the roof has a lot of weight. The vegetation should be small.

The implementation in this case has been done over a fruits and vegetables market very used in the city, having a big impact in the collective knowledge of citizens.
The intervention does not occupy the entire surface of the shelters since they have structural problems and are not able to support more weight. The chosen vegetation is small so there will not be added too much weight, and it needs little maintenance.
The quickness and cleanness of installation is another critical point: due to the interruption of the activity of the market during the installation works, the election of a light an easy system has been crucial. Because of that, a sedum turf and mineral wool is proposed.
Economically it’s a solution a little bit under the range for that kind of systems in the market.

Discussing about the results, it has not significant impact on the temperature reduction in the area. It could be due to the fact the green covering layer has been installed on an existing shadow structure and the implementation of the vegetation on it has not significant impact over the area temperature in the hot season.

Temperture reduction (ºC)	VALUE	UNITS	Year
Ex-ante (2019)	0,66	ºC	
Ex-post (2020)	2,46	ºC	
Ex-post (2021)	0,57	ºC	

CH0101	**14%**	**%**	**2021**

Regarding heatwaves, the results indicate a slightly reduction in risk.

Heatwave risk reduction (%)	VALUE	UNITS	Year
Ex-ante (2019)	67 / 248%	Days /%	
Ex-post (2020)	50/ 1000%	Days /%	
Ex-post (2021)	44 / 191%	Days /%	
CH0108	**- 57**	**%**	**2021**

Regarding Green Areas Sustainability the result is Good, the score reached is 50.

Regarding Annual levels of fine particles, PM2,5 and PM10 , the assessment of this KPI indicates that the Green covering shelter (VAc27) has no influence on PM2,5 and PM10 concentration in the urban air. It is a location with relevant traffic levels (also in the reference site).

For the Citizen perception KPI, the average rate is 6.1, that is positive.

Regarding the job creation KPI, 22 workers were needed.

For business revenue, it's clear that the affluence of consumers to the market has been increased, although it is true that indicators have not been possible to calculate as they are not tangible.

- ***Conclusions and recommendations.***

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The load capacity of the structural support was very low.	We implemented a very light hydroponic system and we didn't cover the full roof.
Economical barriers	How they have been addressed
URBAN GreenUP budget insufficient.	Municipal funding has been increased.
Social barriers	How they have been addressed
No barriers detected.	No barriers detected.
Environmental (including COVID)	How they have been addressed

No barriers detected.	No barriers detected.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	No barriers detected.
Economical barriers	How they have been addressed
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
No barriers detected.	No barriers detected.
Environmental (including COVID)	How they have been addressed
No barriers detected.	No barriers detected.

2.1.17 VAc28 Green Roof

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0109; H0110; CH0401; CH0403; CH0404; CH0408; CH0410; CH0411; CH0703; CH0801; CH1001; CH1002; CH1006	VAc28 Green Roof	SGR
CITY	*DATE OF IMPLEMENTATION*	
VAL	15th August 2020 (M39)	

- ***Results and Discussion***

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

A Green Roof is an intervention in the external upper covering of a building which the main objective is to favour the growth of vegetation keeping the habitability conditions in the rooms below. The inclination of the roof must be between 0 and 45 degrees.

In this specific intervention, two kind of substrate were used:

- A substrate with granular organic and mineral components, similar to that of a traditional garden, with peat and compost. It has been mixed with a high percentage of coconut fiber chosen specifically for the project as it increases moisture retention, avoiding waterlogging and minimizing the need for irrigation. The vegetation of this type of organic-mineral substrate is made up of different plant species, such as succulent plants, sedum or shrubs.
- A second substrate, which is part of a pilot project, made of felted sheep's wool. By using a product of the sheep industry as a substrate, a new life is being given to the material, until now considered waste. This solution is part of the 'Lanaland' project to promote the Circular Economy. In this case, the planted vegetation was two native species of the sedum type, with low nutrient requirements and adapted to local climatic conditions.

Regarding energy saving, we don’t have enough data to assure a significant energy reduction due to the NBS implementation.

Regarding Green Areas Sustainability the result is Good, the score reached is 60.
For the Citizen perception KPI, the average rate is 4.2 (from 1 to 10), that is a bit low.
Regarding the job creation KPI, 17 workers were needed.
Regarding Consumption benefits, the implementation have had an impact on the consumption/buying behavior of customers, making them aware of the need to buy quality and proximity products grown in the building's vegetable orchard.
The impact has been positive, not only in the awareness of market customers and the environment due to the orchard, but also has had a positive economic impact by attracting more customers as can be seen in the data obtained by the occupancy of the parking.

- ***Conclusions and recommendations.***

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The building is old and the roof had a lot of problems regarding rainwater filtration.	The project included a building renovation of the roof.
Economical barriers	How they have been addressed
No barriers detected.	No barriers detected.
Social barriers	How they have been addressed
No barriers detected.	No barriers detected.
Environmental (including COVID)	How they have been addressed
No barriers detected.	No barriers detected.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	No barriers detected.
Economical barriers	How they have been addressed
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
No barriers detected.	No barriers detected.
Environmental (including COVID)	How they have been addressed
Pigeons eats the plants and seeds.	The roof is protected with a net to avoid pigeons enter in.

2.1.18 VAc29 Green Shady Structures

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0108; CH0401; CH0403; CH0404; CH0408; CH0410; CH0411; CH0501; CH0703; CH0801; CH1002; CH1003	VAc29 Green Shady Structures	SGR

CITY	DATE OF IMPLEMENTATION
VAL	26th February 2021 (M45)

- ***Results and Discussion***

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

This NBS is thought to bring shade to places where is not possible to plant trees or install another kind of NBSs that require more space. This NBS can be fixed to the facades of the buildings on the street or by posts fixed to the sidewalk.

This intervention has been a great success of the project, attracting many tourists and also citizens to visit the street and revitalizing its activity. It has been possible to bring shadow in a place where was not possible to plant trees or any kind or vegetation. In addition, an abandoned kiosk at the beginning of the street was restored to be the facilities room.

It is a green infrastructure cover with a stretched textile material in which a substrate with vegetable seeds is placed so that they grow on the support itself. The installation necessary for the operation of the intervention, such as irrigation or lighting wiring, will be suspended from an interwoven aluminum lattice beam from the awnings to the installation room.

The implementation of the green shady structures in the Santa María St. provokes the **reduction of the average temperature of around 2 ºC**. It is a relevant impact considering that are average temperatures.

Temperture reduction (ºC)	VALUE	UNITS	Year
Ex-ante (2019)	0,16	ºC	
Ex-ante (2020)	1,33	ºC	
Ex-post (2021)	-0,72	ºC	
CH0101	**-2,02ºC / -154%**	**%**	**2020 as reference**

Considering **daily maximum temperatures, it was detected a 7ºC reduction**, that is a very relevant impact of this intervention. Additionally, if maximum daily temperatures are compared between reference site and NBS site during the hot season, a change in the pattern clearly appears. Temperatures in Santa María St. go under temperatures in Montero Calvo St. due to the Green shadow structures implementation.

The results also indicates that the NBS provokes a **relevant reduction of the heatwave risk** in the street.

Temperture reduction In maximum daily temperatures(ºC)	VALUE	UNITS	Year
Ex-ante (2019)	-0,23	ºC	
Ex-ante (2020)	5,14	ºC	
Ex-post (2021)	-2,02	ºC	
CH0108	**-7,16ºC / -139%**	**%**	**2020 as reference**

Temperture reduction (ºC)	VALUE	UNITS	Year
Ex-ante (2019)	35 / 130%	Days /%	
Ex-ante (2020)	38 / 760%	Days /%	
Ex-post (2021)	16/ 70%	Days /%	
CH0108	**- 60**	**%**	**2021**

Regarding Green Areas Sustainability the result is Good, the score reached is 47.
Regarding Annual levels of fine particles, PM2,5 and PM10 the assessment of this KPI seems to indicate that the implementation of the green shady structures in the Santa María St. has no influence in the PM2,5 and PM10 concentration in air.
For the Citizen perception KPI, the average rate is 5.7 that is positive.
Regarding the job creation KPI, 22 workers were needed.
For business revenue, it’s clear that the affluence of consumers to the street has been increased, although it is true that indicators have not been possible to calculate as they are not tangible.

- ***Conclusions and recommendations.***

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The fire department regulations required a minimum height for the passage of the truck in an emergency. During the implementation process, one of the facades was being restored.	The final solution adopted is based on the need for the intervention to be light, at the appropriate height for the passage of the truck, and also removable in case of emergency. The design was changed to avoid any anchor direct on that facace.
Economical barriers	How they have been addressed
It was planned to implement shades in two streets, but the budget was limited.	The intervention was done in only one street.
Social barriers	How they have been addressed
There were many complaints from the neighbors before the intervention was carried out due to doubts about the possible results, as it was a totally innovative action.	Informative meetings were held with the neighbors, the reasons for the intervention, the benefits, etc. were explained to them. Once the action was carried out, there have been no more claims.
Environmental (including COVID)	How they have been addressed
Due to the COVID restrictions the end of the construction works was delayed.	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
This NBS is very innovative, so some technical problems occur during the operational phase: water leaks, irrigation failures…	Remote control systems to anticipate problems
Economical barriers	How they have been addressed
No barriers detected	No barriers detected
Social barriers	How they have been addressed

Some citizens doesn´t like the intervention and make noise about it	Educational and communication activities to increase the knowledge of the advantages of NBS
Environmental (including COVID)	How they have been addressed
No barriers detected	No barriers detected

2.1.19 VAc30 Urban Garden biofilter

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105 CH0108 CH0401 CH0405 CH0406 CH0410 CH0411 CH0413 CH0417 CH0501 CH0502 CH0508 CH0505 CH0602 CH0703 CH0801 CH0902 CH0903	Urban Garden biofilter	CAR
CITY	*DATE OF IMPLEMENTATION*	
VALLADOLID	Nov-21	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

In general terms, vegetation affects air quality mainly through the removal of air pollutants (PM, NO_2, O_3) through dry deposition. However, vegetation can also reduce air temperature, which reduces the emission of BVOCs and slows down the creation of secondary pollutants such as O_3 [5].

Despite the limited contribution compared to the overall production of air pollutants emissions at the city level, measures to tackle air quality by enhancing green infrastructure can be considered a good investment due to the number of co-benefits that they produce and their contribution to amenity value over time[6] but with a limited impact at district or city scale. Green infrastructures are beneficial but most of them do not represent a solution to remove completely air pollution from cities.
It should be kept in mind that trying to reduce the concentration of a pollutant once it is already diluted is much more inefficient than when acting directly on the source. In this

[5] http://ec.europa.eu/environment/basics/health-wellbeing/noise/index_en.htm / Wang, Y., Bakker, F., de Groot, R., Wortche, H., Leemans, R., 2015b. Effects of urban trees on local outdoor microclimate: synthesizing field measurements by numerical modelling. Urban Ecosyst. doi:10.1007/s11252-015-0447-7.

[6] Grote et al., 2016. Functional traits of urban trees: air pollution mitigation potential. Front Ecol Environ 2016; doi:10.1002/fee.1426.

sense, biofilter is an NBS acting partially on the source and so its impact on air quality can be higher.

Urban Garden Biofilter. This NBS is composed by three main elements, the extractor system to extract the polluted air from underground car park, the plenum section to distribute the air under the Biofilter and the Biofilter itself to clean the air and metabolize pollutants. It is composed by several layers for support, pollutants absorption and protection and finally is covered by vegetation. The absorption/capture of air pollutants is made by the different layers and the metabolization of these pollutants is made by the soil microbiota and the vegetation. This NBS has been developed by CARTIF in a previous research project.

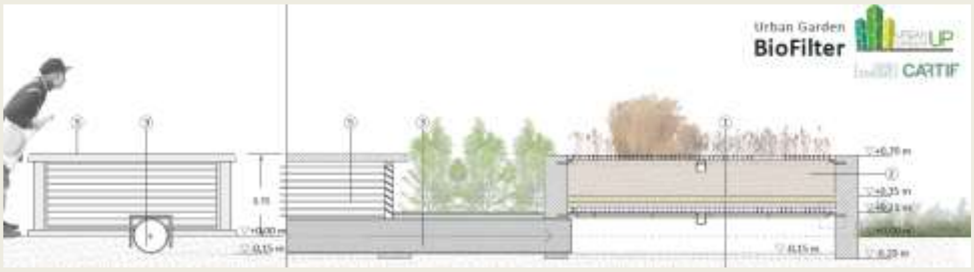
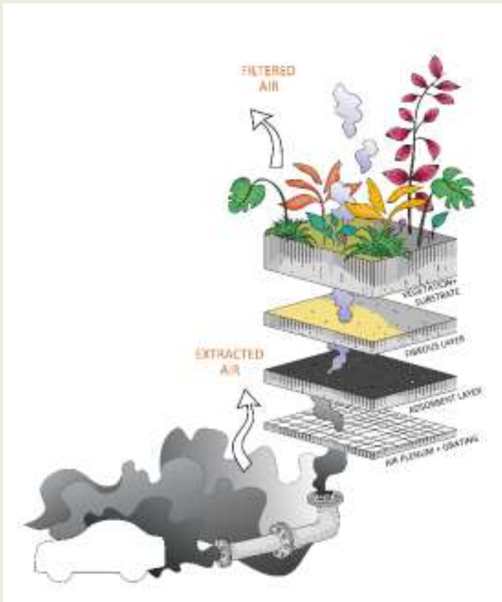


Figure 8. CARTIF. URBAN GreenUP Project. Biofilter cross section

This NBS can be adapted to existing car parks or tunnels or included in the design of new infrastructures. It can be created a new line for indoor air extraction and conduct it to the plenum zone. Then, the air will be cleaned by passing thought the biofilter materials (see Figure 8). Due to the specific design of the biofilter layers, pressure drop of the filter is very low and simple extractor fan is used.

The Urban garden biofilter (see Figure) for capturing PM and NO_X from underground car parks was implemented in Valladolid in November 2021.

Figure 9. Biofilter system schema and pilot unit built in Valldolid (VAc30).



The main KPI planned to assess the impact of the biofilter is CH0508 Emissions trends of NO_2 because it can capture most of NO and NO_2 passing through it. However, this KPI was not possible to measure outside because economic and technical reasons. For that reason, a new way to estimate the impact was developed. Additionally, PM emissions reduction was also estimated. This parameter is also important regarding urban air pollution and the biofilter is capable to capture PM from air. As the reference, $PM_{2,5}$ will be used but PM10 is reduced with similar values.

Due to the fact of not having the outdoor air quality monitoring station and so, not having information about the outdoor air quality, the evaluation of the impact of the system has been done by estimating the amount of pollutants capture by the biofilter. This result has been defined by considering the pollutants capture yields determined in the laboratory and the concentrations inside the indoor car park. Additionally, the extractor fan flow rate is 3.000 m^3/h functioning 12 hour a day between 8 a.m. and 8 p.m. (4380 hours). Annual mean concentrations and Capture yields are shown in Table 2 for NO_X (NO and NO_2) and PM. Then, the annual amounts of PM, NO and NO_2 are calculated.

Table 2. Biofilter summary results.

Parameter	Annual mean concentration indoor (µg/m³)	Biofilter Capture yield (%)	Annual amount capture (kg)
$PM_{2,5}$	4,64 (max. 252)	95	0,06
NO	237 (max. 2543)	95	3,13
NO_2	51 (max. 734)	99	0,70

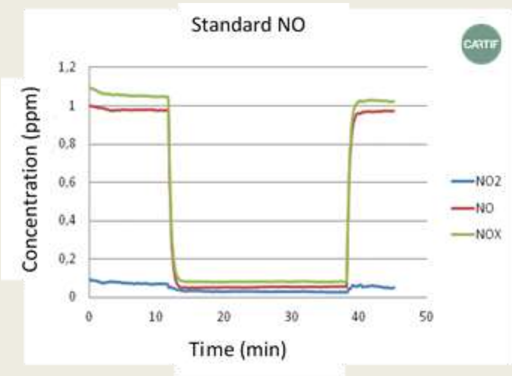


Figure 10. Standard lab test to removal evaluation of the NO by the biofilter.

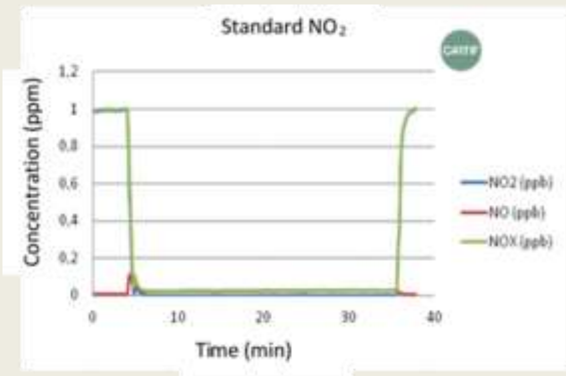


Figure 11. Standard lab test to removal evaluation of the NO by the biofilter.

The monitoring period was between apr-21 and nov-21 for the baseline and nov-21 and dic-22 for the implementation phase. Annual mean values are similar for both periods.

Another interesting study proposed to be carried out in the future with system involves the indoor car park operator. It is focused to establish if the presence of the fan extractor of the biofilter and its continuous operation during peak hours can produce a reduction in the energy consumption of the general ventilation system of the car park. The car park has a big extractor system that acts when CO concentration is higher than 100 ppm. The idea is to reduce the number of times that system starts because of the constant ventilation of the biofilter system (less powerful).

As an example, it can be seen the CO concentration evolution per hour for the 7 days of the week during April 2021 (before of the biofilter installation, see Figure 12) in the graph below. Then, the graph below shows the CO concentration evolution per time and day of the week during April 2022 (see Figure 13).

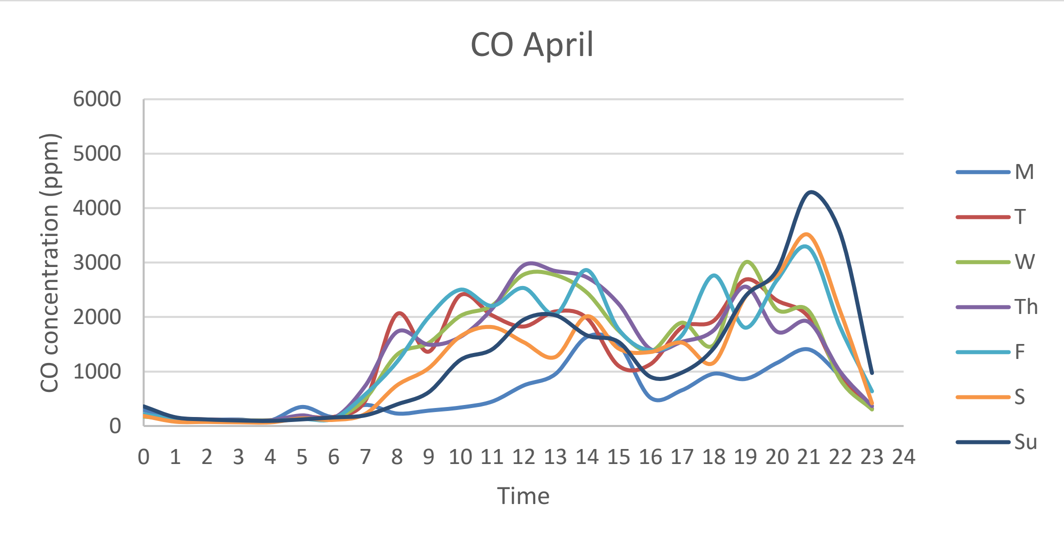


Figure 12. Evolution of the CO concentration through the days of the week in April 2021

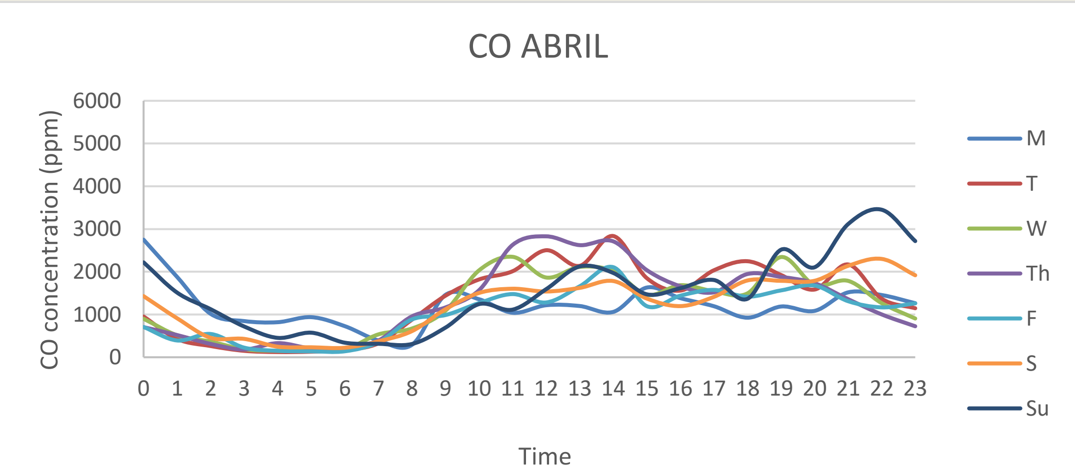


Figure 13. Evolution of the CO concentration through the days of the week in April 2022

As it can be seen, even when it is needed to keep in mind the possible variations introduced by the COVID19 pandemic situation and the weather, the profile after the intervention is softer than previously. It is important to highlight the average values was higher in 2022 probably due to the increment in the occupancy of the car park because of the restrictions decay in the city. Average value for the CO concentration was 1.183,8 ppm (peak value 8.289,2 ppm) in April 2021 and 1.271,8 ppm (peak value 7.909,8 ppm) in April 2022.

However, some important issues related with the biofilter installation can be analysed from the car park point of view. The level of occupancy of the car park has increased since the installation of the air quality monitor due to the restrictions decay of the pandemic situation.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
It is difficult or practicably impossible to have the final construction plans of existing underground car parks. So, it was hard to design the pipes to conduct the polluted air from inside the car park to the plenum zone of the biofilter.	Increasing the efforts to carry out frequent visits to the car park and also, finally, changing the selected car park.
It is hard to measure and determine the impact of the biofilters filtering the air expelled by extraction systems of the indoor car parks.	Define alternative KPIs or protocols to estimate the capture of pollutants and use this information as reference result more than the improvement in the outdoor air quality.
Difficulties to install outdoor air quality monitoring station outside the indoor car park for the lack of electrical connection for the tool. Finally, due to several reason was not possible to install it and no outdoor measurements were collected in the outlet section of the biofilter.	

Economical barriers	How they have been addressed
It is more expensive to implement a biofilter in an existing underground car park than install it in a new one.	Results will be used to promote the installation of biofilter in the new underground car parks.

Civil works to construct the biofilter implies a reduction in the income of the underground car park.	Company of the car park can be compensated with participation in the communication and awareness campaigns.
Social barriers	How they have been addressed
Exposed surface of the biofilter is footed by people and affects to the porosity and the air pressure drop. Most of vegetation planted was vandalized during the two months after construction.	Installing trámex covering to be footed over the soil of the biofilter. Replant Plant creeping species under the trámex covering.
Environmental (including COVID)	How they have been addressed
Lockdown delayed designing, tendering and construction process. Construction works are usually delayed by the social events in public spaces.	Proper planification as every civil works in public spaces with sufficient time buffers.

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Once the biofilter is constructed, it is not easy to carry out operations in the soil structure due to the trámex covering.	Periodically can be needed some big interventions to partially move the tramex covering.
Economical barriers	How they have been addressed
The implementation costs of the Urban Garden are not very high by themselves. However, when considering its installation in an existing parking lot, expenses may increase due to the need for additional interventions. In the case of a newly constructed parking lot or as part of its renovation, the additional cost of the garden is very low.	Hence, it is important to introduce the solution into the catalog managed by the municipality so that for renovations or new parking lots being considered, the installation of biofilters in air outlets is always included.
Social barriers	How they have been addressed
Vandalism such as damages in plants or graffities.	This is an endemic problem that affects the city and many infrastructures in general. It needs to be addressed in an integrated

	manner by the municipality, but it is still unresolved. If necessary, protective barriers can be created. However, this vandalism does not affect the functionality of the system.
Environmental (including COVID)	How they have been addressed
Heavy rain floods the biofilter container and temporary inactive the pollutants capture.	Usually the periods with rain are not the ones needing better air quality levels.

2.1.20 VAc31 Urban orchard, VAc32 Community composting

RELATED KPI CODE	*NBS NAMEs*	*PARTNER*
CH0406 CH0408 CH0409 CH0410 CH0602	VAc31-Urban orchard VAc32-Community composting	VAL
CITY	*DATE OF IMPLEMENTATION*	
VAL	VAc31 Urban orchard: September 2020 VAc32 Community composting: Sept. 2020	

Results and Discussion

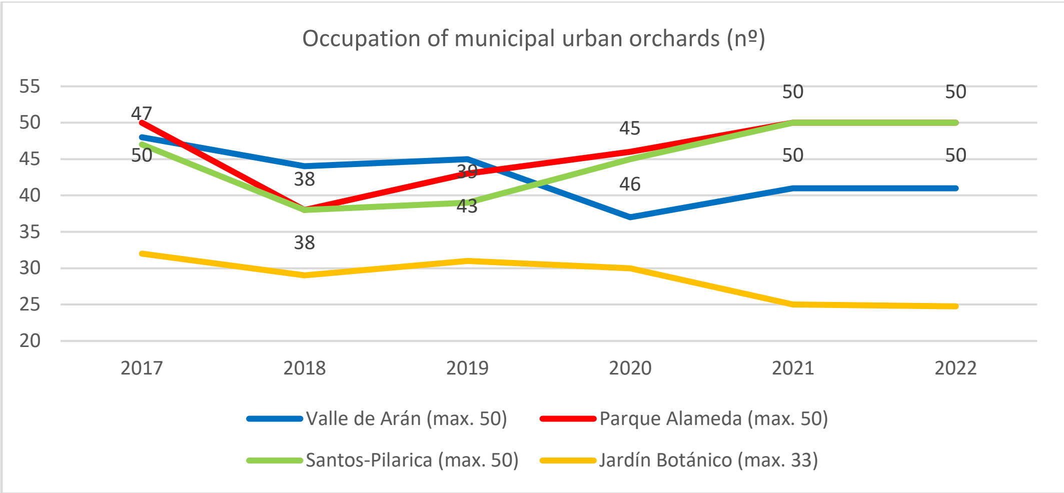
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

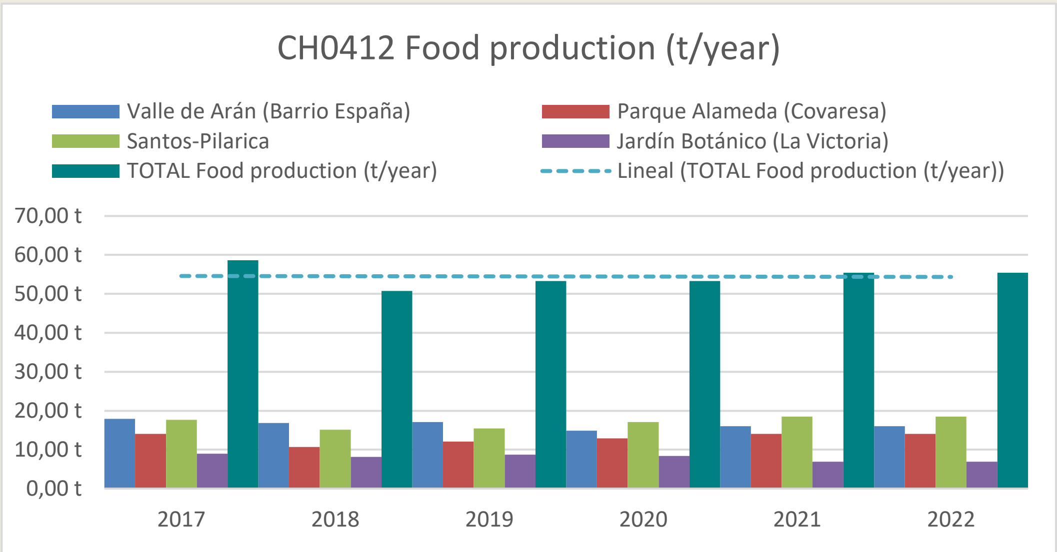
In Valladolid a network of urban orchards already exists in four different locations. These orchards are intended to produce organic fruits and vegetables that are primarily cultivated and consumed by vulnerable populations (such as the unemployed, retired, disabled, and people with special needs). The Valladolid City Council is in charge of managing these public spaces, there are plots for both individual (single beneficiary) and community orchards (manage by associations or groups).

Two interventions have been carried out in the municipal gardens. On the one hand, implementation of drip irrigation. The City Council provided all the materials, which were installed with the support of the gardeners themselves. Likewise, 4 community composting facilities have been installed in each of the four orchards.

The KPI that represent mostly the effectiveness of the solutions is CH0412: Food production. This KPI is estimated with a production factor, that was calculated with real measurements during 2018-2019 with the support of the entity that was in charge of the management of the urban orchards, INEA. Average food production indicator was calculated by INEA in a municipal plot where the gardeners weight the food (Communitary orchard 'Valle de Arán').

Production rate (2018)	Units
240	m2
1.346	kg
5,61	kg/m2





CH0413 Pollinators species increase: Orchards Park Alameda (OPA) is one of the sampling areas that CARTIF has been monitoring about pollinators presence.

		Butterflies	Flies	Beetles	Bees	Others	Average
OPA	2020	0,48	1,81	1,71	1,38	1,10	**5,38**
	2021	1,25	3,57	0,30	4,14	1,39	**9,27**

CH0417- Sustainability of green areas: Sustainability concept integrates social, economic, cultural and environmental aspects. The evaluation of the improvements in the urban orchards received a scoring of "Good" interventions, according to CH04174 methodology.

		Ex-post				
Name	**NBS**	Ecosystem	Construction /operation	Society	**Score**	**Category**
Urban orchards						
Urban orchards	VAc31 Urban orchard	13,3	6,7	20,0	40	Good
	VAc32 Community composting	6,7	26,7	20,0	53	Good

Multiple benefits are analysed, related with well being and improvement of the mental health of the gardeners. However, there have not been launched specific surveys to the gardeners about their level of satisfaction.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Drip irrigation (supply) and community composting (work) are simple installations easy to execute	

Economical barriers	*How they have been addressed*
Insufficient budget from a single area of the City Council to cover the entire cost for the implementation	Distribution of spending between the budget of two areas in the City Council (Environment and Innovation Areas)
Social barriers	*How they have been addressed*
None - Facilities very well received by users (gardeners).	
Environmental (including COVID)	*How they have been addressed*

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
▪ The management of the drip irrigation system requires control, since due to the high water pressure, all the orchard plots have to be irrigated at the same time. ▪ A lid was installed to cover the vegetable waste that is composted, however, the compost bins are usually full and the lid does not close.	▪ Coordination between gardeners thanks to the management of the City Council. ▪ The lid is kept open when it cannot be closed
Economical barriers	*How they have been addressed*
None - Management carried out by the gardeners themselves, with a very low maintenance cost.	
Social barriers	*How they have been addressed*
Use of community composting facilities by only a few gardeners.	Although they are not used by all gardeners, the use of the infrastructure is maximum
Environmental (including COVID)	*How they have been addressed*

2.1.21 VAc35 – Vac 42 Non-technical actions

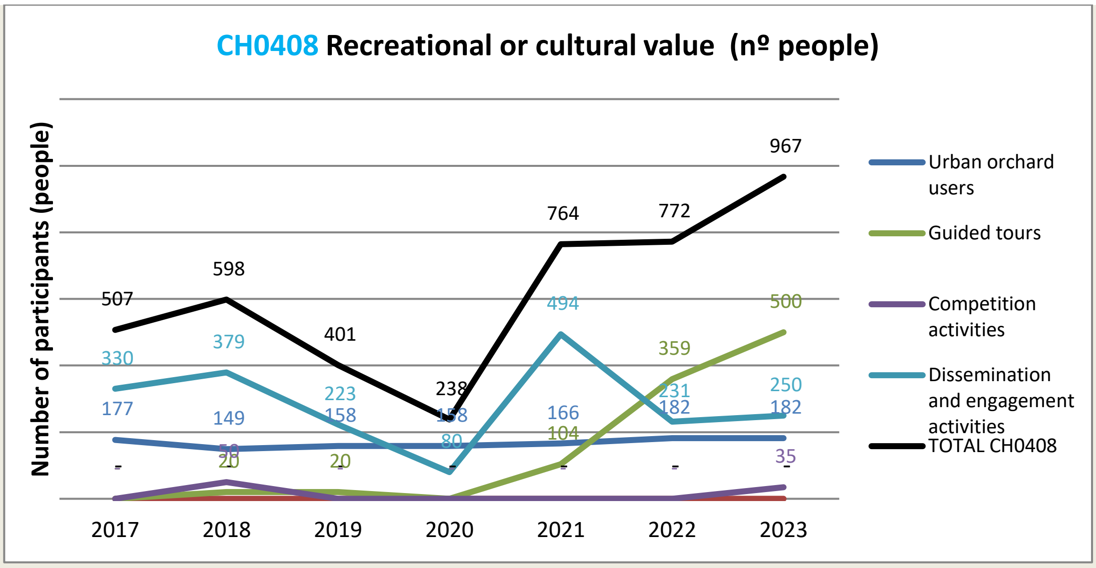
RELATED KPI CODE	*NBS NAMEs*	*PARTNER*
CH0406; CH0408; CH0602; CH0701; CH0702; CH0703; CH0802; CH0803;	VAc35 Educational path in floodable park area; VAc36 Urban Farming Educational activities; VAc37 Engagement Portal for citizen; VAc38 Sponsoring activities; VAc39 Promotion of ecological reasoning and intelligent; VAc40 Single desk for RUP deployment; VAc41 Support to citizen project of NBS; VAc42 City mentoring strategy (Staff Exchange activities)	VAL
CITY	*DATE OF IMPLEMENTATION*	
VAL	From 2018 to 2023	

Results and Discussion

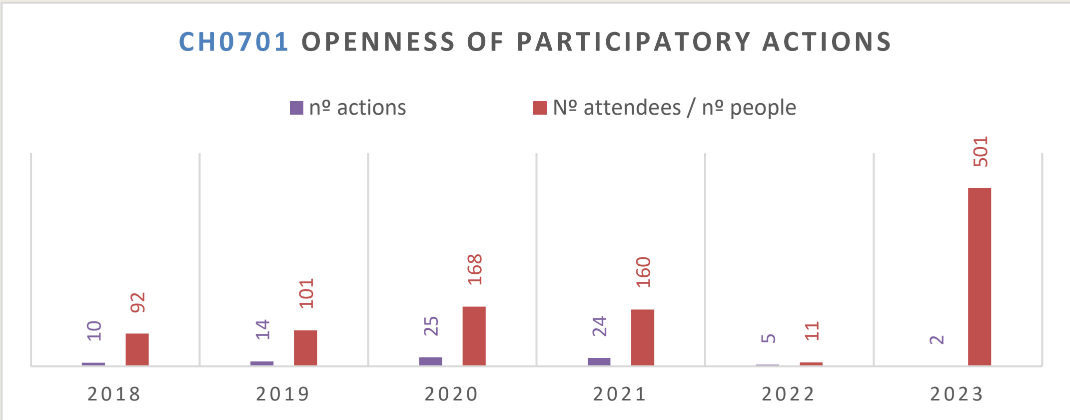
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Since the beginning of the URBAN GreenUP project, numerous non-technical activities have been achieved, related to communication, awareness and citizen participation.

CH0408Recreational or cultural value: Valladolid City Council record the recreational (number of visitors, number of recreational activities) or cultural (number of cultural events, people involved, children in educational activities) value of the non-technical activities that there are organized in the city about the URBAN GreenUP project. The database includes the Participants in guided tours, urban gardeners, competition activities as well as D&E activities such as forum, courses, conferences, congresses, lectures, workshops, seminars, meetings, and symposia.

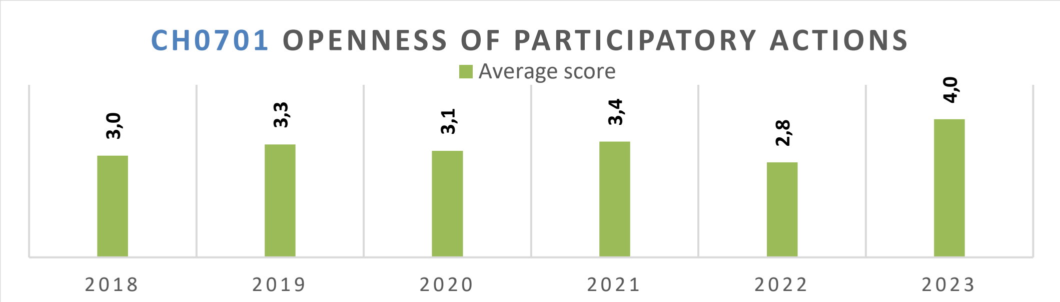


CH0701 Openness of participatory processes: It is based on the participation actions delivered in the city of Valladolid. There are defined two steps, data collection and data evaluation: Step 1. Data collection and characterization: we complete a database completing the Participation techniques, Degrees of participation, Co-creation & Co-production agent. And a second Step 2. which is the Evaluation of participatory processes: Quantitative evaluation (nº processes /year); and a final Qualitative evaluation (Score 1-5)

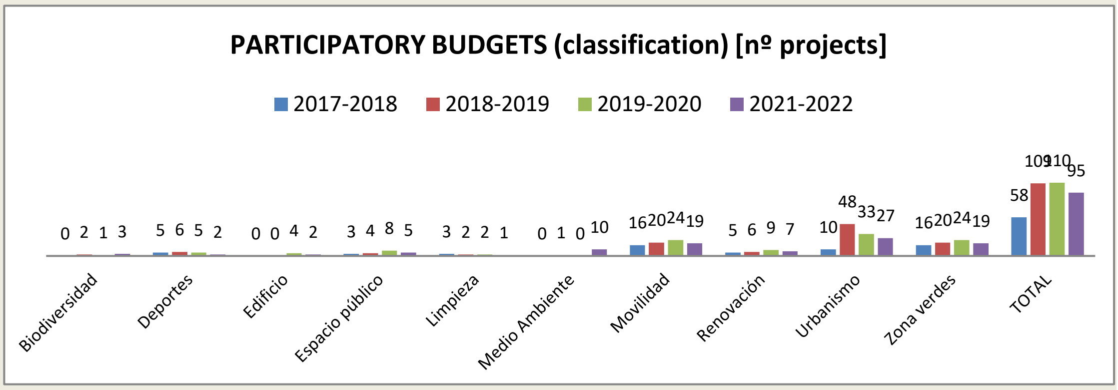


The number of attendees increased a lot in 2023 due to the organization of the "Walks for Innovation", focused on scholars and senior people.

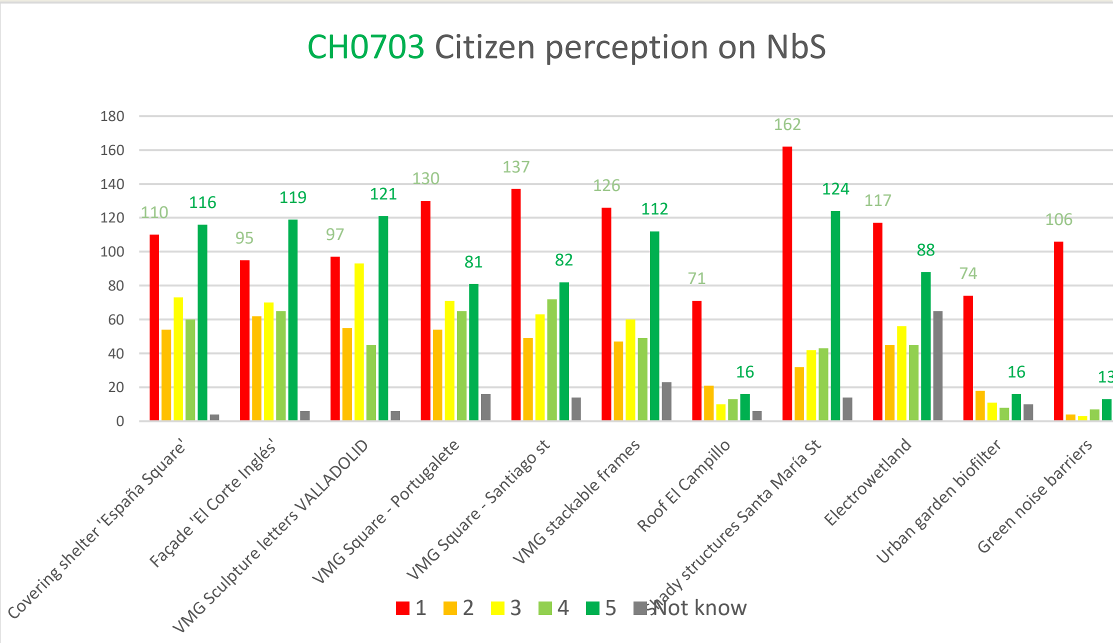
The following table shows that the average score of the openness of the participatory actions has increased to an average of 4 points in 2023.



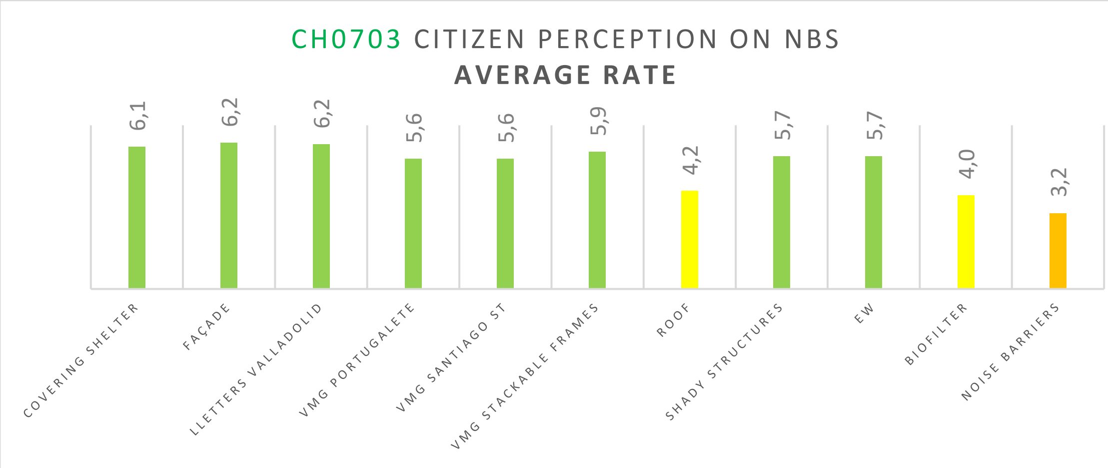
According to the participative budgets, the following chart shows that the most common areas that the citizens are asking for investment are Urban planning (*urbanismo*) and Green areas (*zonas verdes*).



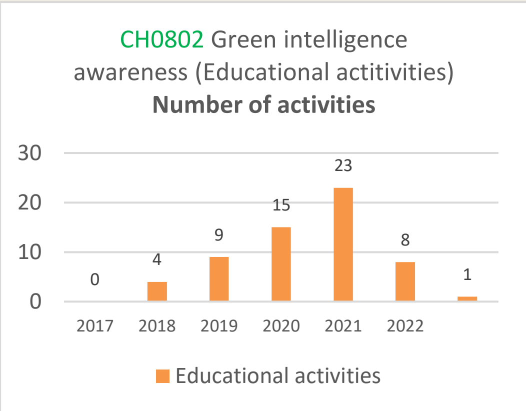
CH0703 Citizen perception: There were launched a survey about the perception and opinion of the citizens on the NbS implemented with the URBAN GreenUP project (2021-2022) [online survey fulfilled by almost 300 inhabitantes]. A likert scale (0-5) shows that the NbS are scored with 1 point or 5 points mostly. Innovative NbS solutions are either loved or disliked.

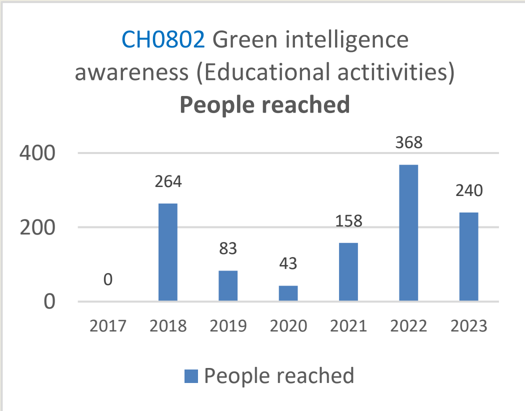


On average rate, citizen perception is 5,30 / 10 (Good perception). We have verified that recently implemented solutions are less liked than when the solutions take longer: that is, citizens reject the new but later they get used to it and like it.

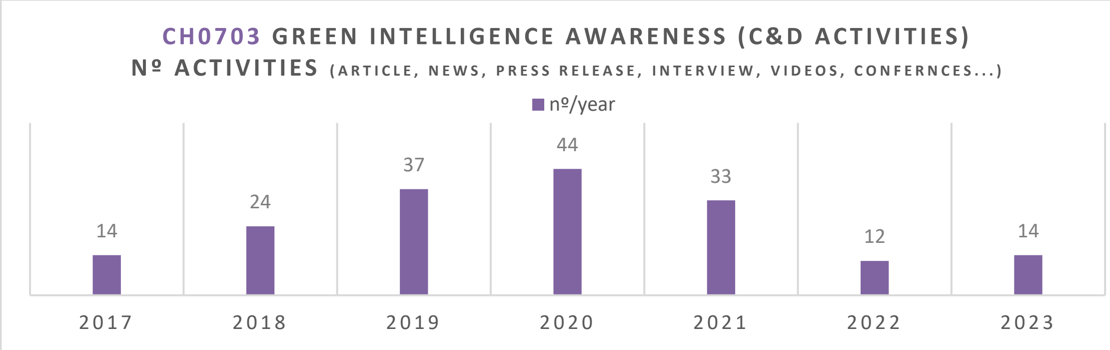


CH0802Green intelligence awareness (Educational activities): Altough the number of in situ activities has been lower due to the Covid 2019 pandemic, the people reached has been increasing, specially before pandemic. However, in 2022 and 2023 a consistent number of people were reached again.

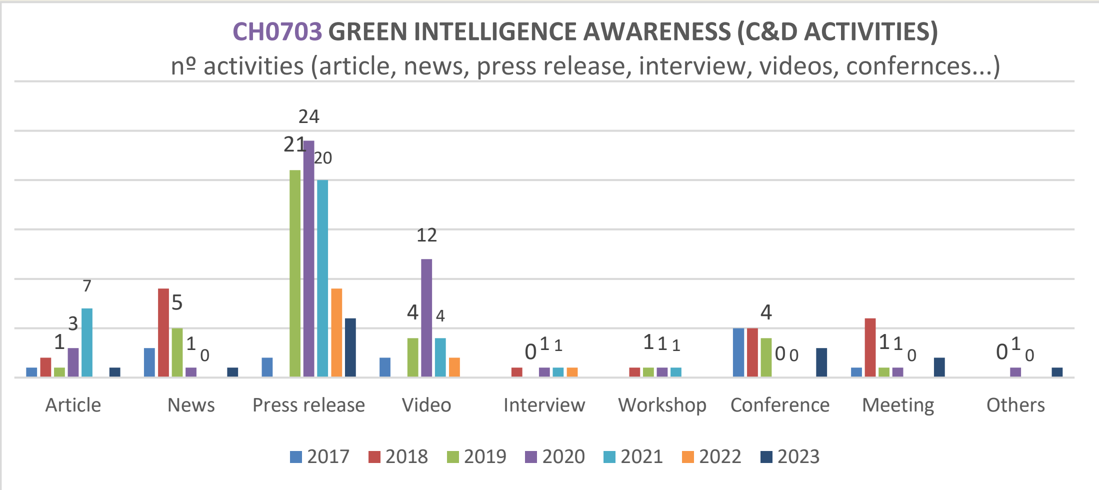




CH0803Green intelligence awareness (Communication and Dissemination activities): Communication actions have been constant throughout the project, with an increase in 2020-2021 of the number of activities (press release, articles, news, interviews, videos, etc) due to the years of full implementation of the solutions.



The following chart illustrates the type of communication and dissemination activities.



Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The online satisfaction survey was carried out with Google Form and was posted on the municipal website for several months, but finally the link was lost and citizens were unable to answer any more.	The link to the online survey could be reopened. The results were analyzed with the surveys received up to that moment.

Economical barriers	*How they have been addressed*
There is no European URBAN GreenUP budget for local communication, which is so important to reach citizens.	Financing with own municipal budget for communication.

Social barriers	*How they have been addressed*
Online surveys are not available to all citizens.	Analysis of the bias involved in conducting only an online survey.
Environmental (including COVID)	*How they have been addressed*
The pandemic impacted non-technical stocks the most. There was no face-to-face activity.	The online actions were carried out during 2020-2021 and in 2022 little by little we began to do more face-to-face or mixed actions (online-face-to-face).

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Economical barriers	*How they have been addressed*
There is no European URBAN GreenUP budget for local communication, which is so important to reach citizens.	Financing with own municipal budget for communication.
Social barriers	*How they have been addressed*
Citizens do not find much interest in the actions communicated by the Valladolid City Council	Greater efforts in more communication actions, improve the language, reach more media (press, social networks), etc.
Environmental (including COVID)	*How they have been addressed*
During the pandemic (2021-2021) no face-to-face action was carried out, but there were many online actions.	Online actions instead of face-to-face

Other comments

European projects have a lot of impact at the local level, but it is necessary to invest budget and efforts in many communication actions, in different media as well as aimed at various stakeholders (young people, the elderly, etc.)

2.2 Liverpool

2.2.1 Lac1 Cycle and pedestrian route

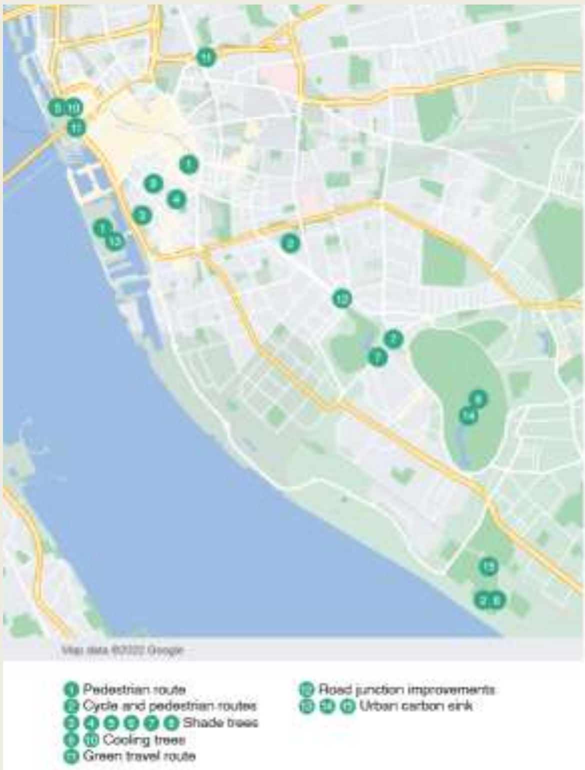
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0106; CH0108; CH0111; CH0403; CH0404; CH0501; CH0502; CH0503:CH0504; CH0505; CH0508; CH0509; CH0511; CH0512; CH0508; CH0602; CH0702; CH0705; CH0801; CH0902; CH0903; CH0904; CH1002; CH1004; CH1005;	Cycle and pedestrian route LAc1	LIV/UoL/CFT

CITY	*DATE OF IMPLEMENTATION*
LIV	Completion of all works July 2020

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location of Pedestrian and Cycle Routes



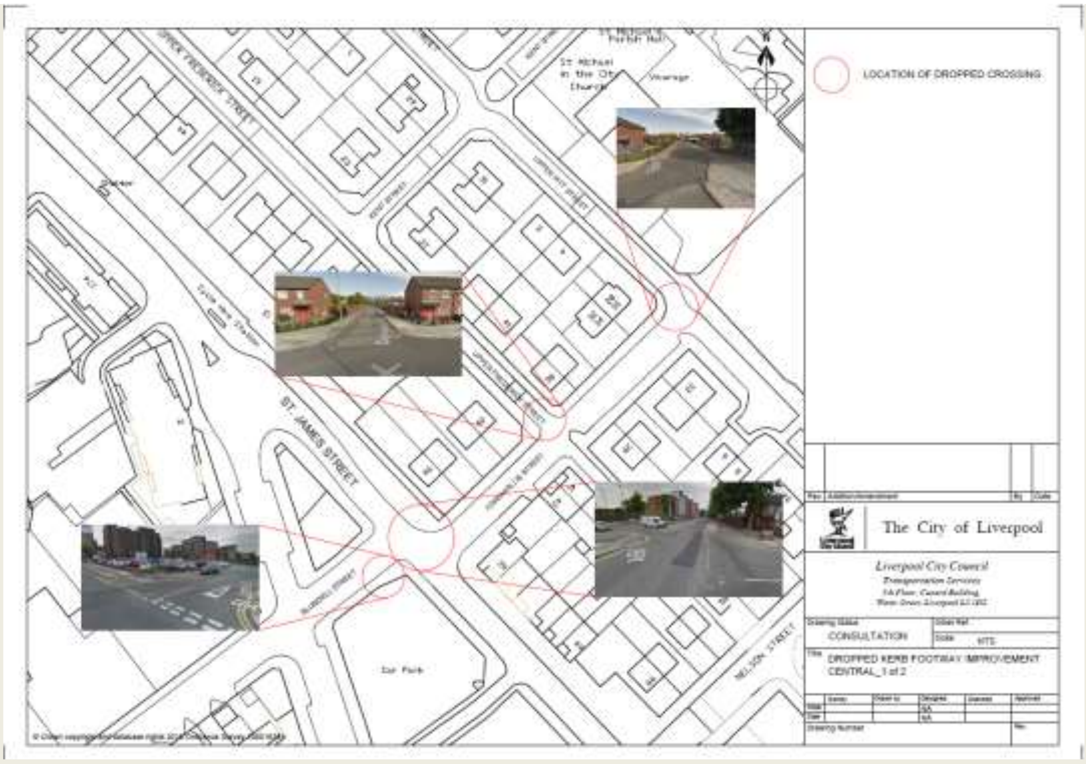
Traffic count methodology equipment:

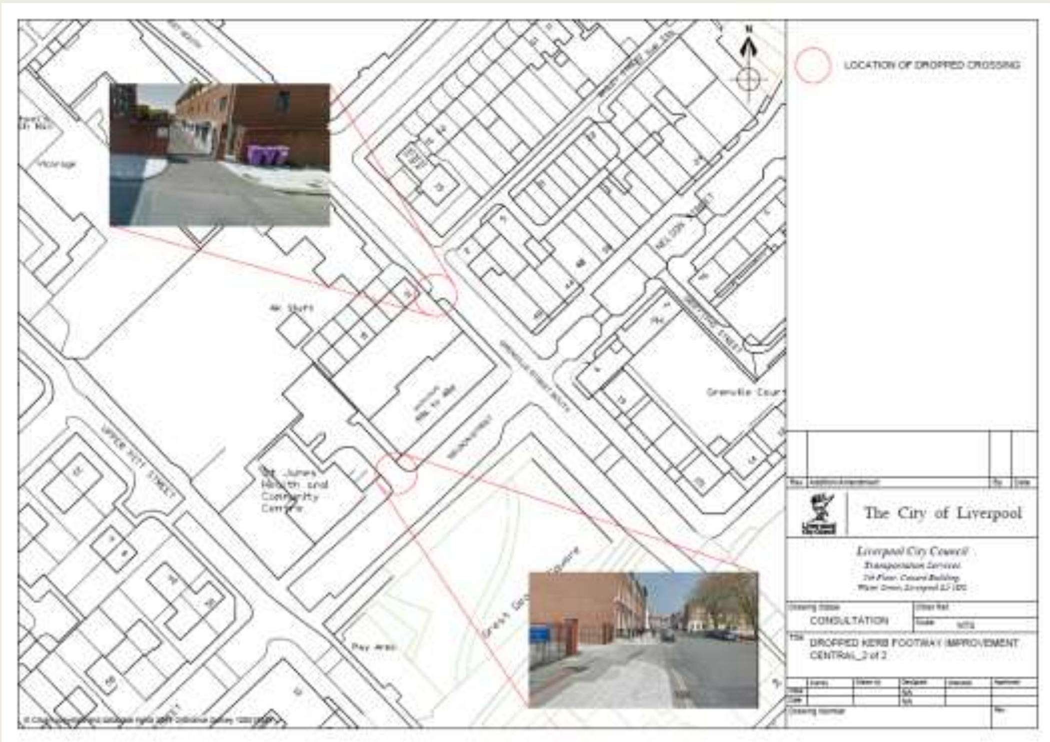
Demo A – Pedestrian routes

Dropped kerb images to show the introduction of tactile dropped kerbs to facilitate pedestrian use of the green corridor route

Locations 1 to 1 identifies the pedestrian route in the Baltic, which has 6 new dropped kerbs locations and one repaired dropped kerb (examples shown).

The following plans show the locations for each of the dropped kerb works on the green route.


LOCATION OF DROPPED CROSSING
ST. JAMES STREET
The City of Liverpool
Liverpool City Council
CONSULTATION
DROPPED KERB FOOTWAY IMPROVEMENT CENTRAL_1 of 2


LOCATION OF DROPPED CROSSING
The City of Liverpool
Liverpool City Council
CONSULTATION
DROPPED KERB FOOTWAY IMPROVEMENT CENTRAL_2 of 2

Demo C - Princess Avenue Cycle and Pedestrian route



Princes Avenue 2017 (before) August 2020 June 2021

Demo C – Dropped kerbs and road resurfacing for cycle and pedestrian route

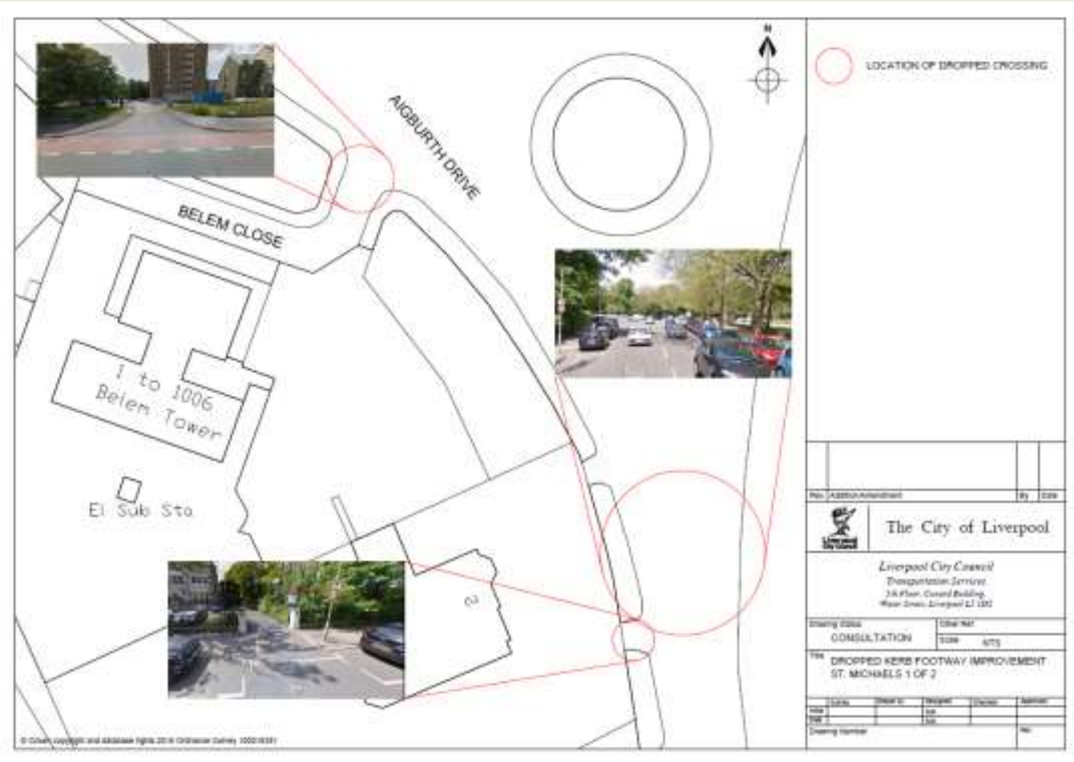


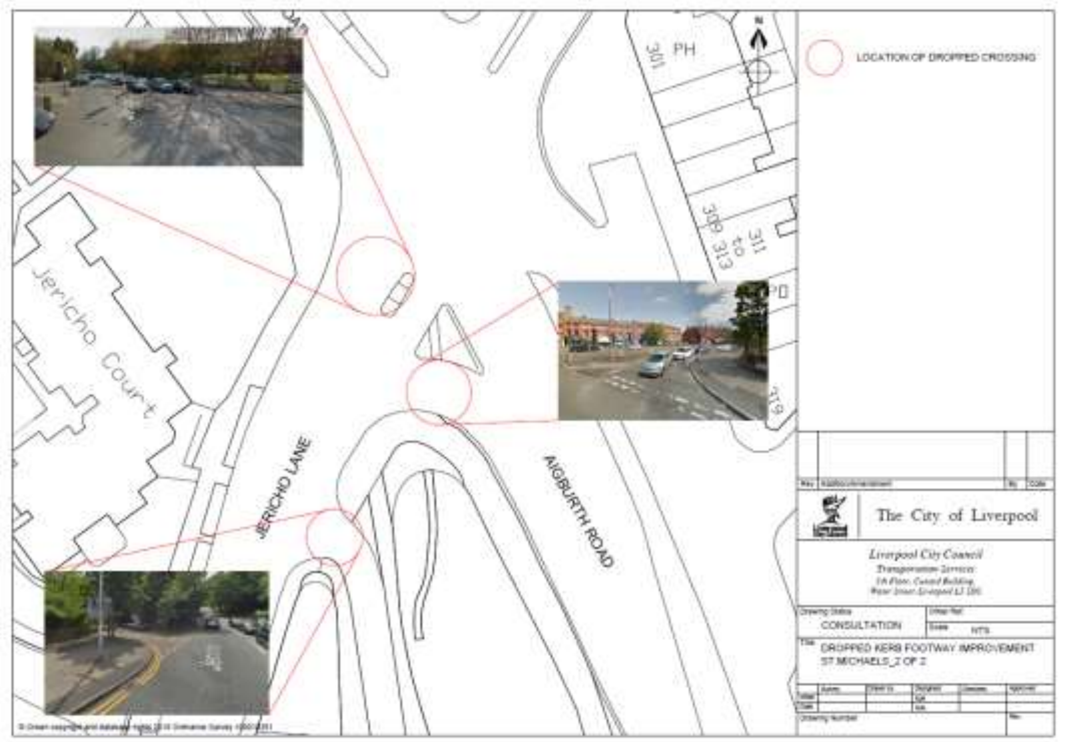




Above and left: Variety of dropped kerbs and road resurfacing works to create the cycle and pedestrian route from Princes Avenue to Otterspool promenade.

The following plans show the locations for each of the dropped kerb works on the green route for Demo C.





The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	3.4	yes	
01	CH0104	CARBON SEQUESTRATION	3.4	yes	
01	CH0105	TEMPERATURE DECREASE	2.5	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	2.5	yes	
01	CH0108	HEATWAVE RISK	4.0	yes	
01	CH0111	SPECIES MOVEMENT	4.4	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	0.8	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	0.0	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	0.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	0.0	Inconclusive	

02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	0.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	1.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	5.0	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	5.0	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	2.0	yes	
04	CH0411	PLANT SPECIES INCREASE	2.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	2.0	yes	
04	CH0413	INSECTIVORE INCREASE	2.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	2.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	4.0	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	4.0	yes	
05	CH0504	NOx TRENDS	2.0	yes	
05	CH0505	Sox TRENDS	2.0	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	1.0	yes	
05	CH0509	Energy savings	1.0	yes	
05	CH0510	Increase in property value	1.0	yes	
05	CH0511	Value of air quality improvements	1.0	yes	
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	1.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	2.8	yes	
07	CH0702	CITIZEN PERCEPTION	2.8	yes	
07	CH0703	SOCIAL LEARNING	2.8	yes	
07	CH0705	ENGAGEMENT WITH NBS	2.8	yes	
08	CH0801	CRIME REDUCTION	3.0	yes	
09	CH0902	WALKING AREA INCREASE	5.0	yes	
09	CH0903	CYCLING AREA INCREASE	5.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	2.8	yes	
10	CH1002	JOB CREATION	1.3	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.3	yes	
10	CH1005	NEW BUSINESSES	1.3	yes	

EcoServR: CH0403: Green Space Accessibility			
Mean	**households**	**population**	**Rank**
Overall Liverpool	11702	23449	1
sub demo C	1189	2530	2

sub demo A	929	1679	3
sub demo B	641	1025	4

QUANTITATIVE DATA SUMMARY			
CH0902: Walking			
NBS	NBS Name	% Change	Rank
LAc5	shade trees	13.9	1
LAc6	cooling trees	13.9	1
LAc12	Pollinator verges and spaces	2.3	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY											
CH0902: Walking		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Baltic POLL	1090	2	541.5	398.8	468	2	642.8	433.4	18.7	1
LAc5	Shade_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	2
LAc6	Cooling_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	3
LAc12	Strand POLL	620	1	778.1	457.1	159	1	737.7	360.6	-5.2	4
LAc12	Ullet Rd POLL	411	1	1536.0	483.0	368	1	1433.0	441.8	-6.7	5
LAc1	Green_Route_1	2337	3	683.1	408.4						

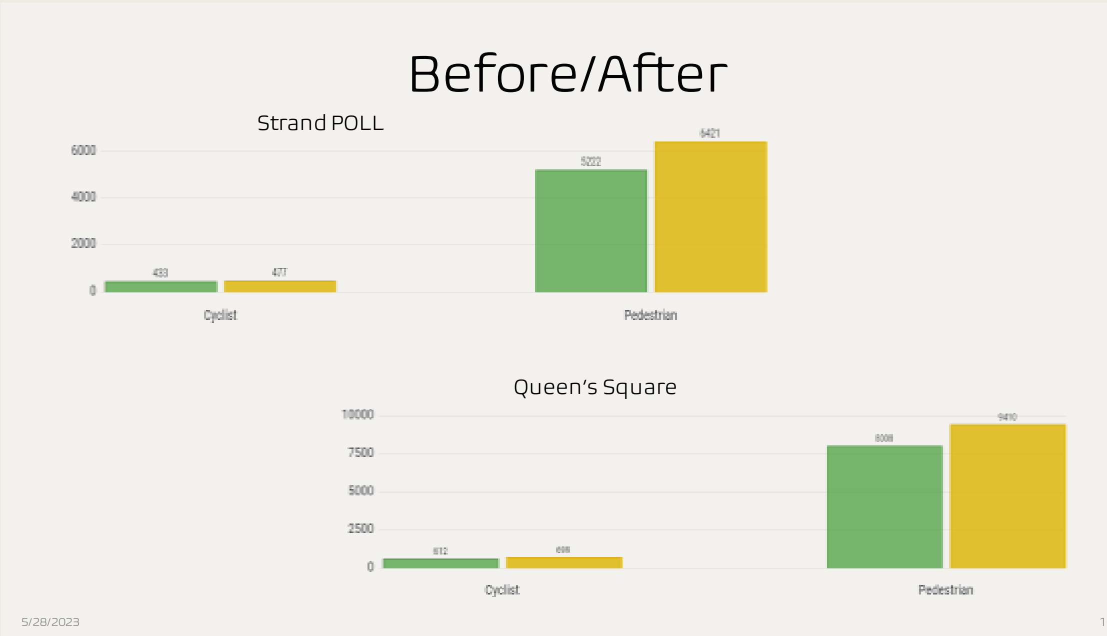
QUANTITATIVE DATA SUMMARY			
CH0903: Cycling			
NBS	NBS Name	% Change	Rank
LAc5	shade trees	86.1	1
LAc6	cooling trees	86.1	1
LAc12	Pollinator verges and spaces	-5.7	2
LAc1	Green Travel Route		

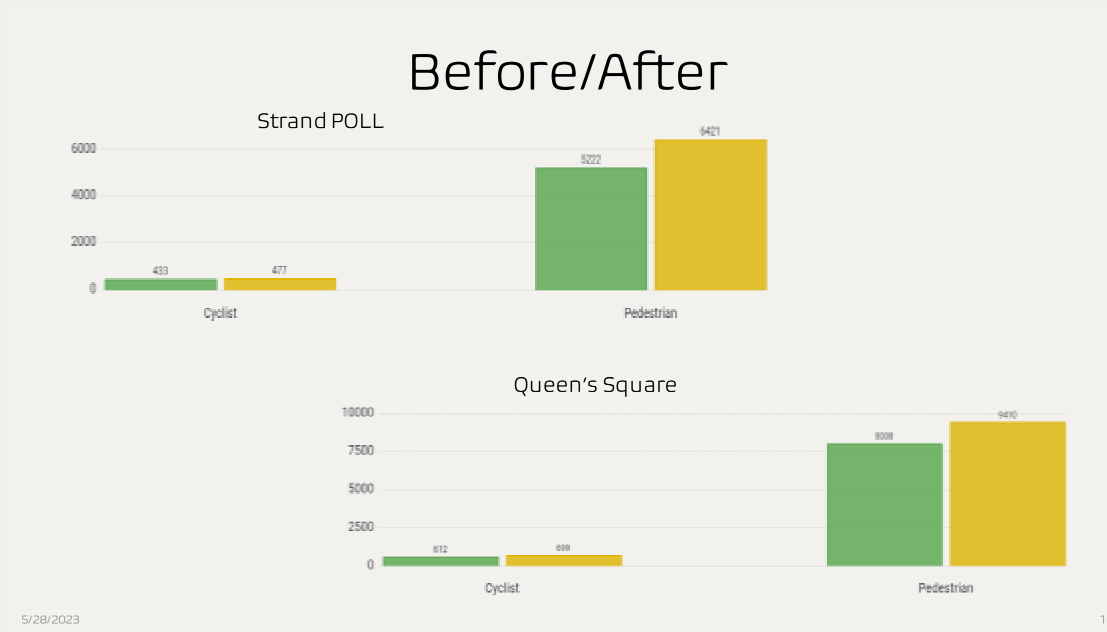
QUANTITATIVE DATA SUMMARY											
CH0903: Cycling		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc5	Shade_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	1
LAc6	Cooling_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	2

LAc12	Baltic POLL	1090	2	48.6	41.1	468	2	54.8	28.0	12.7	3
LAc12	Ullet Rd POLL	411	1	311.7	157.5	368	1	285.8	123.0	-8.3	4
LAc12	Strand POLL	620	1	75.4	44.5	159	1	59.2	20.8	-21.4	5
LAc1	Green_Route_1	2337	3	105.1	108.7						

As can be seen from the differences in % change pre- and post- intervention, it has been difficult to determine if the interventions had any influence on walking and cycling levels and hence on the success of the green travel routes.

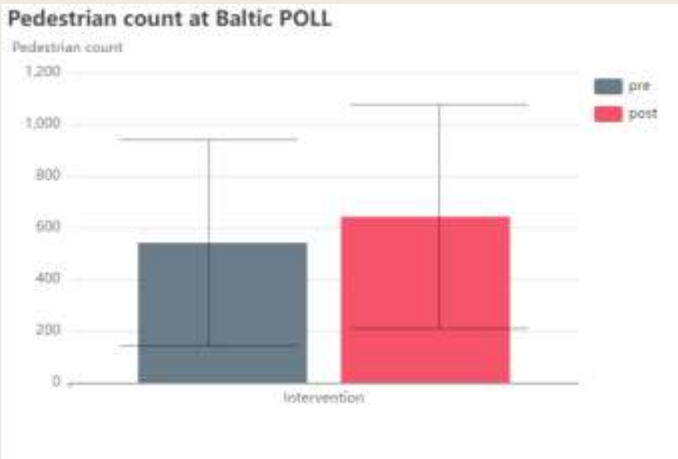
The plots below show the differences pre- and post- interventions for pedestrians and cyclists at different sites. As can be observed, the levels of pedestrians, in particular, seem to increase after the interventions are introduced.

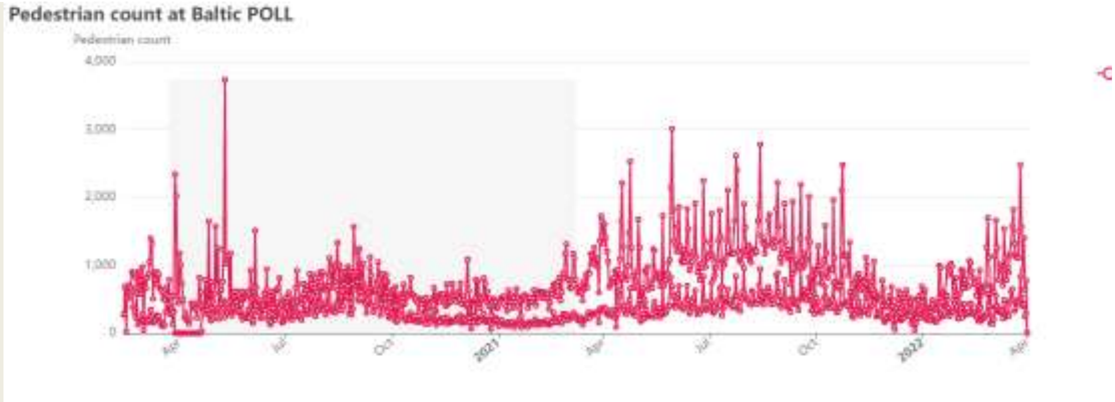




Further plots can be found for different interventions on the Liverpool portal.

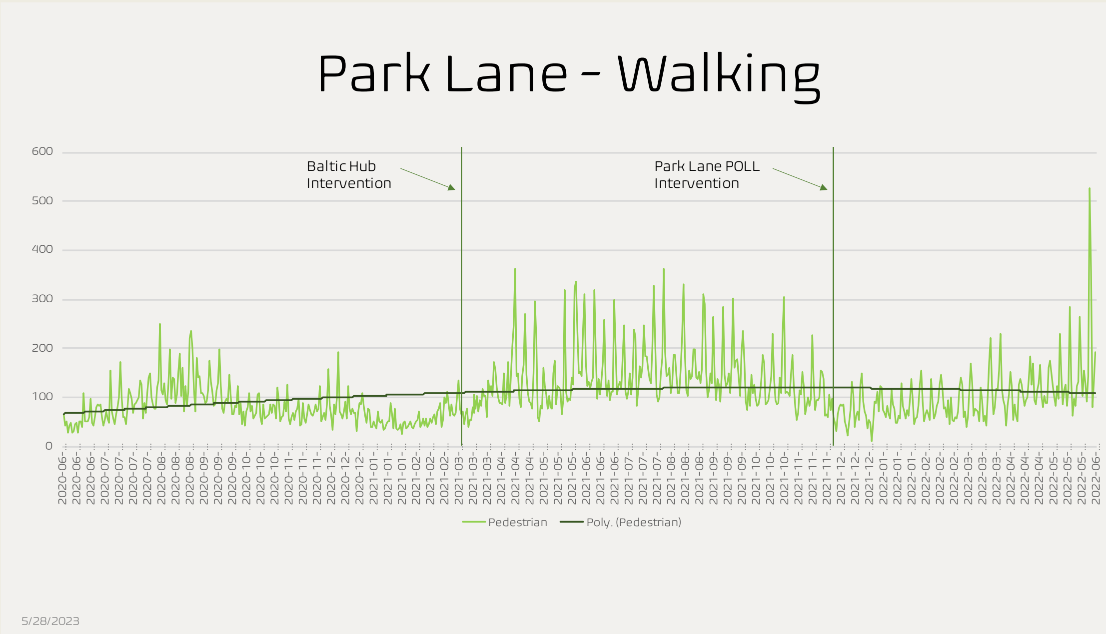
Example plot for pedestrians in Sub Demo A: Baltic green route: Box plot of pre- and post-data; Time line of data (shaded area showing Covid Lockdown):

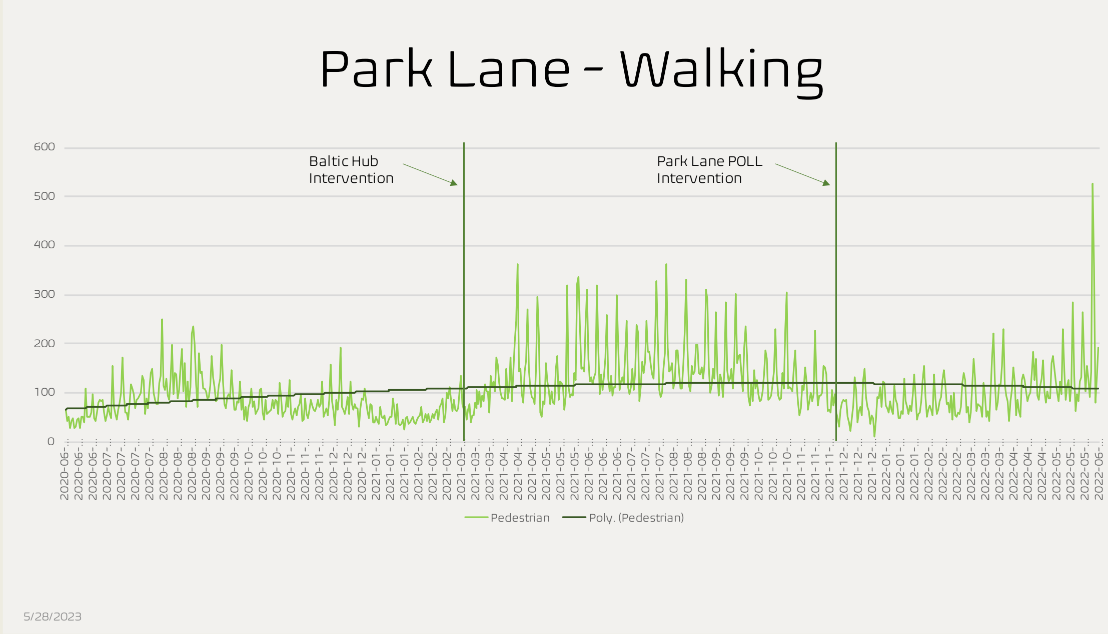




The timeline for the Vivacity data (example plot from the Baltic sub demo A Green Route) shows the depression in numbers with lockdown (grey background) and seasonal effects. The box plot demonstrates a slight increase after the interventions were added for pedestrians. Further analyses may help to determine if any particular interventions made a difference to the walking levels.

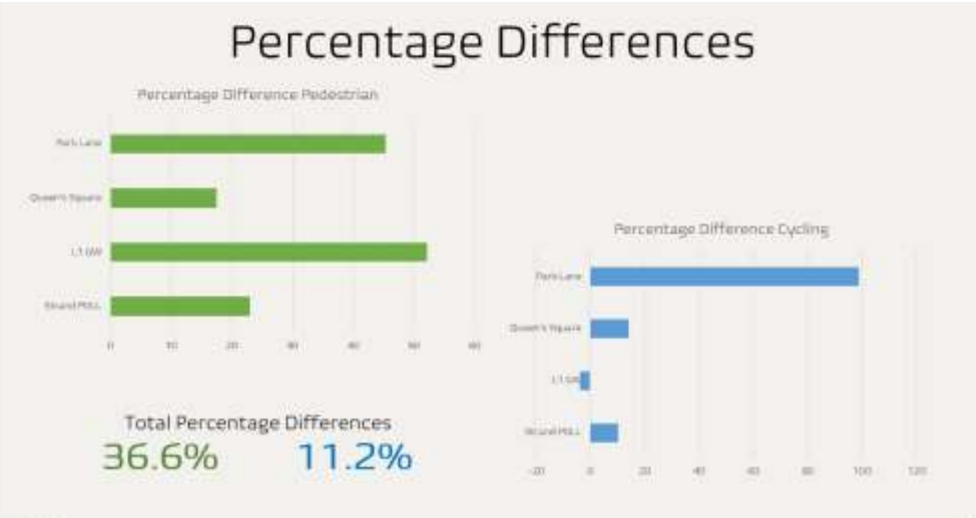
Further example plots for sites with the Baltic sub demo area showing the time line when interventions were introduced for walking and cycling levels:





Summary plot comparing 4 intervention locations

Changes in walking and cycling at 4 NBS locations



Percentage figures based on 6 month before data and 6 month after data

Possible reasons for this include Covid behaviour changes, New cycle routes and paths, Introduction of NBS, Other but a positive story of increased active travel and NBS has potentially played a part

This plot above shows an overall increase of 36.6% and 11.2% for pedestrians and cyclists respectively for 4 different intervention locations.

Further analyses would be required and further data monitoring to assess if the green signed travel routes had any effect.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Works were delayed due to the need for a road closure of a busy junction	The resurfacing and dropped curbs at key junctions were programmed into other planned road closure works or delivered at quiet times
Economical barriers	How they have been addressed
Prices for the works rose slightly from the pre covid quotes	Small additional costs were accommodated within the planned works spend
Works were programmed outside of the Christmas season as per local authority policy.	All highways works have an 8 week Christmas/new year closure period
Works were a low priority post covid as there were many outstanding highways issues that took precedence on staff capacity. Some existing staff also left.	Works were delivered as soon as new staff capacity allowed.
Social barriers	How they have been addressed

Reduced consultation with local community groups at the time of delivery due to covid	Consultation with key groups had already been undertaken prior to covid.
Environmental (including COVID)	How they have been addressed
Works were delayed due to problems sourcing materials and sufficient work force as a result of covid.	Works were delayed on site

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
None – standard works that also incorporated existing utilities	N/A
Economical barriers	How they have been addressed
No further issues were raised	N/A
Social barriers	How they have been addressed
No issues were raised	N/A
Environmental (including COVID)	How they have been addressed
No further issues were raised	N/A

2.2.2 Lac2 Green Travel route

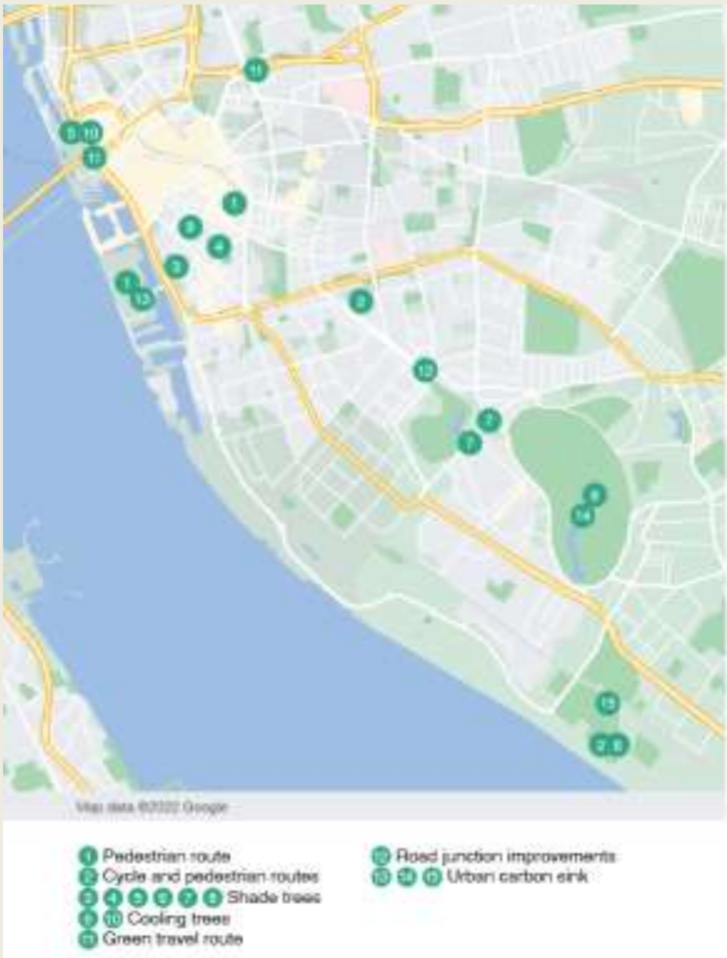
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0111; CH0403; CH0404; CH0501; CH0502; CH0503:CH0504; CH0505; CH0508; CH0509; CH0511; CH0512; CH0508; CH0602; CH0702; CH0705; CH0801; CH0902; CH0903; CH0904; CH1002; CH1004; CH1005;	Green Travel route LAc2	LIV/ UoL/ CFT
CITY	*DATE OF IMPLEMENTATION*	

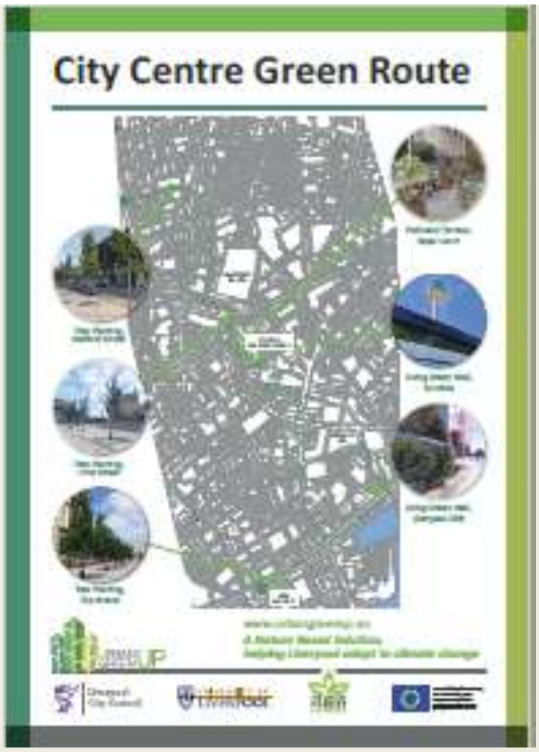
LIV	All works completed July 2020 Final signage completed March 2023	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

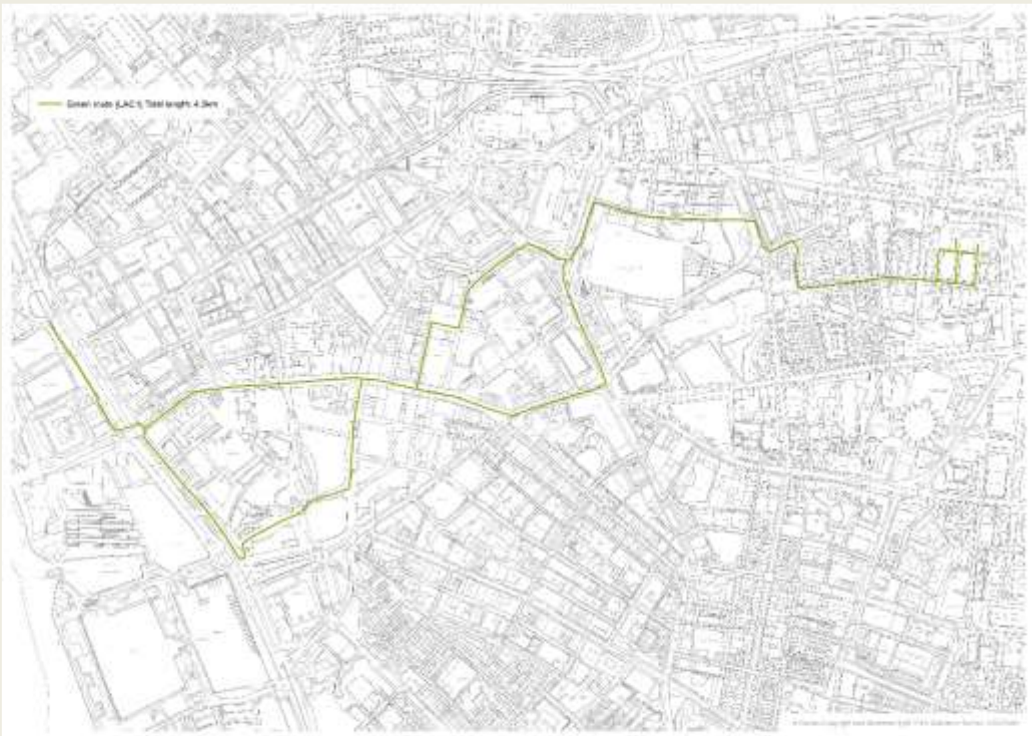
Demo B Green Travel Route – Location



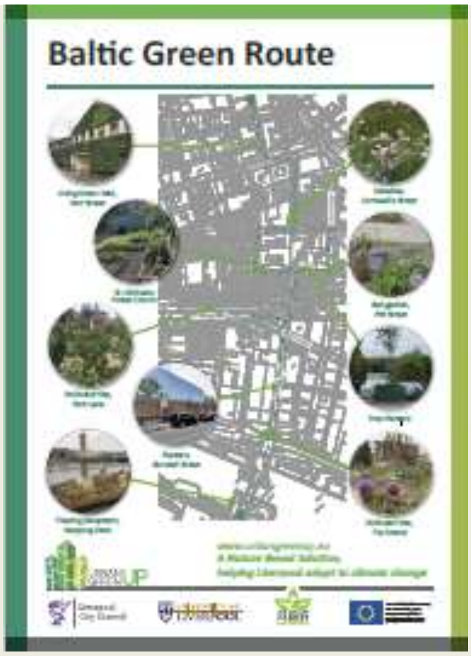


The green travel route is located between numbers 11 to 11 on the above map but is not a linear route. The route links areas of new development to the Business Improvement District area and uses existing green infrastructure and the URBAN GreenUP interventions. It is being promoted through UoL to students. The green travel route is also complemented by the connecting cycle lanes and active travel systems on the Strand

Green Travel Route – Overview and details



Adjacent and linking Strand Connectivity scheme which will extend the green travel route



Example of signage. This one is for the Baltic Green Route.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	3.4	yes	
01	CH0104	CARBON SEQUESTRATION	3.4	yes	
01	CH0105	TEMPERATURE DECREASE	2.5	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	2.5	yes	
01	CH0108	HEATWAVE RISK	4.0	yes	
01	CH0111	SPECIES MOVEMENT	4.4	Inconclusive	

02	CH0201	RUN-OFF COEFFICIENT	0.8	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	0.0	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	0.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	0.0	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	0.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	1.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	5.0	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	5.0	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	2.0	yes	
04	CH0411	PLANT SPECIES INCREASE	2.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	2.0	yes	
04	CH0413	INSECTIVORE INCREASE	2.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	2.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	4.0	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	4.0	yes	
05	CH0504	NOx TRENDS	2.0	yes	
05	CH0505	Sox TRENDS	2.0	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	1.0	yes	
05	CH0509	Energy savings	1.0	yes	
05	CH0510	Increase in property value	1.0	yes	
05	CH0511	Value of air quality improvements	1.0	yes	
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	1.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	2.8	yes	
07	CH0702	CITIZEN PERCEPTION	2.8	yes	
07	CH0703	SOCIAL LEARNING	2.8	yes	
07	CH0705	ENGAGEMENT WITH NBS	2.8	yes	
08	CH0801	CRIME REDUCTION	3.0	yes	
09	CH0902	WALKING AREA INCREASE	5.0	yes	
09	CH0903	CYCLING AREA INCREASE	5.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	2.8	yes	
10	CH1002	JOB CREATION	1.3	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.3	yes	
10	CH1005	NEW BUSINESSES	1.3	yes	

QUANTITATIVE DATA SUMMARY			
CH0902: Walking			
NBS	NBS Name	% Change	Rank
LAc5	shade trees	13.9	1
LAc6	cooling trees	13.9	1
LAc12	Pollinator verges and spaces	2.3	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY											
CH0902: Walking		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Baltic POLL	1090	2	541.5	398.8	468	2	642.8	433.4	18.7	1
LAc5	Shade_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	2
LAc6	Cooling_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	3
LAc12	Strand POLL	620	1	778.1	457.1	159	1	737.7	360.6	-5.2	4
LAc12	Ullet Rd POLL	411	1	1536.0	483.0	368	1	1433.0	441.8	-6.7	5
LAc1	Green_Route_1	2337	3	683.1	408.4						

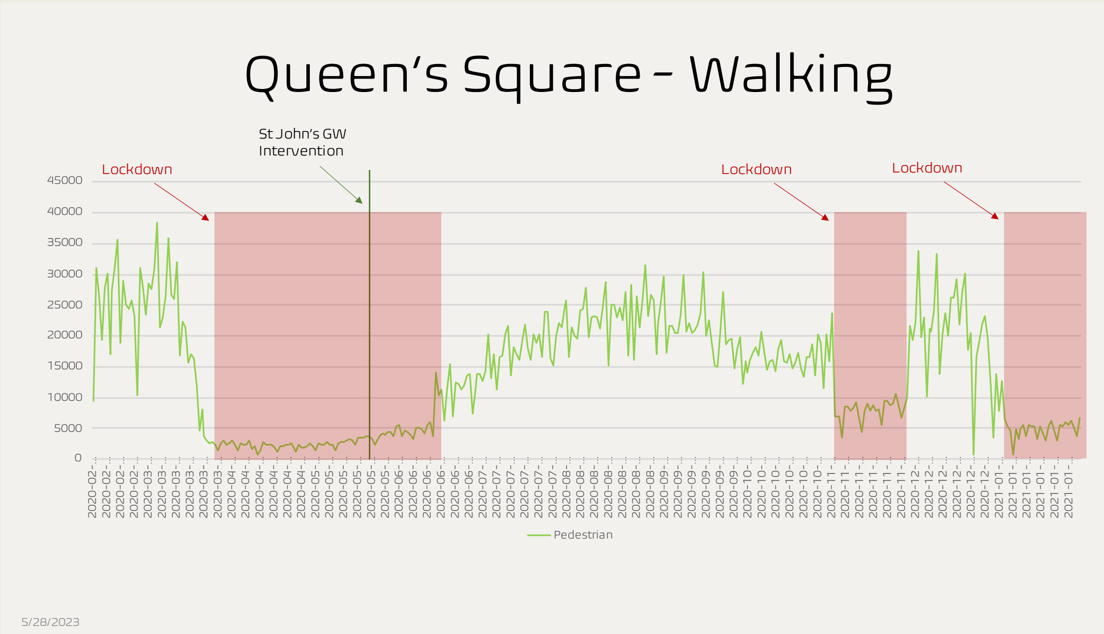
QUANTITATIVE DATA SUMMARY			
CH0903: Cycling			
NBS	NBS Name	% Change	Rank
LAc5	shade trees	86.1	1
LAc6	cooling trees	86.1	1
LAc12	Pollinator verges and spaces	-5.7	2
LAc1	Green Travel Route		

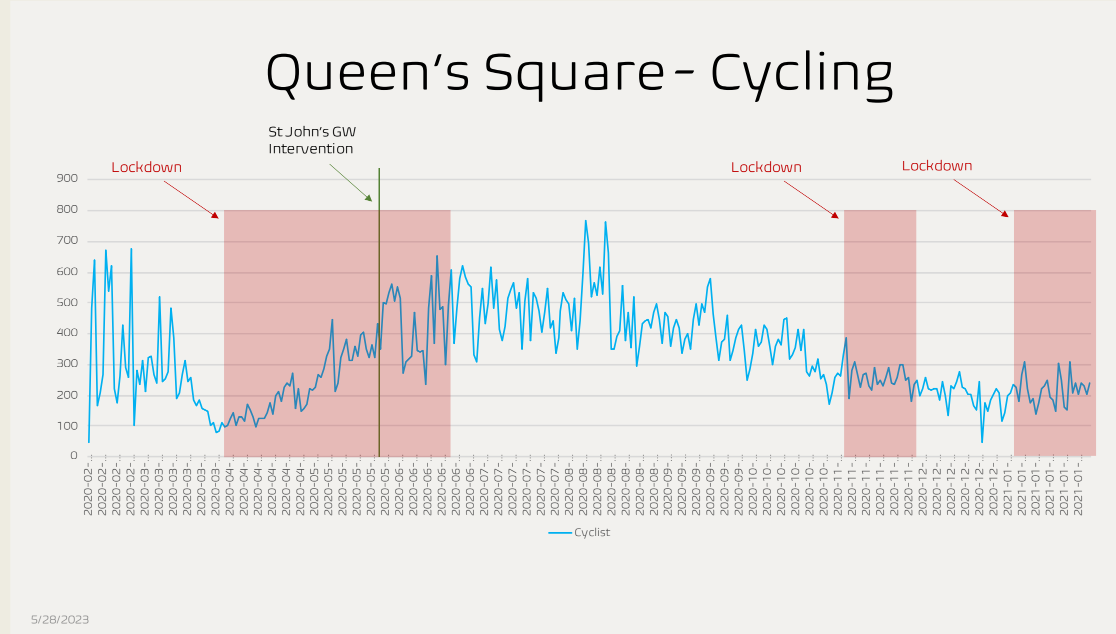
QUANTITATIVE DATA SUMMARY											
CH0903: Cycling		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc5	Shade_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	1
LAc6	Cooling_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	2
LAc12	Baltic POLL	1090	2	48.6	41.1	468	2	54.8	28.0	12.7	3

LAc12	Ullet Rd POLL	411	1	311.7	157.5	368	1	285.8	123.0	-8.3	4
LAc12	Strand POLL	620	1	75.4	44.5	159	1	59.2	20.8	-21.4	5
LAc1	Green_Route_1	2337	3	105.1	108.7						

There was unable to be a separation between the green routes at LAc1 and LAc2 within the data, so the same rankings as for the LAc1 are observed, although it was difficult to calculate an overall % change and hence determine a ranking in comparison with other NBS.

Example Time-series plots showing the influence of the Covid Lockdown on walking and cycling in the city centre at Williamson Square:





For further plots, methods and discussion, please see LAc1.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Delays in completing the final works has meant that the signage has also been delayed as it cannot be produced until all the NBS are in situ.	Temporary signage in place (but is frequently removed) Delayed works.

Signage has many (approval) elements to it which makes for a complex piece of work	More signs needed to be on supports as lamp posts could not be used.

Economical barriers	How they have been addressed
No dedicated budget for signage	Signage costs were accommodated within the NBS costs and green travel route budget

Social barriers	How they have been addressed
Difficult to promote to users without signs in place	Information has been shared on the routes with the universities and others.
Environmental (including COVID)	How they have been addressed
Covid delays on completing all the NBS works in turn delayed the final signage.	Signage installation was delayed.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Signage requires various permissions, approvals, logos etc and each sign is bespoke so installation will have technical issues for fixings etc	Prior consultation with land owners re permissions, signage text, signage fixing locations and logos etc
Economical barriers	How they have been addressed
None to date but a decent contingency budget was included to accommodate any on site issues in signage installation	Include a 10% contingency Have a rate for each size/type of sign and proposed fixing
Social barriers	How they have been addressed
Delays in some landowners responding for permissions	Repeat messaging and requests and consideration of alternative locations
Environmental (including COVID)	How they have been addressed

Covid delayed the installation of various NBS which in turn delayed the signage.	Delayed installation of signage.

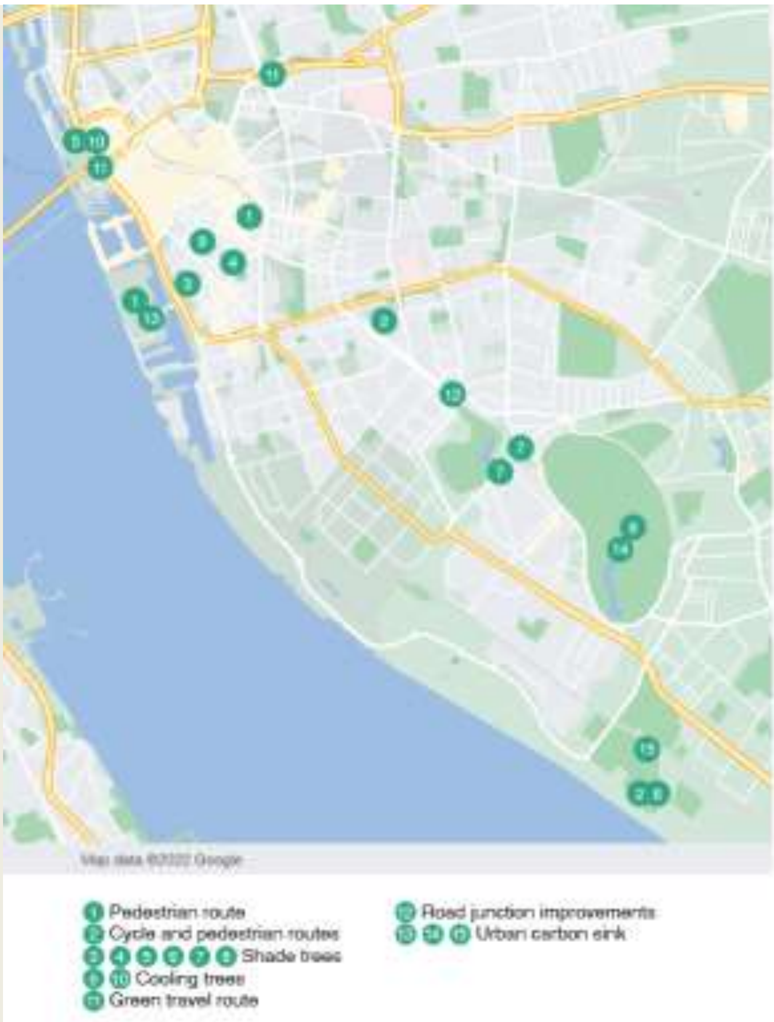
2.2.3 Lac3 Road junction pedestrian improvement

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0111; CH0403; CH0404; CH0501; CH0508; CH0509; CH0510; CH0511; CH0512; CH0508; CH0602; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Road junction pedestrian improvement LAc3	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Completion of all works by July 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Demo C – Road Junction Improvements, Princes Avenue



The map above shows the location of the road junction improvement at location 12. This site is also shown above at the end of the works. The roundabout in this location had caused several road traffic accidents and the works here addressed ongoing issues and created safe crossing places to connect the avenue to the Park. This scheme was part of the Princes Avenue connectivity scheme and delivered by the city council Highways staff. It forms an integral part of the Green Corridor for Demo C.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	0.0	yes	
01	CH0104	CARBON SEQUESTRATION	0.0	yes	
01	CH0105	TEMPERATURE DECREASE	0.0	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	0.0	yes	
01	CH0108	HEATWAVE RISK	0.0	yes	
01	CH0111	SPECIES MOVEMENT	0.0	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	0.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	0.0	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	0.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	0.0	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	0.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	0.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	1.0	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	0.0	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	0.0	yes	
04	CH0411	PLANT SPECIES INCREASE	0.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	0.0	yes	
04	CH0413	INSECTIVORE INCREASE	0.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	0.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	0.0	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	0.0	yes	
05	CH0504	NOx TRENDS	0.0	yes	
05	CH0505	Sox TRENDS	0.0	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	0.0	yes	

05	CH0509	Energy savings	0.0	yes	
05	CH0510	Increase in property value	1.0	yes	
05	CH0511	Value of air quality improvements	2.0	yes	
05	CH0512	Value of air pollution reduction	0.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	0.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	1.0	yes	
07	CH0702	CITIZEN PERCEPTION	1.0	yes	
07	CH0703	SOCIAL LEARNING	0.0	yes	
07	CH0705	ENGAGEMENT WITH NBS	1.0	yes	
08	CH0801	CRIME REDUCTION	0.0	yes	
09	CH0902	WALKING AREA INCREASE	3.0	yes	yes
09	CH0903	CYCLING AREA INCREASE	2.0	Inconclusive	yes
09	CH0904	HEALTH QUALITY PERCEPTION	1.0	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

This NBS was in order to support other NBS and accessibility, so no direct monitoring data were obtained. Please see data tables for Lac1, Lac2 and plots on data portal.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
None reported	
Economical barriers	How they have been addressed
None reported	

Social barriers	How they have been addressed
None reported	Early and wide consultation on the scheme
Environmental (including COVID)	How they have been addressed
Works progressed during covid but slower due to social distancing requirements.	Slight delay in final delivery.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
None reported	N/A
Economical barriers	How they have been addressed
None reported	N/A
Social barriers	How they have been addressed
None reported – covid restrictions meant there was less traffic and fewer people affected	N/A
Environmental (including COVID)	How they have been addressed
Delay in delivery due to social distancing due to covid measures	Slight delay to final delivery.

2.2.4 Lac4 Urban catchment forestry

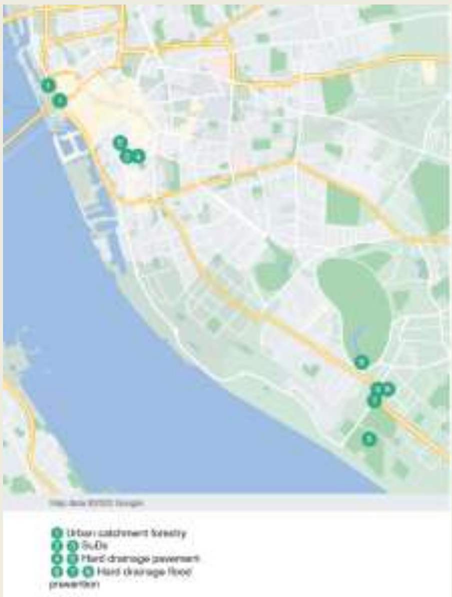
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0105; CH0111; CH0201; CH0207; CHO213; CH0217; CH0212; CH0501; CH0502; CH0503; CH0504, CH0505; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Urban catchment forestry Lac4	LIV/UoL/CFT

CITY	*DATE OF IMPLEMENTATION*	
LIV	Trees in March 2020 and May 2021 Surrounding landscape August 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Demo B - Strand Liverpool



Demo B Urban Catchment Forestry

January 2020

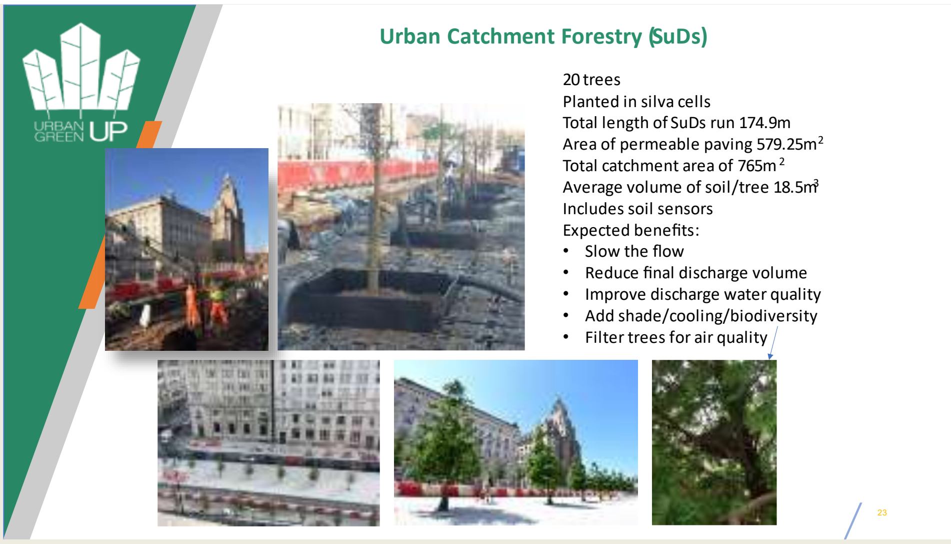
January 2020

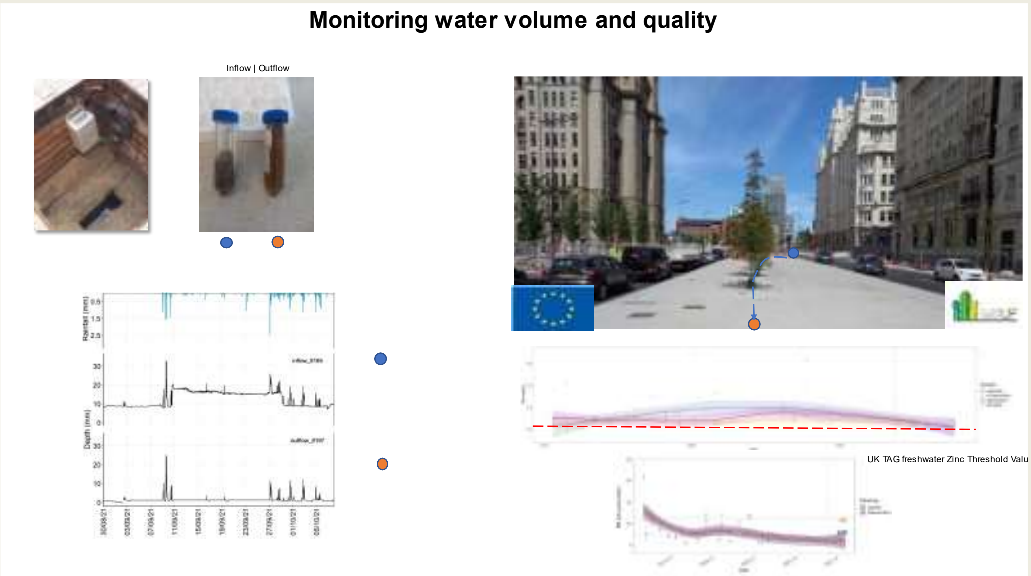
February 2020

April 2020 June 2020 August 2020

Below: February 2020 trees going onto silva cell

Below: August 2021 trees well established and with irrigation programme





The urban catchment forestry category had one site called Strand Tree SUDS.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	4.0	yes	yes
01	CH0104	CARBON SEQUESTRATION	4.0	yes	yes
01	CH0105	TEMPERATURE DECREASE	4.8	yes	no
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	4.8	yes	yes
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.4	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	3.3	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	5.0	yes	yes
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	5.0	Inconclusive	Inconclusive
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	5.0	Inconclusive	no
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	5.0	yes	yes
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	5.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	4.5	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	4.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	1.0	yes	yes
04	CH0411	PLANT SPECIES INCREASE	1.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	1.0	yes	
04	CH0413	INSECTIVORE INCREASE	1.0	yes	no
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.2	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	yes
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	yes
05	CH0504	NOx TRENDS	3.7	yes	yes
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	3.5	yes	
07	CH0703	SOCIAL LEARNING	3.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	3.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	2.0	yes	

09	CH0903	CYCLING AREA INCREASE	2.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	3.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	**NBS name**	**EcoServR: CH0103: Carbon storage (tC)**	**Rank**
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	**NBS**	**EcoServR: CH0104: Carbon sequestration**	**Rank**
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

EcoServR: CH0104: Carbon sequestration (tCO2e)			
NBS	**NBS Name**	**Carbon sequestration (tCO2e)**	**Rank**
lac17	Green filter area	-0.87	1
lac6	cooling trees	-0.62	2
lac5	shade trees	-0.45	3
lac4	Urban catchment forestry	-0.13	4

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			
LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		
LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0106: Temperature reduction			
ranked NBS	**NBS Name**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2
lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4

lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0204: Water slowed down			
ranked NBS	**NBS**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac6	cooling trees	20	4.4	1
lac17	Green filter area	20	2.6	2
lac5	shade trees	20	1.7	3
lac4	Urban catchment forestry	20		

EcoServR: CH0204: Water slowed down				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac17	Green filter area	100	0.4	1
lac5	shade trees	100	0.2	2
lac6	cooling trees	100	0.1	3
lac4	Urban catchment forestry	100	0	4

QUANTITATIVE DATA SUMMARY						
CH0207 Water		% Change				
NBS	NBS name	Specific Conductivity	Dissolved Oxygen	Combined Nitrogen	Phosphate	All metals
LAc4	Urban catchment forestry	57.8	26.2	90.0	510.0	-13.2
LAc8	SuDs & Rain Garden	-15.1	-4.6	-8.8	76.9	21.1
LAc16	Floating gardens	13.8	-5.2	-43.1	48.9	29.3

QUANTITATIVE DATA SUMMARY											
CH0207 Water % Change Metals in Solution											
NBS	NBS Name	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Manganese	Nickel	Lead	Zinc
LAc4	Strand Tree SuDS	119		-41	-8	-17	-49	-61	-17	-41	-37
LAc8	Lower SuDS			-89		489	186	66	38		-63
LAc8	Upper Pitt St RG										
LAc8	Upper SuDS			-92		10	18	10	-55	-8	9
LAc16	SPL FI			-99		0	35	23	-16	48	11

QUANTITATIVE DATA SUMMARY					
CH0207 Water % Change Nutrients in Solution					
NBS	NBS Name	Ammonium (N-NH4)	Nitrite (N-NO2)	Nitrate (N-NO3)	Phosphate (SRP)
LAc4	Strand Tree SuDS	19.2	-64.7	251.5	510.0
LAc8	Lower SuDS	-59.9	-6.3	214.7	94.8
LAc8	Upper Pitt St RG				
LAc8	Upper SuDS	-23.8	16.6	0.1	59.0
LAc16	SPL FI	-20.6	-56.9	-69.4	48.9

QUANTITATIVE DATA SUMMARY	
CH0209 Suspended Sediment Water	% Change

NBS	NBS name	Organic Matter	Suspended Sediment	All Suspended Metals
LAc4	Urban catchment forestry	118.4	-74.6	8.4
LAc8	SuDs & Rain Garden	296.3	-53.8	59.8
LAc16	Floating gardens	1095.1	47.0	-6.9

QUANTITATIVE DATA SUMMARY										
CH0209 Suspended Sediment Water % Change Metals										
NBS	NBS name	Arsenic	Cadmium	Chromium	Copper	Iron	Manganese	Nickel	Lead	Zinc
LAc4	Strand Tree SuDS	12	160	-64	-78	-27	26	51	-26	31
LAc8	Upper SuDS	185	224	23	-16	34	29	48	41	51
LAc16	SPL FI	-59	207	51	-41	-43	-48	-5	-31	-29

EcoServR: CH0403: Green Space Accessibility				
NBS	NBS Name	households	population	Rank
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

EcoServR: CH0403: Green Space Accessibility				
NBS	NBS Name	households	population	Rank
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5

lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

EcoServR: CH0403: Green Space Accessibility				
NBS	**Site**	**households**	**population**	**Rank**
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac4	Urban catchment forestry	454	670	4

EcoServR: CH0410: Pollinator increase			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2
lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac6	cooling trees	20	1.71	1
lac17	Green filter area	20	1.65	2
lac5	shade trees	20	0.21	3
lac4	Urban catchment forestry	20	0.16	4

EcoServR: CH0410: Pollinator increase				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	100	1.91	1
lac6	cooling trees	100	1.76	2
lac4	Urban catchment forestry	100	1.23	3
lac5	shade trees	100	0.22	4

QUANTITATIVE DATA SUMMARY			
CH0502: PM 2.5			
NBS	NBS Name	% Change	Rank
LAc8	SuDs & Rain Garden	-62.6	1
LAc14	Pollinator roofs	-57.3	2
LAc4	Urban catchment forestry	-49.3	3
LAc17	Green filter area	-13.8	4
LAc13	Pollinator walls/vertical	-7.4	5
LAc12	Pollinator verges and spaces	9.0	6

QUANTITATIVE DATA SUMMARY											
CH0502: PM 2.5		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc8	Upper Pitt St RG	30	2	9.9	13.9	2	2	2.0	0.0	-79.8	1
LAc14	Royal Court GR	2	1	26.0	8.5	35	1	11.1	7.5	-57.3	2
LAc4	Strand Tree SuDS	110	4	11.7	13.1	40	4	6.0	6.1	-49.3	3
LAc8	Upper SuDS	18	2	9.2	5.5	22	2	5.0	3.0	-45.3	4
LAc13	Parr St GW	15	1	11.0	7.1	42	2	6.8	7.6	-37.9	5
LAc13	St Johns GW	29	2	15.6	8.5	47	5	9.9	6.8	-36.3	6
LAc17	Lime St TREES	86	3	10.0	8.3	10	3	6.8	7.2	-31.9	7
LAc17	Stafford St TREES	50	2	8.1	6.5	18	2	8.4	7.5	4.3	8
LAc12	Cornwallis St POLL	33	1	8.3	7.7	3	1	9.0	5.6	8.8	9
LAc12	Bott SP Aig Dr POLL	24	1	7.3	5.9	2	1	8.0	2.8	9.1	10
LAc13	L1 GW	30	3	5.3	2.8	70	7	8.1	8.7	52.0	11

QUANTITATIVE DATA SUMMARY			
CH0503: PM 10			
NBS	**NBS Name**	**% Change**	**Rank**
LAc14	Pollinator roofs	-49.3	1
LAc4	Urban catchment forestry	-36.7	2
LAc8	SuDs & Rain Garden	-27.7	3
LAc13	Pollinator walls/vertical	-14.1	4
LAc17	Green filter area	30.2	5
LAc12	Pollinator verges and spaces	32.8	6

QUANTITATIVE DATA SUMMARY											
CH0503: PM 10		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc14	Royal Court GR	2	1	37.5	7.8	35	1	19.0	8.9	-49.3	1
LAc8	Upper Pitt St RG	30	2	16.7	15.8	2	2	10.5	0.7	-37.1	2
LAc4	Strand Tree SuDS	110	4	19.6	14.5	40	4	12.4	9.5	-36.7	3
LAc13	Parr St GW	15	1	19.0	9.1	42	2	12.4	7.5	-34.8	4
LAc13	St Johns GW	29	2	24.0	11.7	47	5	16.0	8.6	-33.5	5
LAc8	Upper SuDS	18	2	16.8	5.9	22	2	13.7	7.7	-18.2	6
LAc17	Lime St TREES	86	3	18.6	12.8	10	3	21.7	15.8	16.7	7
LAc13	L1 GW	30	3	13.0	6.8	70	7	16.4	11.2	26.0	8
LAc12	Bott SP Aig Dr POLL	24	1	15.0	9.0	2	1	19.5	9.2	30.0	9
LAc12	Cornwallis St POLL	33	1	14.8	8.8	3	1	20.0	7.0	35.5	10
LAc17	Stafford St TREES	50	2	14.5	7.4	18	2	20.8	17.4	43.7	11

QUANTITATIVE DATA SUMMARY			
CH0504: NO2			
NBS	**NBS Name**	**% Change**	**Rank**
LAc14	Pollinator roofs	-25.8	1
LAc8	SuDs & Rain Garden	-19.8	2
LAc13	Pollinator walls/vertical	-15.5	3
LAc4	Urban catchment forestry	-13.7	4
LAc17	Green filter area	-8.1	5

LAc12	Pollinator verges and spaces	-7.9	6

QUANTITATIVE DATA SUMMARY											
CH0504: NO2		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc4	Strand Tree SuDS	87	4	40.1	9.3	57	4	34.6	8.7	-13.7	1
LAc17	Lime St TREES	169	6	46.7	11.7	18	5	42.2	7.7	-8.1	2

EcoServR: CH0511: Air quality improvements			
NBS	NBS Name	% Change	Rank
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	20	21.7	1
lac6	cooling trees	20	10.0	2
lac5	shade trees	20	1.7	3
lac4	Urban catchment forestry	20		

EcoServR: CH0511: Air quality improvements				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	100	11.0	1
lac6	cooling trees	100	6.8	2

lac5	shade trees	100	1.1	3
lac4	Urban catchment forestry	100		

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon storage, carbon sequestration, water slowed, green space accessibility, pollinator capacity and air quality.

Quantitative data results positive influences on thermal cooling, metals reduction in water, water removed, and air quality (PM and NO2), but not for thermal cooling, the combined nutrients and phosphate in the water, metals within the suspended water sediment or insectivore levels. Metals within solution in the water were reduced for Chromium, Copper, Cobalt, Iron, Manganese, Nickel, Lead and Zinc. Nutrients within solution increased post-intervention for Ammonium, Nitrate and Phosphate, but reduced for Nitrite.

A high order of ranking as opposed to other NBS were found for:

- carbon storage,
- thermal cooling,
- Metals reduction (Manganese, Iron, Copper) and Nitrite reduction
- Suspended metals reduction (Chromium, Copper, Lead)
- Air quality (PM2.5, PM10 and NO2)

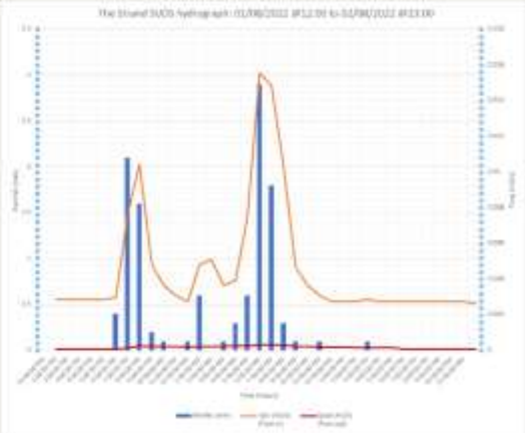
Lower ranking levels were observed for:

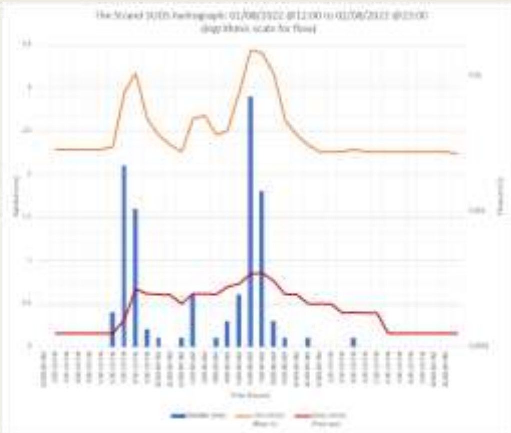
- carbon sequestration,
- temperature reduction (modelled),
- water slowed down (modelled),
- Overall suspended metal reduction
- Green space accessibility
- Pollinator increase (modelled)

The highest percentage changes creating a positive effect were for thermal cooling and for air quality.

Rainfall events were analysed in more detail to observe how the tree SuDs or urban catchment forestry reacted. Two examples were chosen, as below. These plots were created using the Mannings roughness equation to calculate flows. The plot on the right is with a logarithmic scale to be able to observe the flow relationships better. The bars show the incoming rainfall, the upper curve is the inflow, the lower red curve is the outflow. As can be observed the volume at the outflow is always less than the inflow volumes. So the volume of water was always reduced by the tree pit SuDs line. Although it has be unable to specifically determine how much water the trees uptake, as separate from the water being absorbed by the porous base of the tree pits or removed by overflow pipes in the design. Velocity of water was unable to be measured due to sensor and design issues, so it is unclear if the water is slowed down by the tree SuDs.

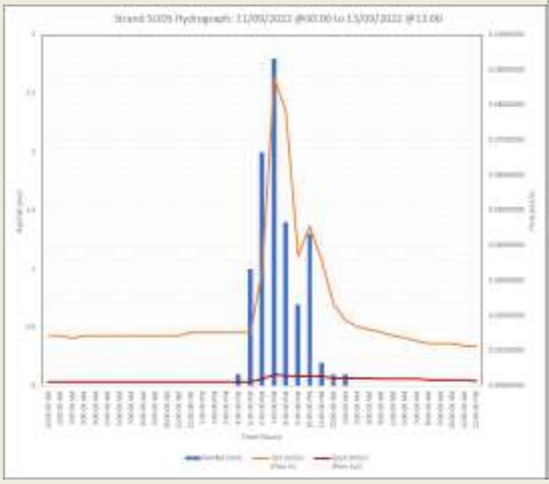
Example 1:

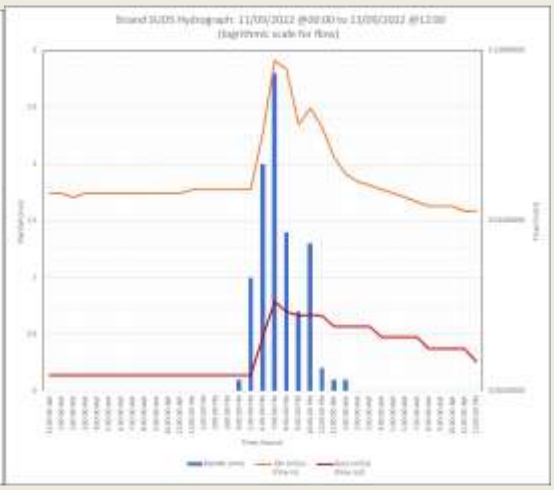




SOIL MOISTURE 01/08/2022 @12:00 to 02/08/2022 @23:00		
	INFLOW AT NORTH TREE	OUTFLOW AT SOUTH TREE
AVERAGE	21.4	23.6
MAX	21.5	23.7
MIN	21.3	23.5

Example 2:





SOIL MOISTURE 11/09/2022 @00:00 to 13/09/2022 @12:00		
	INFLOW AT NORTH TREE	OUTFLOW AT SOUTH TREE
AVERAGE	17.1	19.6
MAX	17.2	19.8
MIN	17.0	19.5

In conclusion, the urban catchment forestry demonstrated beneficial influences on flood prevention (particularly water removal) and some influence on metal contaminants, carbon storage/sequestrations, green space accessibility and air quality.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Utilities needing to cross site	Root barrier wrapped through silva cells
Modelling of rainwater and rainwater flow	Specialist highways engineers
Securing agreed tree species	Early tagging in nursery to secure
Availability of suitable pH soil	Early sourcing to avoid delays
Installation of monitoring equipment	Discussions with contractor on site

Economical barriers	How they have been addressed
None	Works formed part of a costed highways programme and URBAN GreenUP made a fixed contribution
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Issued with blocked boreholes Leaves in chambers	Cleaned out on request, but issues persisted and further cleaning/flushing required Regular clean out of beany drains
Economical barriers	How they have been addressed
None	Works formed part of a costed highways programme and URBAN GreenUP made a fixed contribution
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Contractor connected system without prior notification and opportunity was lost for first flush of system	

2.2.5 Lac 5 Shade trees Report on NBS

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0106; CH0108; CH0111; CH0212; CH0403; CH0404; CH0501; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0705; CH0801; CH0902; CH0904; CH1002; CH1004; CH1005;	Shade trees LAc 5	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Works completed by March 2020 and September 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Shade Trees Locations

Demo A - Shade Trees

Above: Shade tree planting at locations 3 and 4.

Left and below: 12 shade trees planted in the gardens and properties of registered housing providers to create tree lined streets

Demo B - Shade Trees

Shade tree location at location 5 forming part of the Strand connectivity scheme.

Demo C - Shade Trees

Above left: 10 shade trees planted alongside the highway as infill to existing planting at Ullet Road.

Above right: 14 fruiting species planted at Otterspool park to create a mini orchard

Left: 5 semi mature trees planted in Sefton Park to add species and size diversity.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	5.0	yes	yes
01	CH0104	CARBON SEQUESTRATION	5.0	yes	yes
01	CH0105	TEMPERATURE DECREASE	4.8	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	4.0	yes	yes
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.4	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	2.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	2.0	yes	yes
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	2.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	2.0	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	2.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	4.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	3.0	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	3.0	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	1.0	yes	yes
04	CH0411	PLANT SPECIES INCREASE	1.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	1.0	yes	
04	CH0413	INSECTIVORE INCREASE	1.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	
05	CH0504	NOx TRENDS	3.7	yes	
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	yes
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	

06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	3.5	yes	
07	CH0703	SOCIAL LEARNING	3.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	3.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	2.0	yes	
09	CH0903	CYCLING AREA INCREASE	2.0	Inconclusive	yes
09	CH0904	HEALTH QUALITY PERCEPTION	3.5	yes	yes
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	NBS name	EcoServR: CH0103: Carbon storage (tC)	Rank
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	NBS	EcoServR: CH0104: Carbon sequestration	Rank
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5

lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

EcoServR: CH0104: Carbon sequestration (tCO2e)			
NBS	**NBS Name**	**Carbon sequestration (tCO2e)**	**Rank**
lac17	Green filter area	-0.87	1
lac6	cooling trees	-0.62	2
lac5	shade trees	-0.45	3
lac4	Urban catchment forestry	-0.13	4

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			
LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		
LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0106: Temperature reduction			
ranked NBS	**NBS Name**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2
lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4
lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0106: Temperature reduction				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac5	shade trees	20	109.98	
lac6	cooling trees	20		
lac17	Green filter area	20		

EcoServR: CH0106: Temperature reduction				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac6	cooling trees	100	46.66	1
lac17	Green filter area	100	44.67	2
lac5	shade trees	100	9.36	3

EcoServR: CH0204: Water slowed down			
ranked NBS	**NBS**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5

lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac6	cooling trees	20	4.4	1
lac17	Green filter area	20	2.6	2
lac5	shade trees	20	1.7	3
lac4	Urban catchment forestry	20		

EcoServR: CH0204: Water slowed down				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac17	Green filter area	100	0.4	1
lac5	shade trees	100	0.2	2
lac6	cooling trees	100	0.1	3
lac4	Urban catchment forestry	100	0	4

EcoServR: CH0403: Green Space Accessibility				
NBS	**NBS Name**	**households**	**population**	**Rank**
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

EcoServR: CH0403: Green Space Accessibility				
NBS	Site	households	population	Rank
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac4	Urban catchment forestry	454	670	4

EcoServR: CH0410: Pollinator increase			
NBS	NBS Name	% Change	Rank
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2
lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase				
NBS	NBS Name	radius (m)	% Change	Rank
lac6	cooling trees	20	1.71	1
lac17	Green filter area	20	1.65	2
lac5	shade trees	20	0.21	3
lac4	Urban catchment forestry	20	0.16	4

EcoServR: CH0410: Pollinator increase				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	100	1.91	1
lac6	cooling trees	100	1.76	2
lac4	Urban catchment forestry	100	1.23	3

lac5	shade trees	100	0.22	4

EcoServR: CH0511: Air quality improvements			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac17	Green filter area	20	21.7	1
lac6	cooling trees	20	10.0	2
lac5	shade trees	20	1.7	3
lac4	Urban catchment forestry	20		

EcoServR: CH0511: Air quality improvements				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac17	Green filter area	100	11.0	1
lac6	cooling trees	100	6.8	2
lac5	shade trees	100	1.1	3
lac4	Urban catchment forestry	100		

QUANTITATIVE DATA SUMMARY			
CH0902: Walking			
NBS	**NBS Name**	**% Change**	**Rank**

LAc5	shade trees	13.9	1
LAc6	cooling trees	13.9	1
LAc12	Pollinator verges and spaces	2.3	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY

CH0902: Walking		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc12	Baltic POLL	1090	2	541.5	398.8	468	2	642.8	433.4	18.7	1
LAc5	Shade_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	2
LAc6	Cooling_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	3
LAc12	Strand POLL	620	1	778.1	457.1	159	1	737.7	360.6	-5.2	4
LAc12	Ullet Rd POLL	411	1	1536.0	483.0	368	1	1433.0	441.8	-6.7	5
LAc1	Green_Route_1	2337	3	683.1	408.4						

QUANTITATIVE DATA SUMMARY

CH0903: Cycling

NBS	**NBS Name**	**% Change**	**Rank**
LAc5	shade trees	86.1	1
LAc6	cooling trees	86.1	1
LAc12	Pollinator verges and spaces	-5.7	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY

CH0903: Cycling		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc5	Shade_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	1
LAc6	Cooling_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	2
LAc12	Baltic POLL	1090	2	48.6	41.1	468	2	54.8	28.0	12.7	3
LAc12	Ullet Rd POLL	411	1	311.7	157.5	368	1	285.8	123.0	-8.3	4
LAc12	Strand POLL	620	1	75.4	44.5	159	1	59.2	20.8	-21.4	5
LAc1	Green_Route_1	2337	3	105.1	108.7						

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon stored, carbon sequestered, temperature reduction, water slowed, green space accessibility, pollinator capacity, and value of air quality improvements.

Quantitative data results positive influences for thermal cooling and on walking and cycling levels.

A high order of ranking as opposed to other NBS were found for:

- Temperature reduction, particularly at close radii distances
- Water slowed down at higher radii distances,
- Green space accessibility
- Walking levels
- Cycling levels

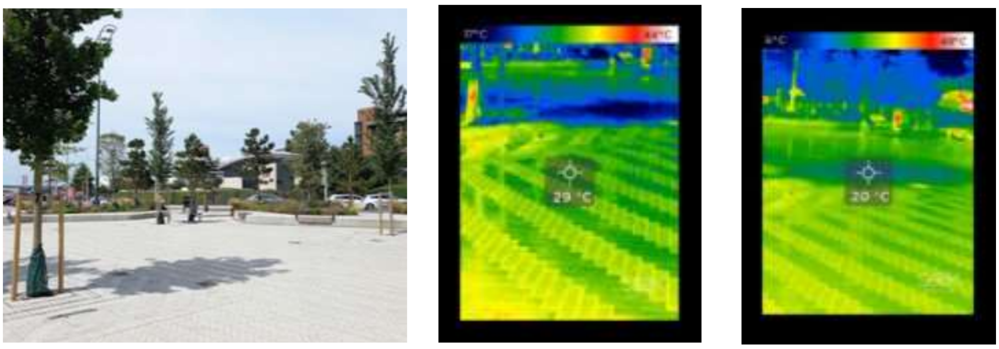
Lower rankings were found for:

- Carbon storage and sequestration
- Modelled pollinator increase
- Air quality improvements

Form the percentage change data tables, shade trees seemed to have great influences on temperature reduction and green space accessibility with slightly greater effects on the cycling levels than the walking levels.

An example of a summary slide for the thermal imaging data and modelling data is as below:

Shade tree thermal imaging data



GI VAL Data Grab DRAFT DATA

Function	Tools	Benefit Quantification
Carbon storage and sequestration	Carbon sequestered by trees	155,000kgCO2e sequestered
	Carbon sequestered through other land use change	507 kgCO2e sequestered

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*

Some amenity sites known to have underground utilities or be close to roads and require root containment.	Surveys used to locate underground utilities and root barriers specified in relevant works
Economical barriers	How they have been addressed
None	N/A
Social barriers	How they have been addressed
Consultation required with owners and not all wanted trees Agreements were required with the Housing provider re risk and aftercare	Housing provider over-ruled those residents not wanting trees
Environmental (including COVID)	How they have been addressed
Works were delayed due to covid and the unavailability of staff and equipment to complete the planting. Large equipment was needed for the larger sized trees which was difficult to locate during lockdown. Some trees had to be held in the maintenance yard for several months awaiting planting	Works were delayed on site Works were delayed on site Trees were watered by staff working through the pandemic.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Ground in the registered provider gardens was quite stony and hard to work. Ground at the amenity space in Demo A contained underground utilities and demolition waste.	Softer areas were selected. Utilities were mapped and avoided. Hand tools were used near underground utilities.

Land in Demos B and C was close to highways and root barrier protection was required	Root barrier was used in locations close to roads and utilities.

Economical barriers	How they have been addressed
No further issues were raised	N/A
Social barriers	How they have been addressed
No issues were raised. Residents not previously wanting trees changed their minds and 2 more asked for trees	Additional trees were provided
Environmental (including COVID)	How they have been addressed
Irrigation was an issue during periods of lockdown	City council staff included all new trees on their irrigation program for a period of time during the first lockdown

2.2.6 Lac 6 Cooling trees

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0106; CH0108; CH0111; CH0212; CH0404; CH0501; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Cooling trees LAc 6	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Works completed by February 2021 and March 2022	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Cooling Tree locations

Demo A – Cooling Trees

Cooling trees in 1.5m x 1.5m x 1m green containers made from recycled resin.

Left: Internal fixing point for guy ropes for tree root balls

Demo B – Cooling Trees

2 cooling trees planted at location 5 as part of the Strand connectivity wider works and 7 cooling/filter trees included on the highway.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	5.0	yes	yes
01	CH0104	CARBON SEQUESTRATION	5.0	yes	yes
01	CH0105	TEMPERATURE DECREASE	4.8	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	4.0	yes	yes
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.4	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	2.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	2.0	yes	yes
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	2.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	2.0	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	2.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	4.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	3.0	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	3.0	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	1.0	yes	yes
04	CH0411	PLANT SPECIES INCREASE	1.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	1.0	yes	
04	CH0413	INSECTIVORE INCREASE	1.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	
05	CH0504	NOx TRENDS	3.7	yes	
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	yes
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	3.5	yes	
07	CH0703	SOCIAL LEARNING	3.5	yes	

07	CH0705	ENGAGEMENT WITH NBS	3.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	2.0	yes	
09	CH0903	CYCLING AREA INCREASE	2.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	3.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	NBS name	EcoServR: CH0103: Carbon storage (tC)	Rank
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	NBS	EcoServR: CH0104: Carbon sequestration	Rank
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		

lac16	Floating gardens		

EcoServR: CH0104: Carbon sequestration (tCO2e)			
NBS	NBS Name	Carbon sequestration (tCO2e)	Rank
lac17	Green filter area	-0.87	1
lac6	cooling trees	-0.62	2
lac5	shade trees	-0.45	3
lac4	Urban catchment forestry	-0.13	4

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			
LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		
LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0106: Temperature reduction			
ranked NBS	NBS Name	% Change	Rank
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2

lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4
lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0106: Temperature reduction				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac5	shade trees	20	109.98	
lac6	cooling trees	20		
lac17	Green filter area	20		

EcoServR: CH0106: Temperature reduction				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac6	cooling trees	100	46.66	1
lac17	Green filter area	100	44.67	2
lac5	shade trees	100	9.36	3

EcoServR: CH0204: Water slowed down			
ranked NBS	**NBS**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down				
NBS	NBS Name	radius (m)	% Change	Rank
lac6	cooling trees	20	4.4	1
lac17	Green filter area	20	2.6	2
lac5	shade trees	20	1.7	3
lac4	Urban catchment forestry	20		

EcoServR: CH0204: Water slowed down				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	100	0.4	1
lac5	shade trees	100	0.2	2
lac6	cooling trees	100	0.1	3
lac4	Urban catchment forestry	100	0	4

EcoServR: CH0403: Green Space Accessibility				
NBS	NBS Name	households	population	Rank
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

EcoServR: CH0403: Green Space Accessibility				
NBS	Site	households	population	Rank
lac5	shade trees	3413	5817	1

lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac4	Urban catchment forestry	454	670	4

EcoServR: CH0410: Pollinator increase			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2
lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac6	cooling trees	20	1.71	1
lac17	Green filter area	20	1.65	2
lac5	shade trees	20	0.21	3
lac4	Urban catchment forestry	20	0.16	4

EcoServR: CH0410: Pollinator increase				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac17	Green filter area	100	1.91	1
lac6	cooling trees	100	1.76	2
lac4	Urban catchment forestry	100	1.23	3
lac5	shade trees	100	0.22	4

EcoServR: CH0511: Air quality improvements

NBS	NBS Name	% Change	Rank
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	20	21.7	1
lac6	cooling trees	20	10.0	2
lac5	shade trees	20	1.7	3
lac4	Urban catchment forestry	20		

EcoServR: CH0511: Air quality improvements				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	100	11.0	1
lac6	cooling trees	100	6.8	2
lac5	shade trees	100	1.1	3
lac4	Urban catchment forestry	100		

QUANTITATIVE DATA SUMMARY			
CH0902: Walking			
NBS	NBS Name	% Change	Rank
LAc5	shade trees	13.9	1
LAc6	cooling trees	13.9	1
LAc12	Pollinator verges and spaces	2.3	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY											
CH0902: Walking		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Baltic POLL	1090	2	541.5	398.8	468	2	642.8	433.4	18.7	1
LAc5	Shade_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	2
LAc6	Cooling_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	3
LAc12	Strand POLL	620	1	778.1	457.1	159	1	737.7	360.6	-5.2	4
LAc12	Ullet Rd POLL	411	1	1536.0	483.0	368	1	1433.0	441.8	-6.7	5
LAc1	Green_Route_1	2337	3	683.1	408.4						

QUANTITATIVE DATA SUMMARY			
CH0903: Cycling			
NBS	NBS Name	% Change	Rank
LAc5	shade trees	86.1	1
LAc6	cooling trees	86.1	1
LAc12	Pollinator verges and spaces	-5.7	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY											
CH0903: Cycling		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc5	Shade_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	1
LAc6	Cooling_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	2
LAc12	Baltic POLL	1090	2	48.6	41.1	468	2	54.8	28.0	12.7	3
LAc12	Ullet Rd POLL	411	1	311.7	157.5	368	1	285.8	123.0	-8.3	4
LAc12	Strand POLL	620	1	75.4	44.5	159	1	59.2	20.8	-21.4	5
LAc1	Green_Route_1	2337	3	105.1	108.7						

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon stored, carbon sequestered, temperature reduction, water slowed, green space accessibility, pollinator capacity, and value of air quality improvements.

Quantitative data results positive influences for thermal cooling and on walking and cycling levels.

A high order of ranking as opposed to other NBS were found for:

- Temperature reduction, particularly at close radii distances
- Water slowed down at higher radii distances,
- Green space accessibility
- Modelled pollinator increase
- Walking levels
- Cycling levels

Lower rankings were found for:

- Carbon storage and sequestration
- Air quality improvements

Form the percentage change data tables, cooling trees seemed to have great influences on temperature reduction and green space accessibility with slightly greater effects on the cycling levels than the walking levels. The cooling tree species were generally ranked higher than the shade tree species for all categories.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Containers were made bespoke and required design	Design included internal fixing point for guy roping tree rootballs
Tree species needed to be robust	Appropriate species selected
Irrigation would be required	Irrigation system included within containers
Trees and containers would be heavy	Forklift truck needed to move containers
Locations required visibility splay assessment, lines of sight, clear stemmed species, road safety audit and avoidance of utility access points	Final locations considered these aspects

Economical barriers	How they have been addressed
The initial set of container trees died due to being stored too long and replacement stock had to be ordered	Replacement stock ordered

Social barriers	How they have been addressed
Consultation only possible by letter drop at the time (Covid)	Letters and plans of work sent to local residents

Environmental (including COVID)	How they have been addressed
Works were delayed due to problems with lockdown and then with a backlog of orders with contractors. Container trees required replacing. It was hard to get the works rescheduled after covid as there were many competing demands.	Container trees stored in yard (unsuccessfully) Container delivery time increased so works were rescheduled.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*

Trees in containers were heavy to lift	Forklift used (some minor damage to containers which will be rectified)
Container trees installed directly onto pavement and not bearers so could not be easily moved without dis-assembly	Bearers to be used under containers
Economical barriers	How they have been addressed
Additional costs were required to relocate 2 of the container trees following numerous complaints by adjacent residents.	Costs included within project allocation
Social barriers	How they have been addressed
Resident accepting container trees later complained about them attracting anti social behaviour	Trees were relocated.
Environmental (including COVID)	How they have been addressed
Works were delayed due to covid as it was hard to get a delivery slot and staff capacity	Trees in containers were installed late.

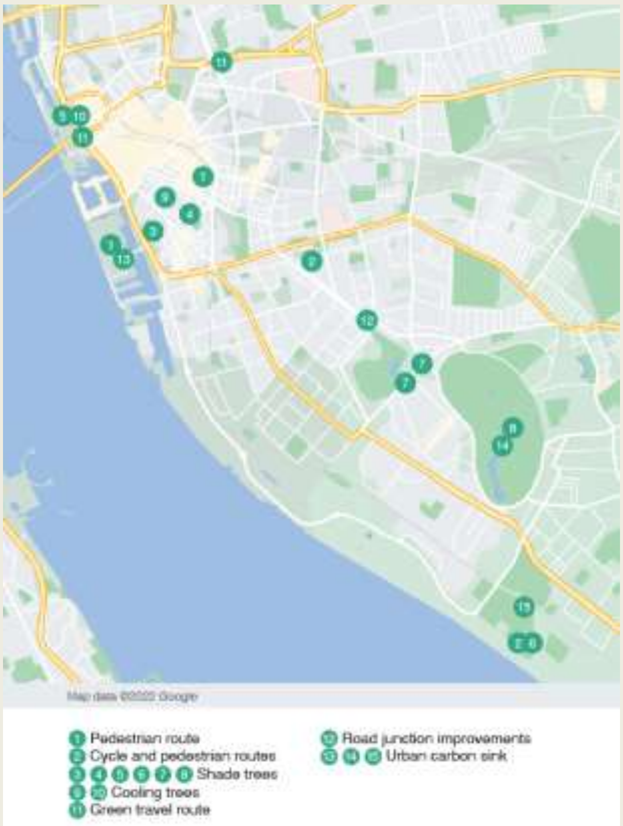
2.2.7 Lac7 Urban carbon sink

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0106; CH0111; CH0201; CH0212; CH0404; CH0501; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Urban carbon sink LAc7	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Various dates between June 2020-May 2022	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Urban carbon sink locations



Demo A -urban carbon sink examples

Above L to R: Island planting, green wall vegetation and various pollinator planting sites



Above: Pollinator planting, tree planting and raingarden planting examples

Demo B – Urban carbon sink examples



Examples of urban carbon sink in Demo B.

Above L to R: St Johns Green wall, Liverpool ONE green wall and a pollinator roof.

Left: An examples of various tree planting schemes

Demo C – Urban carbon sink




Examples of urban carbon sinks in Demo C

Top left: Tree and pollinator planting Ullet Road.

Top right: Sefton Park floating ecosystem

Bottom left: wildflower meadows and aquatic planting at Otterspool Park

Bottom right: Mini orchard and tree planting Otterspool Park

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	4.7	yes	
01	CH0104	CARBON SEQUESTRATION	4.7	yes	
01	CH0105	TEMPERATURE DECREASE	4.0	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	4.2	yes	

01	CH0108	HEATWAVE RISK	4.2	yes	
01	CH0111	SPECIES MOVEMENT	4.4	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	1.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	1.0	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	2.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	2.0	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	1.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	4.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	2.5	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	2.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	2.8	yes	
04	CH0411	PLANT SPECIES INCREASE	2.8	yes	
04	CH0412	FLORAL RESOURCES INCREASE	2.8	yes	
04	CH0413	INSECTIVORE INCREASE	2.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	3.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	4.0	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	4.0	yes	
05	CH0504	NOx TRENDS	4.0	yes	
05	CH0505	Sox TRENDS	4.0	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	2.5	yes	
07	CH0702	CITIZEN PERCEPTION	2.5	yes	
07	CH0703	SOCIAL LEARNING	2.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	2.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	1.0	yes	
09	CH0903	CYCLING AREA INCREASE	1.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	2.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

No direct monitoring data was obtained for this NBS, but the combination of corresponding KPIs and other NBS provide evidence for the positive influence of this NBS.

An example of the GI-Val calculation for the overall effect of the NBS is as below:

GI-VAL DRAFT

Climate, Water, Biodiversity

SUMMARY OF QUANTITIES

BENEFITS			BENEFIT QUANTIFICATION
Benefits groups	Functions	Tools	
1 Climate Change Adaptation & Mitigation	Shelter from wind	1.1 Reduced building energy consumption for heating	0 kWh/yr energy saved
		1.2 Avoided carbon emissions from building energy saving for heating	0 $kgCO_2/yr$ not emitted
	Reduction of urban heat island effect	1.4 Reduced peak summer surface temperatures	6.32 °C in surf. temperature reduction
	Cooling through shading and evapo-transpiration	1.5 Reduced building energy consumption for for cooling	298 kWh/yr energy saved
		1.6 Avoided carbon emissions from building energy saving for cooling	149 $kgCO_2$ not emitted
	Carbon storage and sequestration	1.7 Carbon sequestered by trees	155,000 $kgCO_2e$ sequestered
		1.8 Carbon sequestered through other land use change	507 $kgCO_2e$ sequestered
2 Water management & Flood Alleviation	Interception, storage and infiltration of rainwater	2.1 Energy and carbon emissions savings from reduced stormwater volume entering combined sewers	6,170,000 L/yr water diverted from sewers
10 Biodiversity	Provision of recreation opportunities	10.1 Willingness to pay for protection or enhancement of biodiversity	0.16 Ha of land of biodiversity value added

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The issues for each intervention are addressed separately under their relevant NBS classification	The issues for each intervention are addressed separately under their relevant NBS classification

Economical barriers	How they have been addressed

As above	As above
Social barriers	How they have been addressed
As above	As above
Environmental (including COVID)	How they have been addressed
As above	As above

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The issues for each intervention are addressed separately under their relevant NBS classification	The issues for each intervention are addressed separately under their relevant NBS classification
Economical barriers	How they have been addressed
As above	As above
Social barriers	How they have been addressed
As above	As above
Environmental (including COVID)	How they have been addressed
As above	As above

2.2.8 Lac8 SuDs raingarden

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0108; CH0111; CH0201; CH0204; CH0207; CH0209; CH0217; CH0218; CH0403; CH0404; CH0410; CH0411; CH0412; CH0413; CH0501; CH0502; CH0503; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513;	SuDs raingarden Lac8	LIV/UoL/CFT

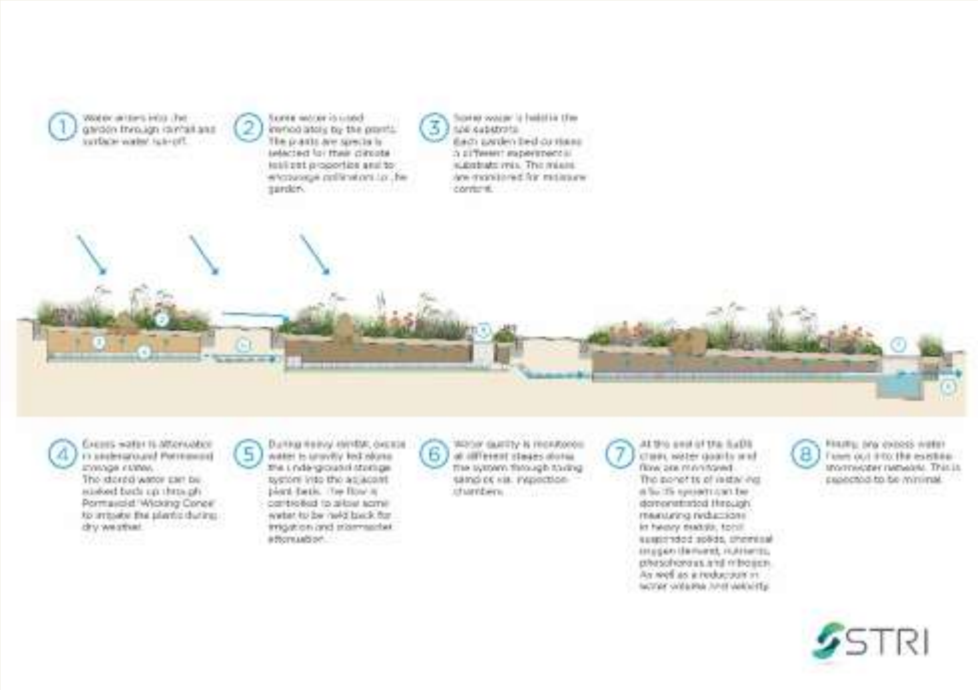
CH0602; CH0703; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;		
CITY	*DATE OF IMPLEMENTATION*	
LIV	June 2022	

Results and Discussion

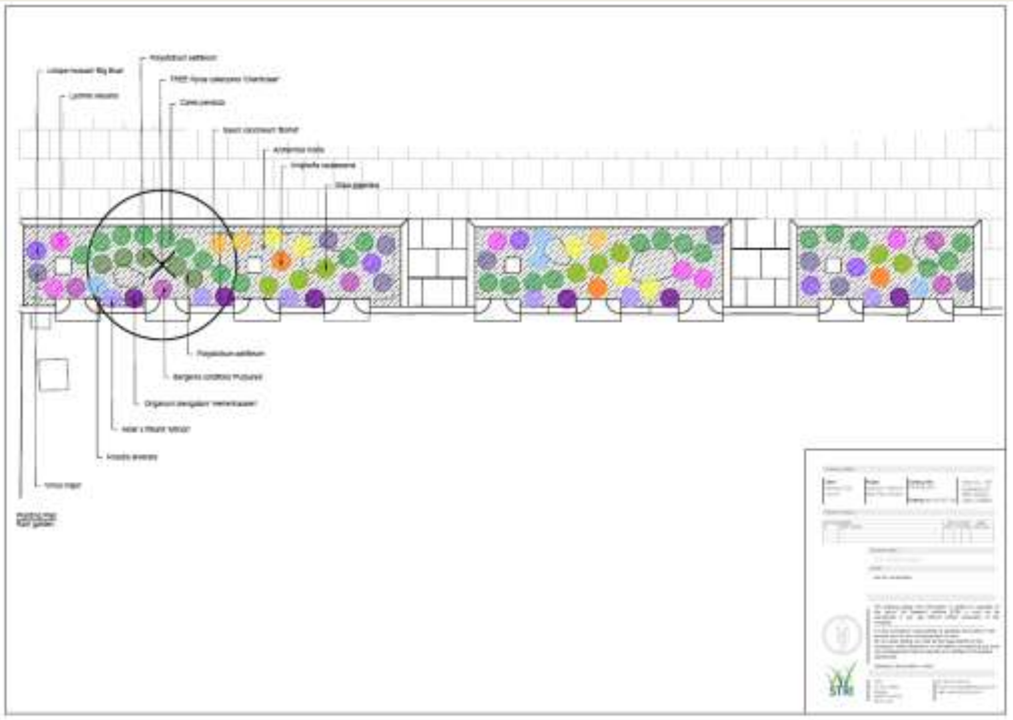
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Demo A raingarden location number 2

Raingarden Design



Planting design of pollinator beds



Before and After

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	2.3	yes	yes
01	CH0104	CARBON SEQUESTRATION	2.3	yes	yes
01	CH0105	TEMPERATURE DECREASE	4.0	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	3.7	yes	yes
01	CH0108	HEATWAVE RISK	2.0	yes	
01	CH0111	SPECIES MOVEMENT	4.6	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	4.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	3.5	yes	no
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	5.0	Inconclusive	Inconclusive
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	5.0	Inconclusive	no
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	3.5	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	5.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	2.5	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	2.5	yes	

04	CH0410	POLLINATOR SPECIES INCREASE	3.7	yes	yes
04	CH0411	PLANT SPECIES INCREASE	3.7	yes	yes
04	CH0412	FLORAL RESOURCES INCREASE	3.7	yes	yes
04	CH0413	INSECTIVORE INCREASE	3.8	yes	yes
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.2	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	2.0	yes	yes
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	2.0	yes	yes
05	CH0504	NOx TRENDS	2.0	yes	yes
05	CH0505	Sox TRENDS	2.0	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	no
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	2.0	yes	
07	CH0702	CITIZEN PERCEPTION	2.0	yes	
07	CH0703	SOCIAL LEARNING	2.0	yes	
07	CH0705	ENGAGEMENT WITH NBS	2.0	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	2.3	yes	
09	CH0903	CYCLING AREA INCREASE	2.3	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	2.0	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	NBS name	EcoServR: CH0103: Carbon storage (tC)	Rank
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4

lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

SuDs & Rain Garden	**EcoServR: CH0103: Carbon storage (tC)**	**Rank**
Upper Pitt St RG	0.75	1
Lower SuDS	0.00	2
Upper SuDS	0.00	3

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	**NBS**	**EcoServR: CH0104: Carbon sequestration**	**Rank**
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

EcoServR: CH0104: Carbon sequestration (tCO2e)		
SuDs & Rain Garden	**Carbon sequestration (tCO2e)**	**Rank**
Lower SuDS	-1.45	1
Upper SuDS	-0.21	2
Upper Pitt St RG		

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			
LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		
LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0106: Temperature reduction			
ranked NBS	NBS Name	% Change	Rank
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2
lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4
lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0106: Temperature reduction			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Lower SuDS	20	2.28	1
Upper SuDS	20	-1.90	2
Upper Pitt St RG	20		

EcoServR: CH0106: Temperature reduction			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Lower SuDS	100	2.18	1
Upper SuDS	100	-1.77	2
Upper Pitt St RG	100		

EcoServR: CH0204: Water slowed down			
ranked NBS	**NBS**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Upper Pitt St RG	20	0.0	1
Lower SuDS	20	-24.3	2
Upper SuDS	20	-31.0	3

EcoServR: CH0204: Water slowed down			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Upper Pitt St RG	100	0.0	1
Upper SuDS	100	-2.7	2
Lower SuDS	100	-3.1	3

QUANTITATIVE DATA SUMMARY						
CH0207 Water		**% Change**				
NBS	**NBS name**	**Specific Conductivity**	**Dissolved Oxygen**	**Combined Nitrogen**	**Phosphate**	**All metals**
LAc4	Urban catchment forestry	57.8	26.2	90.0	510.0	-13.2
LAc8	SuDs & Rain Garden	-15.1	-4.6	-8.8	76.9	21.1
LAc16	Floating gardens	13.8	-5.2	-43.1	48.9	29.3

QUANTITATIVE DATA SUMMARY											
CH0207 Water % Change Metals in Solution											
NBS	**NBS Name**	**Arsenic**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**	**Iron**	**Manganese**	**Nickel**	**Lead**	**Zinc**
LAc4	**Strand Tree SuDS**	119		-41	-8	-17	-49	-61	-17	-41	-37
LAc8	**Lower SuDS**			-89		489	186	66	38		-63
LAc8	**Upper Pitt St RG**										
LAc8	**Upper SuDS**			-92		10	18	10	-55	-8	9
LAc16	**SPL FI**			-99		0	35	23	-16	48	11

QUANTITATIVE DATA SUMMARY					
CH0207 Water % Change Nutrients in Solution					
NBS	**NBS Name**	**Ammonium (N-NH4)**	**Nitrite (N-NO2)**	**Nitrate (N-NO3)**	**Phosphate (SRP)**
LAc4	**Strand Tree SuDS**	19.2	-64.7	251.5	510.0
LAc8	**Lower SuDS**	-59.9	-6.3	214.7	94.8
LAc8	**Upper Pitt St RG**				
LAc8	**Upper SuDS**	-23.8	16.6	0.1	59.0

LAc16	SPL FI	-20.6	-56.9	-69.4	48.9

QUANTITATIVE DATA SUMMARY				
CH0209 Suspended Sediment Water		% Change		
NBS	NBS name	Organic Matter	Suspended Sediment	All Suspended Metals
LAc4	Urban catchment forestry	118.4	-74.6	8.4
LAc8	SuDs & Rain Garden	296.3	-53.8	59.8
LAc16	Floating gardens	1095.1	47.0	-6.9

QUANTITATIVE DATA SUMMARY										
CH0209 Suspended Sediment Water % Change Metals										
NBS	NBS name	Arsenic	Cadmium	Chromium	Copper	Iron	Manganese	Nickel	Lead	Zinc
LAc4	Strand Tree SuDS	12	160	-64	-78	-27	26	51	-26	31
LAc8	Upper SuDS	185	224	23	-16	34	29	48	41	51
LAc16	SPL FI	-59	207	51	-41	-43	-48	-5	-31	-29

EcoServR: CH0403: Green Space Accessibility				
NBS	NBS Name	households	population	Rank
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

QUANTITATIVE DATA SUMMARY
CH0410: Pollinator Count

NBS	NBS Name	% Change	Rank
LAc8	SuDs & Rain Garden	448.6	1
LAc12	Pollinator verges and spaces	286.6	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Count		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	3.4	2.2	928.6	1
LAc8	Upper Pitt St RG	6	1	2.3	2.1	3	1	22.3	19.3	857.1	2
LAc12	Strand POLL	4	1	3.3	2.9	6	1	29.3	24.3	802.6	3
LAc12	Park Lane POLL	3	1	2.0	3.5	7	1	12.4	11.6	521.4	4
LAc12	Top SP Aig Dr POLL	4	1	3.8	2.2	2	1	10.5	0.7	180.0	5
LAc12	Ullet Rd POLL	3	1	5.3	8.4	5	1	12.2	13.2	128.8	6
LAc12	Baltic Hub POLL	4	1	11.0	7.7	2	1	20.0	15.6	81.8	7
LAc8	Lower SuDS	4	1	6.8	5.4	11	1	9.5	11.7	40.1	8
LAc12	Lower SuDS POLL	4	1	6.8	5.4	11	1	9.5	11.7	40.1	9
LAc12	Cornwallis St POLL	10	1	5.2	9.0	3	1	3.0	5.2	-42.3	10
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	11
LAc12	Wapping POLL	5	1	2.6	5.8	2	1	1.0	1.4	-61.5	12
LAc12	Princes Av POLL					7	1	14.9	21.2		
LAc12	Princes roundabt POLL	5	1	2.8	5.7						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	12.0	15.6		
LAc13	Parr St GW	1	1	0.0		12	1	6.3	9.7		
LAc13	St Johns GW					10	1	1.9	2.7		

LAc16	Wapping FI	1	1	3.0							

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Diversity			
NBS	NBS Name	% Change	Rank
LAc12	Pollinator verges and spaces	77.7	1
LAc8	SuDs & Rain Garden	41.8	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Diversity		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	1.7	0.8	414.3	1
LAc12	Park Lane POLL	3	1	1.0	1.7	7	1	2.9	2.5	185.7	2
LAc8	Upper Pitt St RG	6	1	1.2	1.0	3	1	2.3	2.1	100.0	3
LAc12	Strand POLL	4	1	1.3	1.0	6	1	2.5	2.2	100.0	4
LAc12	Top SP Aig Dr POLL	4	1	2.3	0.5	2	1	3.0	0.0	33.3	5
LAc12	Baltic Hub POLL	4	1	3.8	1.0	2	1	4.5	0.7	20.0	6
LAc12	Ullet Rd POLL	3	1	1.0	1.0	5	1	1.2	1.3	20.0	7
LAc8	Lower SuDS	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	8
LAc12	Lower SuDS POLL	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	9
LAc12	Wapping POLL	5	1	0.6	1.3	2	1	0.5	0.7	-16.7	10
LAc12	Cornwallis St POLL	10	1	1.7	2.6	3	1	1.0	1.7	-41.2	11
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	12
LAc12	Princes Av POLL					7	1	1.6	1.6		
LAc12	Princes roundabt POLL	5	1	0.8	1.3						
LAc12	Top SP roundabt POLL	1	1	1.0							

LAc13	L1 GW					2	1	2.0	1.4		
LAc13	Parr St GW	1	1	0.0		12	1	1.3	1.2		
LAc13	St Johns GW					10	1	1.1	1.4		
LAc16	Wapping FI	1	1	1.0							

EcoServR: CH0410: Pollinator increase			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2
lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Lower SuDS	20	3.95	1
Upper Pitt St RG	20	0.60	2
Upper SuDS	20	0.03	3

EcoServR: CH0410: Pollinator increase			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Lower SuDS	100	2.31	1
Upper Pitt St RG	100	0.15	2
Upper SuDS	100	0.01	3

QUANTITATIVE DATA SUMMARY
CH0411: Plant Count

NBS	NBS Name	% Change	Rank
LAc13	Pollinator walls/vertical	1108.3	1
LAc12	Pollinator verges and spaces	77.4	2
LAc8	SuDs & Rain Garden	68.4	3
LAc16	Floating gardens	33.3	4

QUANTITATIVE DATA SUMMARY											
CH0411: Plant Count		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc13	Parr St GW	1	1	1.0		12	1	12.1	4.7	1108.3	1
LAc12	Strand POLL	4	1	3.3	0.5	6	1	12.3	3.7	279.5	2
LAc12	Park Lane POLL	3	1	4.3	2.3	7	1	9.6	5.5	120.9	3
LAc12	Wapping POLL	5	1	4.4	2.3	2	1	9.0	4.2	104.5	4
LAc8	Upper Pitt St RG	6	1	4.2	2.6	3	1	7.7	2.3	84.0	5
LAc12	Baltic Hub POLL	4	1	7.3	2.5	2	1	11.5	0.7	58.6	6
LAc8	Lower SuDS	4	1	1.3	0.5	11	1	1.9	0.5	52.7	7
LAc12	Lower SuDS POLL	4	1	1.3	0.5	11	1	1.9	0.5	52.7	8
LAc12	Bott SP Aig Dr POLL	3	1	1.3	0.6	7	1	2.0	0.0	50.0	9
LAc12	Top SP Aig Dr POLL	4	1	1.5	0.6	2	1	2.0	0.0	33.3	10
LAc16	SPL FI	2	1	1.5	0.7	1	1	2.0		33.3	11
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.8	0.4	8.0	12
LAc12	Cornwallis St POLL	10	1	5.6	2.3	3	1	5.0	1.0	-10.7	13
LAc12	Princes Av POLL					7	1	1.9	0.4		
LAc12	Princes roundabt POLL	5	1	1.4	0.5						
LAc12	Top SP roundabt POLL	1	1	2.0							
LAc13	L1 GW					2	1	2.0	0.0		
LAc13	St Johns GW					10	1	12.4	3.2		
LAc16	Wapping FI	1	1	4.0							

QUANTITATIVE DATA SUMMARY			
CH0411: Plant diversity			
NBS	NBS Name	% Change	Rank
LAc13	Pollinator walls/vertical	541.7	1
LAc12	Pollinator verges and spaces	55.0	2

LAc8	SuDs & Rain Garden	52.4	3
LAc16	Floating gardens	0.0	4

QUANTITATIVE DATA SUMMARY											
CH0411: Plant diversity		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc13	Parr St GW	1	1	1.0		12	1	6.4	2.4	541.7	1
LAc12	Park Lane POLL	3	1	2.7	0.6	7	1	6.3	3.5	135.7	2
LAc12	Strand POLL	4	1	3.3	0.5	6	1	7.5	2.1	130.8	3
LAc12	Wapping POLL	5	1	3.0	1.6	2	1	5.5	0.7	83.3	4
LAc12	Bott SP Aig Dr POLL	3	1	1.0	0.0	7	1	1.7	0.5	71.4	5
LAc8	Upper Pitt St RG	6	1	3.2	1.6	3	1	5.3	1.2	68.4	6
LAc12	Top SP Aig Dr POLL	4	1	1.3	0.5	2	1	2.0	0.0	60.0	7
LAc12	Baltic Hub POLL	4	1	3.8	1.5	2	1	5.5	0.7	46.7	8
LAc8	Lower SuDS	4	1	1.0	0.0	11	1	1.4	0.5	36.4	9
LAc12	Lower SuDS POLL	4	1	1.0	0.0	11	1	1.4	0.5	36.4	10
LAc16	SPL FI	2	1	1.0	0.0	1	1	1.0		0.0	11
LAc12	Cornwallis St POLL	10	1	4.7	1.3	3	1	3.3	0.6	-29.1	12
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.0	0.0	-40.0	13
LAc12	Princes Av POLL					7	1	1.3	0.5		
LAc12	Princes roundabt POLL	5	1	1.2	0.4						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	2.0	0.0		
LAc13	St Johns GW					10	1	7.4	1.8		
LAc16	Wapping FI	1	1	2.0							

QUANTITATIVE DATA SUMMARY			
CH0412: Flower Count			
NBS	NBS Name	% Change	Rank
LAc12	Pollinator verges and spaces	510.8	1
LAc8	SuDs & Rain Garden	328.7	2
LAc13	Pollinator walls/vertical	228.8	3
LAc16	Floating gardens	-10.8	4

QUANTITATIVE DATA SUMMARY											
CH0412: Flower Count		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc 12	Bott SP Aig Dr POLL	3	1	28.0	14.8	7	1	528.1	935.8	1786.2	1
LAc 12	Park Lane POLL	3	1	37.3	24.9	7	1	401.3	470.9	974.9	2
LAc 12	Strand POLL	4	1	67.0	23.6	6	1	565.3	411.1	743.8	3
LAc 8	Lower SuDS	4	1	37.0	23.9	11	1	267.5	205.8	623.1	4
LAc 12	Lower SuDS POLL	4	1	37.0	23.9	11	1	267.5	205.8	623.1	5
LAc 13	Parr St GW	1	1	50.0		12	1	164.4	190.8	228.8	6
LAc 12	Cornwallis St POLL	10	1	84.8	124.6	3	1	233.3	182.4	175.2	7
LAc 12	Top SP Aig Dr POLL	4	1	660.3	1043.5	2	1	1487.5	1594.5	125.3	8
LAc 12	Wapping POLL	5	1	196.6	293.5	2	1	319.0	161.2	62.3	9
LAc 12	Ullet Rd POLL	3	1	170.7	246.3	5	1	269.4	92.6	57.9	10
LAc 12	Baltic Hub POLL	4	1	326.0	178.6	2	1	483.0	521.8	48.2	11
LAc 8	Upper Pitt St RG	6	1	94.8	58.7	3	1	127.3	42.1	34.3	12
LAc 16	SPL FI	2	1	115.5	92.6	1	1	103.0		-10.8	13
LAc 12	Princes Av POLL					7	1	402.3	563.9		
LAc 12	Princes roundabt POLL	5	1	98.2	144.5						
LAc 12	Top SP roundabt POLL	1	1	135.0							
LAc 13	L1 GW					2	1	206.0	217.8		
LAc 13	St Johns GW					10	1	378.2	368.5		
LAc 16	Wapping FI	1	1	162.0							

QUANTITATIVE DATA SUMMARY			
CH0502: PM 2.5			
NBS	NBS Name	% Change	Rank
LAc8	SuDs & Rain Garden	-62.6	1
LAc14	Pollinator roofs	-57.3	2

LAc4	Urban catchment forestry	-49.3	3
LAc17	Green filter area	-13.8	4
LAc13	Pollinator walls/vertical	-7.4	5
LAc12	Pollinator verges and spaces	9.0	6

QUANTITATIVE DATA SUMMARY											
CH0502: PM 2.5		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc8	Upper Pitt St RG	30	2	9.9	13.9	2	2	2.0	0.0	-79.8	1
LAc14	Royal Court GR	2	1	26.0	8.5	35	1	11.1	7.5	-57.3	2
LAc4	Strand Tree SuDS	110	4	11.7	13.1	40	4	6.0	6.1	-49.3	3
LAc8	Upper SuDS	18	2	9.2	5.5	22	2	5.0	3.0	-45.3	4
LAc13	Parr St GW	15	1	11.0	7.1	42	2	6.8	7.6	-37.9	5
LAc13	St Johns GW	29	2	15.6	8.5	47	5	9.9	6.8	-36.3	6
LAc17	Lime St TREES	86	3	10.0	8.3	10	3	6.8	7.2	-31.9	7
LAc17	Stafford St TREES	50	2	8.1	6.5	18	2	8.4	7.5	4.3	8
LAc12	Cornwallis St POLL	33	1	8.3	7.7	3	1	9.0	5.6	8.8	9
LAc12	Bott SP Aig Dr POLL	24	1	7.3	5.9	2	1	8.0	2.8	9.1	10
LAc13	L1 GW	30	3	5.3	2.8	70	7	8.1	8.7	52.0	11

QUANTITATIVE DATA SUMMARY			
CH0503: PM 10			
NBS	NBS Name	% Change	Rank
LAc14	Pollinator roofs	-49.3	1
LAc4	Urban catchment forestry	-36.7	2
LAc8	SuDs & Rain Garden	-27.7	3
LAc13	Pollinator walls/vertical	-14.1	4
LAc17	Green filter area	30.2	5
LAc12	Pollinator verges and spaces	32.8	6

QUANTITATIVE DATA SUMMARY			
CH0503: PM 10	Pre-Intervention	Post-Intervention	% Change

NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc14	Royal Court GR	2	1	37.5	7.8	35	1	19.0	8.9	-49.3	1
LAc8	Upper Pitt St RG	30	2	16.7	15.8	2	2	10.5	0.7	-37.1	2
LAc4	Strand Tree SuDS	110	4	19.6	14.5	40	4	12.4	9.5	-36.7	3
LAc13	Parr St GW	15	1	19.0	9.1	42	2	12.4	7.5	-34.8	4
LAc13	St Johns GW	29	2	24.0	11.7	47	5	16.0	8.6	-33.5	5
LAc8	Upper SuDS	18	2	16.8	5.9	22	2	13.7	7.7	-18.2	6
LAc17	Lime St TREES	86	3	18.6	12.8	10	3	21.7	15.8	16.7	7
LAc13	L1 GW	30	3	13.0	6.8	70	7	16.4	11.2	26.0	8
LAc12	Bott SP Aig Dr POLL	24	1	15.0	9.0	2	1	19.5	9.2	30.0	9
LAc12	Cornwallis St POLL	33	1	14.8	8.8	3	1	20.0	7.0	35.5	10
LAc17	Stafford St TREES	50	2	14.5	7.4	18	2	20.8	17.4	43.7	11

QUANTITATIVE DATA SUMMARY			
CH0504: NO2			
NBS	NBS Name	% Change	Rank
LAc14	Pollinator roofs	-25.8	1
LAc8	SuDs & Rain Garden	-19.8	2
LAc13	Pollinator walls/vertical	-15.5	3
LAc4	Urban catchment forestry	-13.7	4
LAc17	Green filter area	-8.1	5
LAc12	Pollinator verges and spaces	-7.9	6

EcoServR: CH0511: Air quality improvements			
NBS	NBS Name	% Change	Rank
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7

lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Upper Pitt St RG	20	5.5	1
Lower SuDS	20	-4.0	2
Upper SuDS	20	-8.1	3

EcoServR: CH0511: Air quality improvements			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Upper Pitt St RG	100	4.6	1
Lower SuDS	100	-2.6	2
Upper SuDS	100	-5.2	3

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon storage, carbon sequestration, temperature reduction, green space accessibility, pollinator capacity, air quality, but not for water slowed or value of air quality reduction.

Quantitative data results positive influences on combined nutrients in solution, pollinator increase, plant diversity and floral abundance, air quality, but not for metals in solution or suspended sediment.

Metals in the water showed an increased effect for combined metals in solution and in suspended sediment. Nutrients within solution were reduced for combined nitrogen, but increased for phosphate. As there was no pre-intervention data for the raingarden, a percentage change with the introduction of the intervention could not be established.

A high order of ranking as opposed to other NBS for the raingarden were found for:

- Carbon storage
- Carbon sequestration
- Pollinator increase and diversity
- Floral abundance
- Air quality (PM2.5, PM10 and NO2)

Lower rankings for the raingarden were found for:

- Temperature reduction (modelled)

- Water slowed down (modelled), although of more effect than the water retention ponds
- Green space accessibility
- Pollintator capacity (modelled)
- Plant count and diversity
- Air quality (modelled), although higher than water retention ponds

The highest percentage changes creating a positive effect were for pollinator increase and diversity, plant divesity and floral abundance.

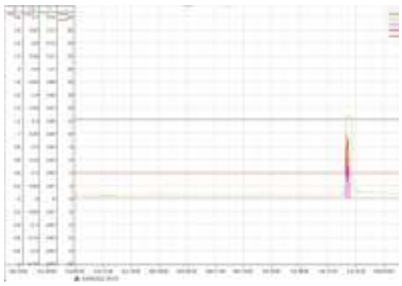
An example of a snapshot of data from from the water flow meters is as below:

Rain garden snapshot plots

Precipitation over time

Screen grab byepg Sunday 04/09/22 am to Tuesday09/09/22 pm

Depth, Velocity, Flow over time



For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*

Utilities needing to cross site Modelling of rainwater and rainwater flow Securing agreed planting species Licenses and permissions Installation of monitoring equipment One original site had large void Procurement approach of consortium created concern	Root barrier wrapped through silva cells Specialist highways engineers Securing in nursery Regular contact with highways and utilities Discussions with contractor on site Works here could not be progressed Senior mangers approved but it took time
Economical barriers	How they have been addressed
Increased costs for improved monitoring Costs for section 50, section 106 and TTRO traffic permits	Contingency being considered Council waived some, utility company costs within contingency
Social barriers	How they have been addressed
None – but design was in liaison with accessibility officer	N/A
Environmental (including COVID)	How they have been addressed
Procurement issues as no valid returns on 2 occasions during lockdown year and then delayed by prioritization of procurement for personal protective equipment	Consortium of companies assembled together Works delayed for installation

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Initial rejection of one license	Call to utilities and resubmission
Economical barriers	How they have been addressed
Potential need to excavate deeper to make sewer connection	Additional costs to come from contingency
Social barriers	How they have been addressed

None	N/A
Environmental (including COVID)	How they have been addressed
None during implementation	N/A

2.2.9 Lac8 SuDs water retention ponds

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0108; CH0111; CH0201; CH0204; CH0207; CH0209; CH0217; CHO218; CH0403; CH0404; CH0410; CH0411; CH0412; CH0413; CH0501; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0703; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	SuDs water retention ponds Lac8	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	June 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Demo C water retention ponds location 3	Water retention pond top pond	Water retention pond lower pond
		

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	2.3	yes	yes
01	CH0104	CARBON SEQUESTRATION	2.3	yes	yes
01	CH0105	TEMPERATURE DECREASE	4.0	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	3.7	yes	yes
01	CH0108	HEATWAVE RISK	2.0	yes	
01	CH0111	SPECIES MOVEMENT	4.6	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	4.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	3.5	yes	no
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	5.0	Inconclusive	Inconclusive
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	5.0	Inconclusive	no
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	3.5	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	5.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	2.5	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	2.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	2.3	yes	yes
04	CH0411	PLANT SPECIES INCREASE	2.3	yes	yes
04	CH0412	FLORAL RESOURCES INCREASE	2.3	yes	yes
04	CH0413	INSECTIVORE INCREASE	3.8	yes	yes
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.2	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	2.0	yes	yes
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	2.0	yes	yes
05	CH0504	NOx TRENDS	2.0	yes	yes
05	CH0505	Sox TRENDS	2.0	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	no

05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	2.0	yes	
07	CH0702	CITIZEN PERCEPTION	2.0	yes	
07	CH0703	SOCIAL LEARNING	2.0	yes	
07	CH0705	ENGAGEMENT WITH NBS	2.0	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	2.3	yes	
09	CH0903	CYCLING AREA INCREASE	2.3	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	2.0	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	NBS name	EcoServR: CH0103: Carbon storage (tC)	Rank
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

SuDs & Rain Garden	EcoServR: CH0103: Carbon storage (tC)	Rank
Upper Pitt St RG	0.75	1
Lower SuDS	0.00	2
Upper SuDS	0.00	3

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	**NBS**	**EcoServR: CH0104: Carbon sequestration**	**Rank**
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

EcoServR: CH0104: Carbon sequestration (tCO2e)		
SuDs & Rain Garden	**Carbon sequestration (tCO2e)**	**Rank**
Lower SuDS	-1.45	1
Upper SuDS	-0.21	2
Upper Pitt St RG		

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			

LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		
LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0106: Temperature reduction			
ranked NBS	**NBS Name**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2
lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4
lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0106: Temperature reduction		
SuDs-Water retention ponds	**% Change**	**Rank**
Lower SuDs	2.2	1
Upper SuDs	-1.8	2

EcoServR: CH0106: Temperature reduction			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Lower SuDS	20	2.28	1
Upper SuDS	20	-1.90	2
Upper Pitt St RG	20		

EcoServR: CH0106: Temperature reduction

SuDs & Rain Garden	radius (m)	% Change	Rank
Lower SuDS	100	2.18	1
Upper SuDS	100	-1.77	2
Upper Pitt St RG	100		

EcoServR: CH0204: Water slowed down			
ranked NBS	NBS	% Change	Rank
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down			
SuDs & Rain Garden	radius (m)	% Change	Rank
Upper Pitt St RG	20	0.0	1
Lower SuDS	20	-24.3	2
Upper SuDS	20	-31.0	3

EcoServR: CH0204: Water slowed down			
SuDs & Rain Garden	radius (m)	% Change	Rank
Upper Pitt St RG	100	0.0	1
Upper SuDS	100	-2.7	2
Lower SuDS	100	-3.1	3

QUANTITATIVE DATA SUMMARY	
CH0207 Water	% Change

NBS	NBS name	Specific Conductivity	Dissolved Oxygen	Combined Nitrogen	Phosphate	All metals
LAc4	Urban catchment forestry	57.8	26.2	90.0	510.0	-13.2
LAc8	SuDs & Rain Garden	-15.1	-4.6	-8.8	76.9	21.1
LAc16	Floating gardens	13.8	-5.2	-43.1	48.9	29.3

QUANTITATIVE DATA SUMMARY											
CH0207 Water % Change Metals in Solution											
NBS	NBS Name	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Manganese	Nickel	Lead	Zinc
LAc4	Strand Tree SuDS	119		-41	-8	-17	-49	-61	-17	-41	-37
LAc8	Lower SuDS			-89		489	186	66	38		-63
LAc8	Upper Pitt St RG										
LAc8	Upper SuDS			-92		10	18	10	-55	-8	9
LAc16	SPL FI			-99		0	35	23	-16	48	11

QUANTITATIVE DATA SUMMARY					
CH0207 Water % Change Nutrients in Solution					
NBS	NBS Name	Ammonium (N-NH4)	Nitrite (N-NO2)	Nitrate (N-NO3)	Phosphate (SRP)
LAc4	Strand Tree SuDS	19.2	-64.7	251.5	510.0
LAc8	Lower SuDS	-59.9	-6.3	214.7	94.8
LAc8	Upper Pitt St RG				
LAc8	Upper SuDS	-23.8	16.6	0.1	59.0
LAc16	SPL FI	-20.6	-56.9	-69.4	48.9

QUANTITATIVE DATA SUMMARY				
CH0209 Suspended Sediment Water		% Change		
NBS	NBS name	Organic Matter	Suspended Sediment	All Suspended Metals
LAc4	Urban catchment forestry	118.4	-74.6	8.4
LAc8	SuDs & Rain Garden	296.3	-53.8	59.8
LAc16	Floating gardens	1095.1	47.0	-6.9

QUANTITATIVE DATA SUMMARY										
CH0209 Suspended Sediment Water % Change Metals										
NBS	**NBS name**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Nickel**	**Lead**	**Zinc**
LAc4	**Strand Tree SuDS**	12	160	-64	-78	-27	26	51	-26	31
LAc8	**Upper SuDS**	185	224	23	-16	34	29	48	41	51
LAc16	**SPL FI**	-59	207	51	-41	-43	-48	-5	-31	-29

EcoServR: CH0403: Green Space Accessibility				
NBS	**NBS Name**	**households**	**population**	**Rank**
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc8	SuDs & Rain Garden	448.6	1
LAc12	Pollinator verges and spaces	286.6	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Count	**Pre-Intervention**	**Post-Intervention**	**% Change**

NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	3.4	2.2	928.6	1
LAc8	Upper Pitt St RG	6	1	2.3	2.1	3	1	22.3	19.3	857.1	2
LAc12	Strand POLL	4	1	3.3	2.9	6	1	29.3	24.3	802.6	3
LAc12	Park Lane POLL	3	1	2.0	3.5	7	1	12.4	11.6	521.4	4
LAc12	Top SP Aig Dr POLL	4	1	3.8	2.2	2	1	10.5	0.7	180.0	5
LAc12	Ullet Rd POLL	3	1	5.3	8.4	5	1	12.2	13.2	128.8	6
LAc12	Baltic Hub POLL	4	1	11.0	7.7	2	1	20.0	15.6	81.8	7
LAc8	Lower SuDS	4	1	6.8	5.4	11	1	9.5	11.7	40.1	8
LAc12	Lower SuDS POLL	4	1	6.8	5.4	11	1	9.5	11.7	40.1	9
LAc12	Cornwallis St POLL	10	1	5.2	9.0	3	1	3.0	5.2	-42.3	10
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	11
LAc12	Wapping POLL	5	1	2.6	5.8	2	1	1.0	1.4	-61.5	12
LAc12	Princes Av POLL					7	1	14.9	21.2		
LAc12	Princes roundabt POLL	5	1	2.8	5.7						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	12.0	15.6		
LAc13	Parr St GW	1	1	0.0		12	1	6.3	9.7		
LAc13	St Johns GW					10	1	1.9	2.7		
LAc16	Wapping FI	1	1	3.0							

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Diversity			
NBS	**NBS Name**	**% Change**	**Rank**
LAc12	Pollinator verges and spaces	77.7	1
LAc8	SuDs & Rain Garden	41.8	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Diversity		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	1.7	0.8	414.3	1
LAc12	Park Lane POLL	3	1	1.0	1.7	7	1	2.9	2.5	185.7	2
LAc8	Upper Pitt St RG	6	1	1.2	1.0	3	1	2.3	2.1	100.0	3
LAc12	Strand POLL	4	1	1.3	1.0	6	1	2.5	2.2	100.0	4
LAc12	Top SP Aig Dr POLL	4	1	2.3	0.5	2	1	3.0	0.0	33.3	5
LAc12	Baltic Hub POLL	4	1	3.8	1.0	2	1	4.5	0.7	20.0	6
LAc12	Ullet Rd POLL	3	1	1.0	1.0	5	1	1.2	1.3	20.0	7
LAc8	Lower SuDS	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	8
LAc12	Lower SuDS POLL	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	9
LAc12	Wapping POLL	5	1	0.6	1.3	2	1	0.5	0.7	-16.7	10
LAc12	Cornwallis St POLL	10	1	1.7	2.6	3	1	1.0	1.7	-41.2	11
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	12
LAc12	Princes Av POLL					7	1	1.6	1.6		
LAc12	Princes roundabt POLL	5	1	0.8	1.3						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	2.0	1.4		
LAc13	Parr St GW	1	1	0.0		12	1	1.3	1.2		
LAc13	St Johns GW					10	1	1.1	1.4		
LAc16	Wapping FI	1	1	1.0							

EcoServR: CH0410: Pollinator increase			
NBS	NBS Name	% Change	Rank
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2

lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Lower SuDS	20	3.95	1
Upper Pitt St RG	20	0.60	2
Upper SuDS	20	0.03	3

EcoServR: CH0410: Pollinator increase			
SuDs & Rain Garden	**radius (m)**	**% Change**	**Rank**
Lower SuDS	100	2.31	1
Upper Pitt St RG	100	0.15	2
Upper SuDS	100	0.01	3

QUANTITATIVE DATA SUMMARY			
CH0412: Flower Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc12	Pollinator verges and spaces	510.8	1
LAc8	SuDs & Rain Garden	328.7	2
LAc13	Pollinator walls/vertical	228.8	3
LAc16	Floating gardens	-10.8	4

QUANTITATIVE DATA SUMMARY											
CH0412: Flower Count		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank

LAc 12	Bott SP Aig Dr POLL	3	1	28.0	14.8	7	1	528.1	935.8	1786.2	1
LAc 12	Park Lane POLL	3	1	37.3	24.9	7	1	401.3	470.9	974.9	2
LAc 12	Strand POLL	4	1	67.0	23.6	6	1	565.3	411.1	743.8	3
LAc 8	Lower SuDS	4	1	37.0	23.9	11	1	267.5	205.8	623.1	4
LAc 12	Lower SuDS POLL	4	1	37.0	23.9	11	1	267.5	205.8	623.1	5
LAc 13	Parr St GW	1	1	50.0		12	1	164.4	190.8	228.8	6
LAc 12	Cornwallis St POLL	10	1	84.8	124.6	3	1	233.3	182.4	175.2	7
LAc 12	Top SP Aig Dr POLL	4	1	660.3	1043.5	2	1	1487.5	1594.5	125.3	8
LAc 12	Wapping POLL	5	1	196.6	293.5	2	1	319.0	161.2	62.3	9
LAc 12	Ullet Rd POLL	3	1	170.7	246.3	5	1	269.4	92.6	57.9	10
LAc 12	Baltic Hub POLL	4	1	326.0	178.6	2	1	483.0	521.8	48.2	11
LAc 8	Upper Pitt St RG	6	1	94.8	58.7	3	1	127.3	42.1	34.3	12
LAc 16	SPL FI	2	1	115.5	92.6	1	1	103.0		-10.8	13
LAc 12	Princes Av POLL					7	1	402.3	563.9		
LAc 12	Princes roundabt POLL	5	1	98.2	144.5						
LAc 12	Top SP roundabt POLL	1	1	135.0							
LAc 13	L1 GW					2	1	206.0	217.8		
LAc 13	St Johns GW					10	1	378.2	368.5		
LAc 16	Wapping FI	1	1	162.0							

QUANTITATIVE DATA SUMMARY			
CH0502: PM 2.5			
NBS	**NBS Name**	**% Change**	**Rank**
LAc8	SuDs & Rain Garden	-62.6	1
LAc14	Pollinator roofs	-57.3	2
LAc4	Urban catchment forestry	-49.3	3
LAc17	Green filter area	-13.8	4
LAc13	Pollinator walls/vertical	-7.4	5
LAc12	Pollinator verges and spaces	9.0	6

QUANTITATIVE DATA SUMMARY											
CH0502: PM 2.5		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc8	Upper Pitt St RG	30	2	9.9	13.9	2	2	2.0	0.0	-79.8	1
LAc14	Royal Court GR	2	1	26.0	8.5	35	1	11.1	7.5	-57.3	2
LAc4	Strand Tree SuDS	110	4	11.7	13.1	40	4	6.0	6.1	-49.3	3
LAc8	Upper SuDS	18	2	9.2	5.5	22	2	5.0	3.0	-45.3	4
LAc13	Parr St GW	15	1	11.0	7.1	42	2	6.8	7.6	-37.9	5
LAc13	St Johns GW	29	2	15.6	8.5	47	5	9.9	6.8	-36.3	6
LAc17	Lime St TREES	86	3	10.0	8.3	10	3	6.8	7.2	-31.9	7
LAc17	Stafford St TREES	50	2	8.1	6.5	18	2	8.4	7.5	4.3	8
LAc12	Cornwallis St POLL	33	1	8.3	7.7	3	1	9.0	5.6	8.8	9
LAc12	Bott SP Aig Dr POLL	24	1	7.3	5.9	2	1	8.0	2.8	9.1	10
LAc13	L1 GW	30	3	5.3	2.8	70	7	8.1	8.7	52.0	11

QUANTITATIVE DATA SUMMARY			
CH0503: PM 10			
NBS	NBS Name	% Change	Rank
LAc14	Pollinator roofs	-49.3	1
LAc4	Urban catchment forestry	-36.7	2
LAc8	SuDs & Rain Garden	-27.7	3
LAc13	Pollinator walls/vertical	-14.1	4
LAc17	Green filter area	30.2	5
LAc12	Pollinator verges and spaces	32.8	6

QUANTITATIVE DATA SUMMARY											
CH0503: PM 10		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc14	Royal Court GR	2	1	37.5	7.8	35	1	19.0	8.9	-49.3	1
LAc8	Upper Pitt St RG	30	2	16.7	15.8	2	2	10.5	0.7	-37.1	2

LAc4	Strand Tree SuDS	110	4	19.6	14.5	40	4	12.4	9.5	-36.7	3
LAc13	Parr St GW	15	1	19.0	9.1	42	2	12.4	7.5	-34.8	4
LAc13	St Johns GW	29	2	24.0	11.7	47	5	16.0	8.6	-33.5	5
LAc8	Upper SuDS	18	2	16.8	5.9	22	2	13.7	7.7	-18.2	6
LAc17	Lime St TREES	86	3	18.6	12.8	10	3	21.7	15.8	16.7	7
LAc13	L1 GW	30	3	13.0	6.8	70	7	16.4	11.2	26.0	8
LAc12	Bott SP Aig Dr POLL	24	1	15.0	9.0	2	1	19.5	9.2	30.0	9
LAc12	Cornwallis St POLL	33	1	14.8	8.8	3	1	20.0	7.0	35.5	10
LAc17	Stafford St TREES	50	2	14.5	7.4	18	2	20.8	17.4	43.7	11

QUANTITATIVE DATA SUMMARY			
CH0504: NO2			
NBS	**NBS Name**	**% Change**	**Rank**
LAc14	Pollinator roofs	-25.8	1
LAc8	SuDs & Rain Garden	-19.8	2
LAc13	Pollinator walls/vertical	-15.5	3
LAc4	Urban catchment forestry	-13.7	4
LAc17	Green filter area	-8.1	5
LAc12	Pollinator verges and spaces	-7.9	6

EcoServR: CH0511: Air quality improvements			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements

SuDs & Rain Garden	radius (m)	% Change	Rank
Upper Pitt St RG	20	5.5	1
Lower SuDS	20	-4.0	2
Upper SuDS	20	-8.1	3

EcoServR: CH0511: Air quality improvements			
SuDs & Rain Garden	radius (m)	% Change	Rank
Upper Pitt St RG	100	4.6	1
Lower SuDS	100	-2.6	2
Upper SuDS	100	-5.2	3

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon storage, carbon sequestration, temperature reduction, green space accessibility, pollinator capacity, air quality, but not for water slowed or value of air quality reduction.

Quantitative data results positive influences on combined nutrients in solution, pollinator increase, plant diversity and floral abundance, insectivore increase, air quality, but not for metals in solution or suspended sediment.

Metals in solution reduced for Chromium and for Nickel in the Upper SuDs site. Copper in the suspended Sediment was reduced in the Upper SuDs site. For the nutrients in solution, Ammonium reduced for both water retention ponds, and nitrite for the Lower SuDs site

A high order of ranking as opposed to other NBS for the water retention ponds were found for:

- Carbon storage
- Carbon sequestration, with higher results that for the raingarden
- Chromium metal reduction (solution)
- Ammonium reduction in solution
- Pollinator increase and diversity, although the lower Suds showed a slight reduction in pollinator diversity
- Floral abundance
- Air quality (PM2.5, PM10 and NO2)

Lower rankings the water retention ponds were found for:

- Water slowed down (modelled), although of less effect than the raingarden
- Green space accessibility
- Pollinator capacity (modelled)
- Plant count and diversity
- Air quality (modelled)

The highest percentage changes creating a positive effect were for pollinator increase and diversity, plant divesity and floral abundance, as well as for air quality.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Top pond- walls nearby prevented further excavation of silts and widening of pond	Worked to maximise available capacity
Top pond – silt needed to be removed to reduce deposits on site and avoid increasing bank slope for safety	Silt was deposited in adjacent woodland so banks could retain a shallow slope
Lower pond- water culvert maps were unreliable	Design needed to be flexible

Adjacent site had blocked water course	Council worked with adjacent land owner to unblock adjacent water course as wider works
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Pathways were closed for a short while and parts of the park were cordoned off for works	Temporary signage was put in place to communicate the works to residents
Environmental (including COVID)	How they have been addressed
A newt survey was an unexpected request	Consultants commissioned – no newts found

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Lower pond – existing mapping of water culverts was unreliable and a culvert was found on the site of the proposed pond	Culvert was used to drain excess water from new pond and new pond shape was adapted to accommodate the culvert
Lower pond- site had previously been an old glass tip and ash rubbish dump	Sand lining was needed before a pond liner could be laid to avoid any old glass piercing the pond liner
Economical barriers	How they have been addressed
Additional costs were required to sand line the site	Accommodated within contingency costs
Social barriers	How they have been addressed
The site remained closed to general public for longer due to covid restrictions on working	Temporary notices

Opportunities for schools engagement was lost due to covid	Lost opportunity but additional planting will now involve Friends Groups.
Environmental (including COVID)	How they have been addressed
Opportunity for more holistic works	Opportunities were taken to add wildflower and woodland planting in the vicinity of both ponds and 2 bird and 2 bat boxes were also installed
Gaps in planting and exposed muddy banks make site less attractive	Additional peripheral planting to be included to fill in gaps, provide surface water cover via a lily and add in boggy plants for exposed banks during drier periods

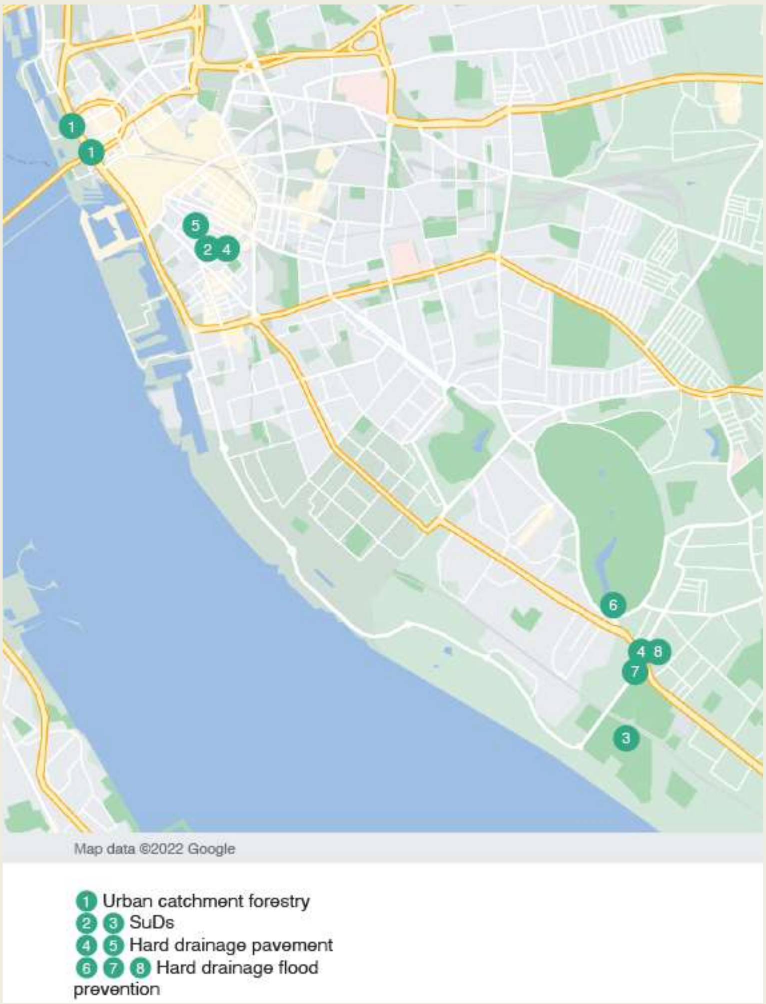
2.2.10 Lac9 Hard drainage flood prevention

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0111; CH0501; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Hard drainage flood prevention Lac9	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Between August 2020 and March 2022	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location of works



Location 6 – Sefton Park Outflow

New outflow added to meet Reservoir Engineer specifications for water flow.

Location 7 – Additional drainage and culvert works

Location 8 – Safety manhole cover for access

These civils works were required to ensure that the water flow for the water retention ponds met safety standards. The additional drains were installed a topographical 'low spot' and drain accumulating water back into the top water retention pond.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	3.8	yes	
01	CH0104	CARBON SEQUESTRATION	3.8	yes	
01	CH0105	TEMPERATURE DECREASE	1.0	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	1.0	yes	
01	CH0108	HEATWAVE RISK	2.0	yes	
01	CH0111	SPECIES MOVEMENT	1.0	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	2.8	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	2.7	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	1.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	1.0	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	2.7	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	1.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	2.0	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	2.0	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	0.0	yes	
04	CH0411	PLANT SPECIES INCREASE	0.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	0.0	yes	
04	CH0413	INSECTIVORE INCREASE	0.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	0.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	0.0	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	0.0	yes	
05	CH0504	NOx TRENDS	0.0	yes	
05	CH0505	Sox TRENDS	0.0	yes	

05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	2.0	yes	
05	CH0509	Energy savings	2.0	yes	
05	CH0510	Increase in property value	2.0	yes	
05	CH0511	Value of air quality improvements	2.0	yes	
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	2.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	2.0	yes	
07	CH0702	CITIZEN PERCEPTION	1.0	yes	
07	CH0703	SOCIAL LEARNING	1.0	yes	
07	CH0705	ENGAGEMENT WITH NBS	1.0	yes	
08	CH0801	CRIME REDUCTION	0.0	yes	
09	CH0902	WALKING AREA INCREASE	2.0	yes	
09	CH0903	CYCLING AREA INCREASE	2.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	1.0	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

As these works were to support other NBS, no monitoring data were available.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The lake is under the control of a reservoir engineer and the outflow had to be replaced with one that was designed to be fit for purpose	A water specialist on outflow design was commissioned to produce the necessary drawings for the later manufacture

Economical barriers	How they have been addressed

The design costs of the water specialist had not been anticipated at the start of the project	Project budgets were increased to accommodate this additional cost
Social barriers	How they have been addressed
Concerns that the site looked messy and that the water retention ponds would not work	Temporary explanatory signage and the inclusion of a viewing platform and wider new paths for accessibility
Environmental (including COVID)	How they have been addressed
Works took place during covid so access was limited	Reduced opportunity to visit and photograph

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Once installed the main overflow system proved to be a problem with ducklings who were in danger of being drawn into the culvert Some water culverts were unmarked on maps and one was accidentally damaged by the contactor	A wire mesh was placed around the edges and part of the system in discussion and agreement with the reservoir engineer Contractor repaired to satisfaction of city council drainage engineer
Economical barriers	How they have been addressed
Steel prices increased in the design phase	Accommodated within the project contingency
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed

Covid delayed design and manufacture and installation of civils works	Scheme was delayed

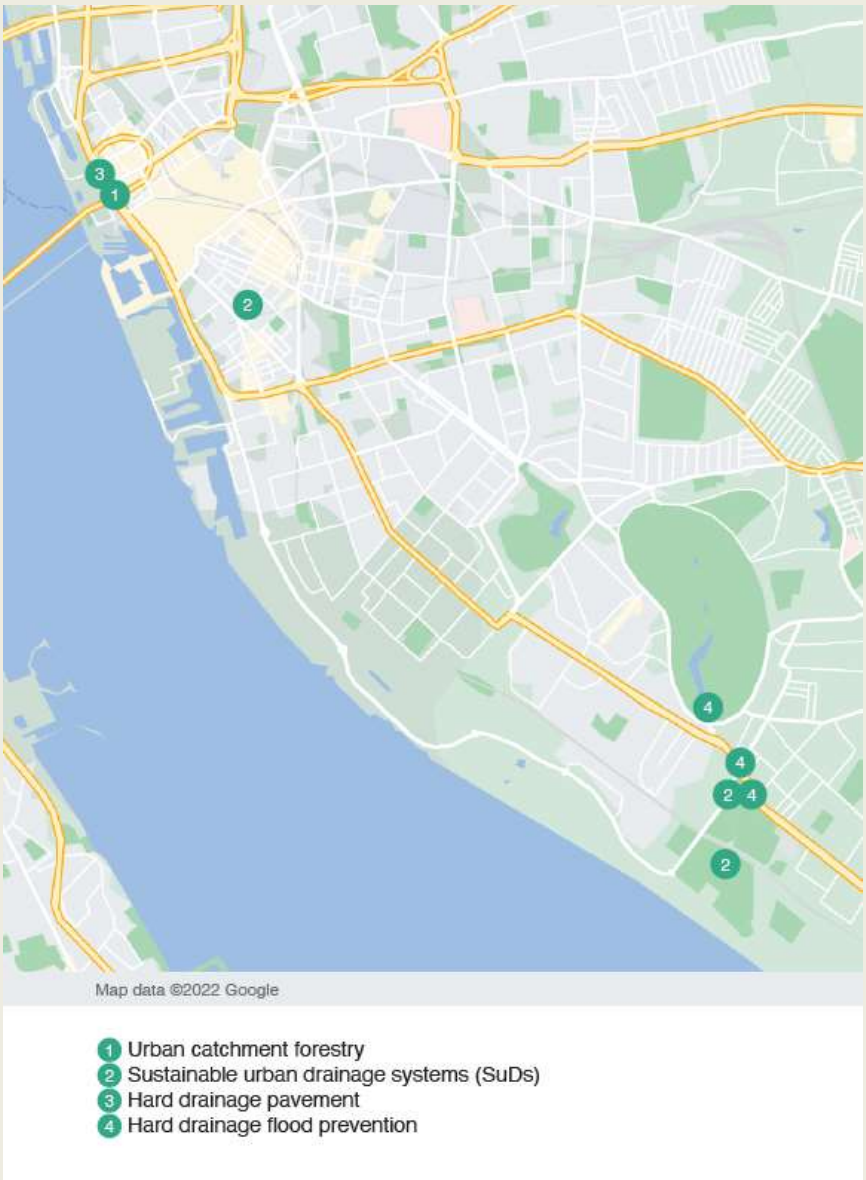
2.2.11 Lac10 Hard drainage pavements

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0111; CH0201; CH0212; CH0602; CH0501; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Hard drainage pavements Lac10	LIV/ UoL/ CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	August 2021 (Strand) Location 1 Summer 2022 (Kent Street) Location 5	

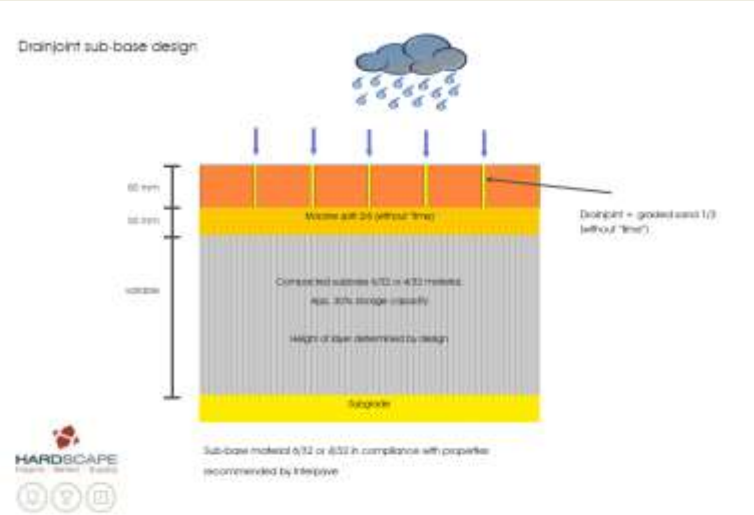
Results and Discussion

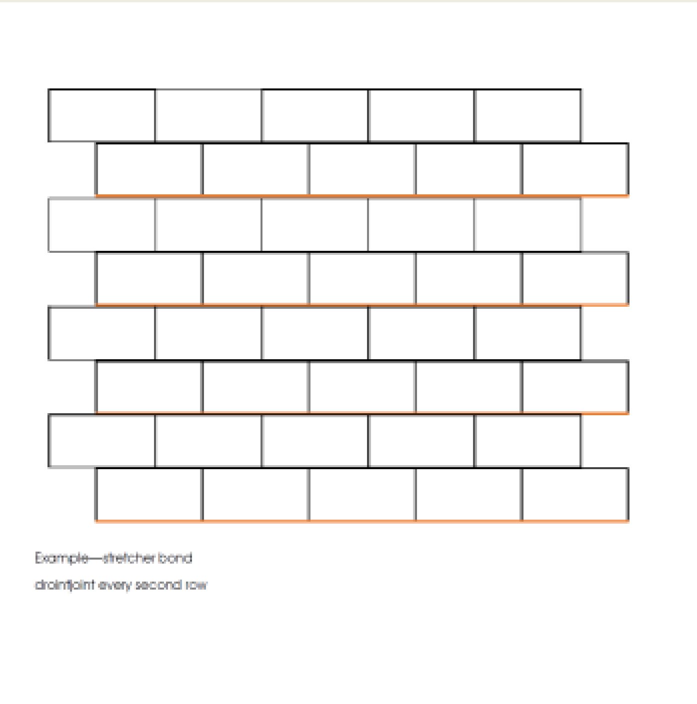
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

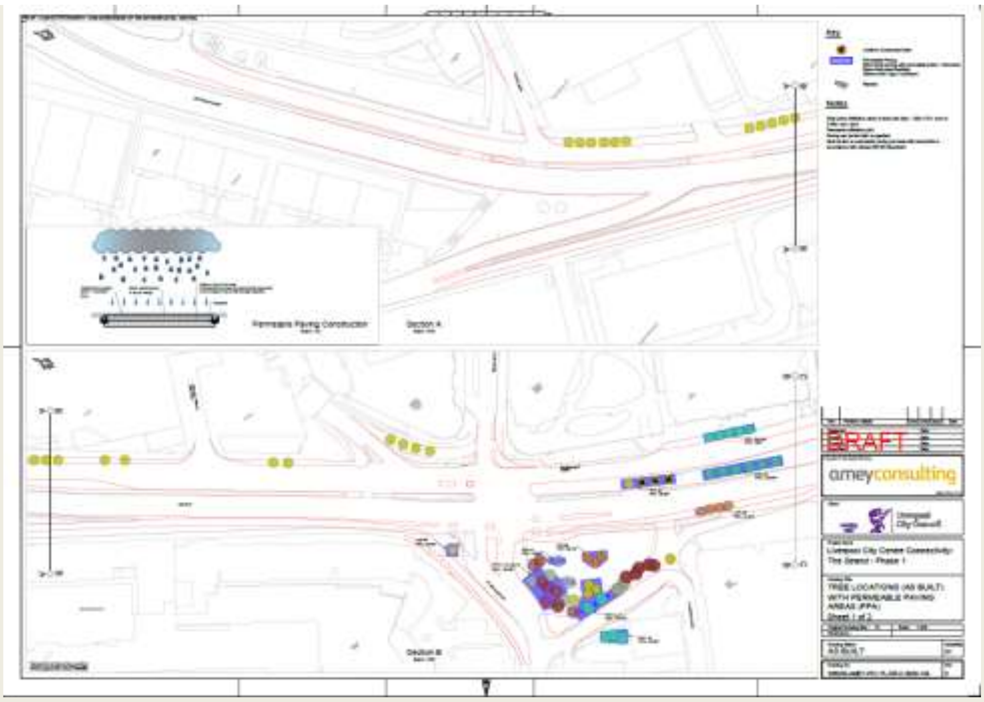
Hard drainage pavements at Location 3

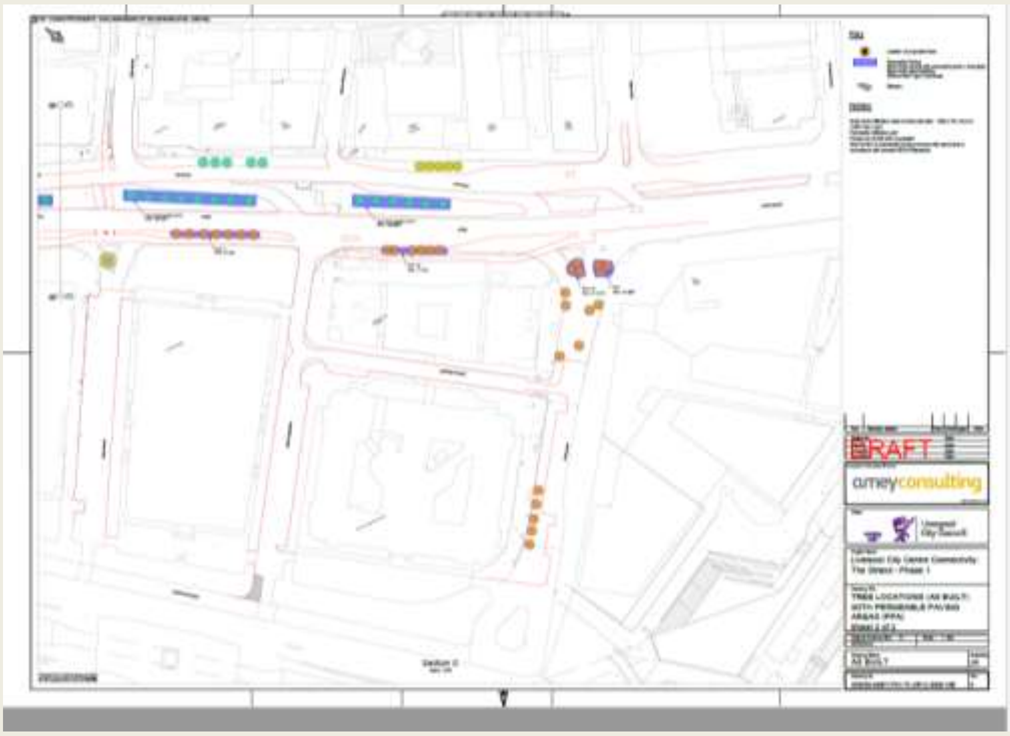


Location 1 – Strand tree planting with urban catchment forestry and permeable paved areas.









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01	CH0108	HEATWAVE RISK	2.0	yes	
01	CH0111	SPECIES MOVEMENT	1.0	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	2.8	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	2.7	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	1.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	1.0	Inconclusive	
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04	CH0403	GREEN SPACE ACCESSIBILITY	2.0	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	2.0	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	0.0	yes	
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04	CH0412	FLORAL RESOURCES INCREASE	0.0	yes	
04	CH0413	INSECTIVORE INCREASE	0.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	0.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	0.0	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	0.0	yes	
05	CH0504	NOx TRENDS	0.0	yes	
05	CH0505	Sox TRENDS	0.0	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
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07	CH0703	SOCIAL LEARNING	1.0	yes	
07	CH0705	ENGAGEMENT WITH NBS	1.0	yes	
08	CH0801	CRIME REDUCTION	0.0	yes	
09	CH0902	WALKING AREA INCREASE	2.0	yes	
09	CH0903	CYCLING AREA INCREASE	2.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	1.0	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

As these works were to support other NBS, no monitoring data were available.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Strand works – none Elsewhere on Kent Street – original contractor did not have the skills to complete the work satisfactorily	N/A Works transferred to highways project and will be delivered as part of a new cycle route summer 2023
Economical barriers	How they have been addressed
None	N/A
Social barriers	How they have been addressed
Delay in works at site	Temporary signage
Environmental (including COVID)	How they have been addressed

None	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Appointed contractor did not have the expertise to complete the works at a smaller additional site on Kent Street	Works have been passed to the council's highways team to be delivered summer 2023
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

2.2.12 Lac 11 Biochar

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
Did not progress	Lac 11 Biochar	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Did not progress	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

The use of biochar was not supported on the intended schemes as the quality of the material could not be guaranteed and it was considered that there would be toxins in the biochar that cold damage the trees.   The action was cancelled.

Report on the Proposed Use of Biochar

“ I have, as promised, considered the cost / benefit of adding biochar to soils in the course of pit planting semi-mature street trees on the Strand, in Liverpool. I have looked at quite a wide range of literature in doing this from peer-reviewed research publications to suppliers' promotional material. The United Kingdom Biochar Research Centre UKBR) is based in Edinburgh University and they hold an archive database of projects which is available to researchers - https://www.biochar.ac.uk. I have requested a user login to this but am yet to receive this, so have had to make do with the publicly available information on their website. I have also considered carefully research reports available on the United States Biochar Initiative (USBI) https://biochar-us.org which offers free access to publications.

Biochar is not one material but a wide group of porous carbonaceous solids produced by the pyrolysis (burning with limited oxygen supply) of organic materials. A wide range of organic materials can be used as feed stock and these include sewage sludges, wheat straw, softwood pellets, rice husk, oil seed rape straw and micanthus straw; however, the list can be extended to include almost any organic by-product. Research quality biochars are produced from dried pelletised feedstocks. The characteristics of biochar are heavily influenced by the maximum temperature reached during pyrolysis which for biochars destined for use in research will either be 550^{0}C or 700ºC.

Biochars produced on a commercial scale are far more variable than those produced for research. This is due to the use of less homogenous feedstocks and their more variable moisture content that leads to greater variation in temperature, which can be as low as 250^{0}C.

Biochar is produced in accordance with one of three standards. The International Biochar Initiative (IBI) is employed for commercial production but the range of value offered for potentially toxic elements is extremely wide. The maximum values are very considerably higher than those permitted for use in green waste compost and sewage sludges. While it may be that the high limits set reflect the lack of solubility of metals within Biochar (and hence their low potential for leaching), the standard is not appropriate for Biochars marketed for use as soil amendments and / or fertilisers in public open spaces. The European Biochar Standard (EBC premium) proposes thresholds for potentially toxic elements that are not dissimilar to those for green waste compost and sewage sludges and would appear to provide a more suitable basis on which to determine the suitability of a biochar for use as a soil amendment and / or fertiliser in public open spaces. The Biochar Quality Mandate (BQM) is the most exacting standard available, with the lowest thresholds for potentially toxic elements. This standard seems to be most suitable for the use of biochar for specialist purposes, such as the clean-up of contaminated land where the low starting concentrations of potentially toxic elements offers – presumably - the greatest scope for their absorption.

Research in Biochars dates back to the mid-2000s. Focus initially was on the role that the material could play in the de-contamination of industrial sites. The scope widened in the 2010s to consider the potential of the material to sequestrate carbon and to reduce CO2 production, as a means of climate change mitigation. Attention most recently has turned to the role of biochar as a soil amendment and its potential value in improving soil hydraulic properties and promoting plant growth.

A common misnomer is that biochars are fertilisers. This is incorrect. The fertiliser value of biochar is generally low (but dependent on the feedstock and temperature of pyrolysis) and considerably less than green waste compost and sewage sludge. A variety of materials which include seaweed, wormcasts and mycorrhizal fungi are added to biochar in proprietary products sold commercially as soil improvers and fertilisers. It is uncertain as to what extent the response of vegetation to these products is attributable to the biochar component itself or to the additives, all of which have - in their own right - individually been demonstrated to be effective in supporting plant growth.

Testimonials for proprietary products from commercial suppliers appear to be based largely on anecdotal evidence. Suppliers offer little or no guidance on how to use the products to maximum benefit.

The benefits to plant growth of using 'neat' biochar (un-amended) are not clear-cut. Experimental work has demonstrated that while soil physical properties may be improved through the addition of biochar the effects on soil chemical properties may not always be as predicted or desired. A common theme in the literature is that soil and plant response is heavily dependent on the feedstock from which the biochar is derived and the temperature of pyrolysis. Those materials that retain some residual fertiliser value produce the strongest growth responses. The results of trial work appear at face value to be far less predictable than those associated with the use of green waste compost and sewage sludge.

The particular concerns I would have with using biochar as a soil amendment in planting pits would be:

1. **Adverse effect on pH** – Most biochars are strongly to very strongly alkaline with a pH of 9-10. The optimum pH of soils for most species of trees used for street planting is moderately acid at 5.5-6. The addition of biochar is likely to raise soil pH.
2. **Immobilisation of zinc** – Biochar and arbuscular mycorrhizal fungi are known to bind metals, reducing their availability. This has implications for the availability of zinc to trees and has the potential to induce deficiency. This would have serious consequences for tree health as zinc plays an important role in chlorophyll production (chloroplast development), which would reduce photosynthetic rate and lead to a multitude of plant disease syndromes. This impact will be compounded by the effect of raising pH through the addition of biochar as the availability of zinc is reduced above pH 7.5
3. **Immobilisation of nitrogen** – Biochar has the potential to reduce mineralisation rates by the absorption of ammonium nitrogen and nitrate nitrogen onto biochar surfaces due to increased cation exchange capacity, as well as to immobilise nitrogen as a result of microbial degradation of labile (soluble) forms of carbon. These are most likely to have survived low temperature (@250ºC) pyrolysis.

The effects of biochar application on newly planted street trees will be dependent on five factors:

1. **The feedstock from which the biochar is produced** – this will govern the nutrient value, the proportion and forms of carbon, ash content and concentration of potentially toxic elements.

2. **Temperature of pyrolysis** – this will determine the proportion and forms of carbon and concentration of potentially toxic elements.
3. **Addition of other materials** – the extent to which the characteristics of the biochar are modified by the combination (and amounts) of other materials with proven benefits are applied.
4. **Proportion of biochar** – the amount of biochar added to the topsoil and possibly subsoil used to backfill planting pits.
5. **Soil texture** – the benefits of biochar addition will be greatest in coarse textured (sandy) soils where its impact on hydraulic properties (water retention) will be greatest.

The use of biochar as proposed is considered to represent a risk to a high-profile planting scheme. The risks could be mitigated to some extent (but not entirely) by obtaining a biochar test certificate and further details of the feedstock and production process.

Use could be made of a proprietary biochar based soil amendment / fertiliser instead of 'neat' 'biochar, but the results of using such a product would be difficult to interpret without an extensive range of treatments (ideally replicated and randomised), and it would be impossible to distinguish between the contribution of the biochar and the added materials.

Given that biochars greatest strength is in promoting improvement to soil hydraulic properties, its use as an amendment to subsoil could be contemplated. The burial of organic matter in soils below 500 mm would not normally be advised due to the potential for oxygen depletion and the development of anaerobic soil conditions. However, the high ratio of stable to labile carbon in biochar reduces this risk and could provide two benefits. The first would be an increase in water-holding-capacity and secondly, a means of absorption of nitrate nitrogen, ammonium nitrogen and phosphate leached from topsoil. Limiting use of Biochar to just one soil layer within soil pits would reduce the significance of any adverse effects (trees would still be able to obtain sufficient zinc from topsoils).

While biochars do have unique properties their value as a soil amendment / fertiliser is questionable. Biochars do not appear to offer a great deal of benefit 'over and above' those of PAS 100 green waste composts (PAS100:2018). Used correctly these would provide many of the same benefits as biochars to soil hydraulic properties. However, green waste composts are capable of supplying nitrogen, phosphorus and potassium in readily available and slow release forms, as well moderating pH towards neutral. Zinc and copper contained in green waste compost can also be beneficial. Green waste composts appear to be better than biochar in almost every conceivable way as a soil amendment and fertiliser; the product seems to represent have something of the *Emperor's new clothes* about it!

Extensive use was made of green waste composts in soil manufacture under the Newlands Project when a detailed understanding of characteristics of composts available from Organics Recycling accredited producers across the NW of England was gained. Green waste compost produced by Fairfield Environmental Services, New Smithfield Market, Openshaw, Manchester, was identified as quite unique and outstanding with excellent nutrient values, high organic/low mineral content and consistently low concentrations of potentially toxic elements. The feedstock comprises of a substantial amount of soft and stoned fruit and vegetables, which accounts for its unique properties. This would certainly be a suitable (and better) alternative to biochar for street planting on the strand and other street tree projects. Ex-situ spreading and incorporation at 20% v/v of compost (0-20 mm grade) by volume to topsoil would be recommended.

Finally, if you are intent on using biochar, 10% v/v would definitely be too high. Most experimental work has trialled far lower application rates with 6 % v/v sufficient to produce meaningful improvements to soil water-holding-capacity.

I have identified three potential suppliers of which the last 'Soil Fixer' provides the most comprehensive (and balanced) information on the product and greatest transparency on feedstock and process. None of the companies include a certificate of analysis, nor confirm the temperature at which pyrolysis takes place (on their websites).

1. Carbon Gold https://www.carbongold.com
2. Oxford Biochar - https://www.oxfordbiochar.org
3. Soil Fixer- https://www.soilfixer.co.uk

The following would be able to carry out analysis of biochar and to assess the conformity of products to the European Biochar Standard (EBC premium)]

1. Contaminated Land Assessment & Remediation Research Centre, University of Edinburgh, UK
2. Lancrop Laboratories, Yara UK Limited, Pocklington, UK
3. NRM laboratories (Cawood Scientific), Bracknell, Berkshire, UK

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The quality and composition of biochar could not be guaranteed	The use of biochar was cancelled in the project
Economical barriers	How they have been addressed
N/A	
Social barriers	How they have been addressed
Politicians did not want to risk project failure on high profile works	The use of biochar was cancelled in the project
Environmental (including COVID)	How they have been addressed
Potential for the trees to die from biochar toxins etc	The use of biochar was cancelled in the project

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
N/A	
Economical barriers	How they have been addressed
N/A	
Social barriers	How they have been addressed
N/A	
Environmental (including COVID)	How they have been addressed
N/A	

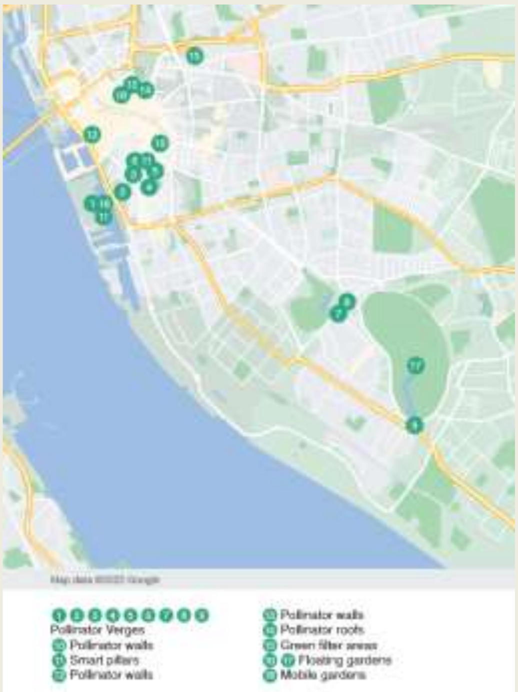
2.2.13 Lac 12 pollinator verges

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0111; CH0201; CH0212; CH0404; CH0410; CHO411; CH0412; CH0413; CH0501; CH0502; CH0503; CH0504, CH0505; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CHO703; CH0702; CH0705; CH0801; CHO904; CH1002; CH1004; CH1005;	Lac 12 pollinator verges	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Demo A November 2021 – March 2022 Demo C July 2020 – Nov 2021	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Pollinator Planting locations



Demo A – Pollinator planting

Baltic Hub 525m2 peripheral bulb planting	Cornwallis Street – 140 m2 wildflower turf
	

Wapping slipway 570m2 hydroseeding




Wapping Strand – 500 m2 coastal pollinator planting


Park Lane 400m2 woodland pollinator planting


Demo C Pollinator planting

Ullet Road 685m2 (411m2 bulbs; 97m2 wildflower turf; 177m2 seeding)

Princes Avenue 1265 m2 pollinator turf

Aigbuth 423m2 (256m2 bulbs; 87m2 turf, 80m2 seeding)

EcoServR: Assumptions on habitat codes for the UGU interventions

Intervention type	Code	Description	Notes
Shade trees	A13	Mixed woodland	No code for trees outside woodland; assuming mixed to average out differences between coniferous and broadleaved trees
Cooling trees			
Green filter trees			
Orchard	A112o	Orchard	
Pollinator planting	J55	Brownfield/garden/park	
SuDS ponds	G1	Standing water	

Green roof	GR	Green roof	Added to EcoservR for UGU (limited evidence base)
Green wall	GW	Green wall	Added to EcoservR for UGU (limited evidence base)
Floating island	FI	Floating island	Added to EcoservR for UGU (limited evidence base)
Smart pollinator pillars	POLL	Pollinator baskets	Added to EcoservR for UGU (limited evidence base)

The pollinator verge sites were all labelled POLL in the tables below.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	4.0	yes	yes
01	CH0104	CARBON SEQUESTRATION	4.0	yes	
01	CH0105	TEMPERATURE DECREASE	4.0	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	4.5	yes	yes
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.6	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	3.3	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	2.0	yes	yes
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	2.2	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	2.2	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	2.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	4.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	4.5	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	4.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	5.0	yes	yes
04	CH0411	PLANT SPECIES INCREASE	5.0	yes	yes
04	CH0412	FLORAL RESOURCES INCREASE	5.0	yes	yes

04	CH0413	INSECTIVORE INCREASE	3.8	yes	yes
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.2	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	no
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	no
05	CH0504	NOx TRENDS	3.7	yes	yes
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	yes
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	3.5	yes	
07	CH0703	SOCIAL LEARNING	3.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	3.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	3.0	yes	yes
09	CH0903	CYCLING AREA INCREASE	3.0	Inconclusive	no
09	CH0904	HEALTH QUALITY PERCEPTION	3.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	NBS name	EcoServR: CH0103: Carbon storage (tC)	Rank
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

Pollinator verges and spaces	EcoServR: CH0103: Carbon storage (tC)	Rank
Princes Av POLL	40.3	1
Lower SuDS POLL	17.2	2
Baltic Hub POLL	16.4	3
Wapping POLL	11.7	4
Bott SP Aig Dr POLL	5.3	5
Park Lane POLL	5.2	6
Strand POLL	4.6	7
Top SP Aig Dr POLL	4.3	8
Ullet Rd POLL	3.1	9
Princes roundabt POLL	3.0	10
Upper SuDS POLL	2.6	11
Cornwallis St POLL	1.2	12
Pitt St POLL	0.4	13

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	**NBS**	**EcoServR: CH0104: Carbon sequestration**	**Rank**
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			
LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		
LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0106: Temperature reduction			
ranked NBS	**NBS Name**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2
lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4
lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0106: Temperature reduction				
Sub Demo Area	Pollinator verges and spaces	radius (m)	% Change	Rank
C	Ullet Rd POLL	20	455.33	1
A	Strand POLL	20	226.44	2
A	Baltic POLL	20	9.14	3
C	Lower SuDS POLL	20	2.21	4
A	Wapping POLL	20	0.02	5
C	Upper SuDS POLL	20	-1.86	6
A	Baltic Hub POLL	20		
A	Cornwallis St POLL	20		
A	Pitt St POLL	20		
C	Bott SP Aig Dr POLL	20		
C	Park Lane POLL	20		
C	Princes Av POLL	20		
C	Princes roundabt POLL	20		
C	Top SP Aig Dr POLL	20		

EcoServR: CH0106: Temperature reduction				
Sub Demo Area	Pollinator verges and spaces	radius (m)	% Change	Rank
C	Top SP Aig Dr POLL	100	485.13	1
A	Strand POLL	100	21.77	2
C	Ullet Rd POLL	100	14.93	3
A	Baltic POLL	100	6.75	4
C	Lower SuDS POLL	100	2.15	5
A	Wapping POLL	100	0.79	6
C	Bott SP Aig Dr POLL	100	0.00	7
C	Princes Av POLL	100	0.00	7
C	Princes roundabt POLL	100	0.00	7
C	Upper SuDS POLL	100	-1.71	8
A	Baltic Hub POLL	100		
A	Cornwallis St POLL	100		
A	Pitt St POLL	100		

C	Park Lane POLL	100		

EcoServR: CH0204: Water slowed down			
ranked NBS	**NBS**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down				
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**	**Rank**
C	Princes Av POLL	20	156.2	1
C	Princes roundabt POLL	20	100.0	2
A	Wapping POLL	20	67.1	3
C	Ullet Rd POLL	20	17.4	4
A	Cornwallis St POLL	20	6.9	5
C	Bott SP Aig Dr POLL	20	5.6	6
C	Top SP Aig Dr POLL	20	0.0	7
A	Pitt St POLL	20	-0.4	8
A	Baltic POLL	20	-2.2	9
A	Park Lane POLL	20	-3.8	10
A	Strand POLL	20	-4.5	11
A	Baltic Hub POLL	20	-11.5	12
C	Lower SuDS POLL	20	-15.6	13
C	Upper SuDS POLL	20	-24.5	14

EcoServR: CH0204: Water slowed down				
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**	**Rank**
C	Princes Av POLL	100	11.5	1
A	Wapping POLL	100	10.7	2
C	Princes roundabt POLL	100	4.4	3
A	Cornwallis St POLL	100	2.7	4
C	Ullet Rd POLL	100	1.0	5
C	Top SP Aig Dr POLL	100	0.9	6
C	Bott SP Aig Dr POLL	100	0.7	7
A	Pitt St POLL	100	0.6	8
A	Baltic POLL	100	0.5	9
A	Park Lane POLL	100	-0.5	10
A	Strand POLL	100	-2.1	11
C	Upper SuDS POLL	100	-2.4	12
C	Lower SuDS POLL	100	-2.7	13
A	Baltic Hub POLL	100	-3.6	14

EcoServR: CH0403: Green Space Accessibility				
NBS	**NBS Name**	**households**	**population**	**Rank**
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

EcoServR: CH0403: Green Space Accessibility				
Sub Demo Area	**Pollinator verges and spaces**	**households**	**population**	**Rank**
C	Princes Av POLL	4187	9025	1

C	Princes roundabt POLL	2130	4675	2
C	Upper SuDS POLL	1771	4031	3
C	Bott SP Aig Dr POLL	1763	3979	4
A	Cornwallis St POLL	1361	2469	5
A	Baltic POLL	1252	2266	6
A	Pitt St POLL	1106	2007	7
A	Baltic Hub POLL	965	1785	8
A	Park Lane POLL	894	1589	9
C	Lower SuDS POLL	634	1475	10
C	Top SP Aig Dr POLL	710	1116	11
C	Ullet Rd POLL	716	1110	12
A	Strand POLL	549	980	13
A	Wapping POLL	354	612	14

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Count			
NBS	NBS Name	% Change	Rank
LAc8	SuDs & Rain Garden	448.6	1
LAc12	Pollinator verges and spaces	286.6	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Count		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	3.4	2.2	928.6	1
LAc8	Upper Pitt St RG	6	1	2.3	2.1	3	1	22.3	19.3	857.1	2
LAc12	Strand POLL	4	1	3.3	2.9	6	1	29.3	24.3	802.6	3
LAc12	Park Lane POLL	3	1	2.0	3.5	7	1	12.4	11.6	521.4	4
LAc12	Top SP Aig Dr POLL	4	1	3.8	2.2	2	1	10.5	0.7	180.0	5
LAc12	Ullet Rd POLL	3	1	5.3	8.4	5	1	12.2	13.2	128.8	6
LAc12	Baltic Hub POLL	4	1	11.0	7.7	2	1	20.0	15.6	81.8	7

LAc8	Lower SuDS	4	1	6.8	5.4	11	1	9.5	11.7	40.1	8
LAc12	Lower SuDS POLL	4	1	6.8	5.4	11	1	9.5	11.7	40.1	9
LAc12	Cornwallis St POLL	10	1	5.2	9.0	3	1	3.0	5.2	-42.3	10
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	11
LAc12	Wapping POLL	5	1	2.6	5.8	2	1	1.0	1.4	-61.5	12
LAc12	Princes Av POLL					7	1	14.9	21.2		
LAc12	Princes roundabt POLL	5	1	2.8	5.7						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	12.0	15.6		
LAc13	Parr St GW	1	1	0.0		12	1	6.3	9.7		
LAc13	St Johns GW					10	1	1.9	2.7		
LAc16	Wapping FI	1	1	3.0							

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Diversity			
NBS	**NBS Name**	**% Change**	**Rank**
LAc12	Pollinator verges and spaces	77.7	1
LAc8	SuDs & Rain Garden	41.8	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Diversity		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	1.7	0.8	414.3	1
LAc12	Park Lane POLL	3	1	1.0	1.7	7	1	2.9	2.5	185.7	2
LAc8	Upper Pitt St RG	6	1	1.2	1.0	3	1	2.3	2.1	100.0	3
LAc12	Strand POLL	4	1	1.3	1.0	6	1	2.5	2.2	100.0	4
LAc12	Top SP Aig Dr POLL	4	1	2.3	0.5	2	1	3.0	0.0	33.3	5
LAc12	Baltic Hub POLL	4	1	3.8	1.0	2	1	4.5	0.7	20.0	6
LAc12	Ullet Rd POLL	3	1	1.0	1.0	5	1	1.2	1.3	20.0	7
LAc8	Lower SuDS	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	8
LAc12	Lower SuDS POLL	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	9
LAc12	Wapping POLL	5	1	0.6	1.3	2	1	0.5	0.7	-16.7	10

LAc12	Cornwallis St POLL	10	1	1.7	2.6	3	1	1.0	1.7	-41.2	11
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	12
LAc12	Princes Av POLL					7	1	1.6	1.6		
LAc12	Princes roundabt POLL	5	1	0.8	1.3						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	2.0	1.4		
LAc13	Parr St GW	1	1	0.0		12	1	1.3	1.2		
LAc13	St Johns GW					10	1	1.1	1.4		
LAc16	Wapping FI	1	1	1.0							

EcoServR: CH0410: Pollinator increase			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2
lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase				
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**	**Rank**
A	Wapping POLL	20	14.42	1
A	Baltic POLL	20	4.79	2
A	Baltic Hub POLL	20	4.09	3
C	Lower SuDS POLL	20	3.98	4
A	Cornwallis St POLL	20	0.78	5
A	Strand POLL	20	0.55	6
C	Princes Av POLL	20	0.17	7
A	Park Lane POLL	20	0.16	8

C	Bott SP Aig Dr POLL	20	0.15	9
C	Princes roundabt POLL	20	0.13	10
C	Top SP Aig Dr POLL	20	0.12	11
C	Upper SuDS POLL	20	0.06	12
C	Ullet Rd POLL	20	0.01	13
A	Pitt St POLL	20	0.00	14

EcoServR: CH0410: Pollinator increase				
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**	**Rank**
A	Wapping POLL	100	9.69	1
A	Baltic POLL	100	3.55	2
A	Baltic Hub POLL	100	2.44	3
C	Lower SuDS POLL	100	2.39	4
A	Strand POLL	100	0.56	5
A	Cornwallis St POLL	100	0.18	6
A	Pitt St POLL	100	0.11	7
C	Princes roundabt POLL	100	0.06	8
C	Princes Av POLL	100	0.04	9
A	Park Lane POLL	100	0.02	10
C	Bott SP Aig Dr POLL	100	0.02	11
C	Ullet Rd POLL	100	0.01	12
C	Top SP Aig Dr POLL	100	0.01	13
C	Upper SuDS POLL	100	0.01	14

QUANTITATIVE DATA SUMMARY			
CH0411: Plant Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc13	Pollinator walls/vertical	1108.3	1
LAc12	Pollinator verges and spaces	77.4	2
LAc8	SuDs & Rain Garden	68.4	3
LAc16	Floating gardens	33.3	4

QUANTITATIVE DATA SUMMARY											
CH0411: Plant Count		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc13	Parr St GW	1	1	1.0		12	1	12.1	4.7	1108.3	1
LAc12	Strand POLL	4	1	3.3	0.5	6	1	12.3	3.7	279.5	2
LAc12	Park Lane POLL	3	1	4.3	2.3	7	1	9.6	5.5	120.9	3
LAc12	Wapping POLL	5	1	4.4	2.3	2	1	9.0	4.2	104.5	4
LAc8	Upper Pitt St RG	6	1	4.2	2.6	3	1	7.7	2.3	84.0	5
LAc12	Baltic Hub POLL	4	1	7.3	2.5	2	1	11.5	0.7	58.6	6
LAc8	Lower SuDS	4	1	1.3	0.5	11	1	1.9	0.5	52.7	7
LAc12	Lower SuDS POLL	4	1	1.3	0.5	11	1	1.9	0.5	52.7	8
LAc12	Bott SP Aig Dr POLL	3	1	1.3	0.6	7	1	2.0	0.0	50.0	9
LAc12	Top SP Aig Dr POLL	4	1	1.5	0.6	2	1	2.0	0.0	33.3	10
LAc16	SPL FI	2	1	1.5	0.7	1	1	2.0		33.3	11
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.8	0.4	8.0	12
LAc12	Cornwallis St POLL	10	1	5.6	2.3	3	1	5.0	1.0	-10.7	13
LAc12	Princes Av POLL					7	1	1.9	0.4		
LAc12	Princes roundabt POLL	5	1	1.4	0.5						
LAc12	Top SP roundabt POLL	1	1	2.0							
LAc13	L1 GW					2	1	2.0	0.0		
LAc13	St Johns GW					10	1	12.4	3.2		
LAc16	Wapping FI	1	1	4.0							

QUANTITATIVE DATA SUMMARY			
CH0411: Plant diversity			
NBS	NBS Name	% Change	Rank
LAc13	Pollinator walls/vertical	541.7	1
LAc12	Pollinator verges and spaces	55.0	2
LAc8	SuDs & Rain Garden	52.4	3
LAc16	Floating gardens	0.0	4

QUANTITATIVE DATA SUMMARY											
CH0411: Plant diversity		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank

LAc13	Parr St GW	1	1	1.0		12	1	6.4	2.4	541.7	1
LAc12	Park Lane POLL	3	1	2.7	0.6	7	1	6.3	3.5	135.7	2
LAc12	Strand POLL	4	1	3.3	0.5	6	1	7.5	2.1	130.8	3
LAc12	Wapping POLL	5	1	3.0	1.6	2	1	5.5	0.7	83.3	4
LAc12	Bott SP Aig Dr POLL	3	1	1.0	0.0	7	1	1.7	0.5	71.4	5
LAc8	Upper Pitt St RG	6	1	3.2	1.6	3	1	5.3	1.2	68.4	6
LAc12	Top SP Aig Dr POLL	4	1	1.3	0.5	2	1	2.0	0.0	60.0	7
LAc12	Baltic Hub POLL	4	1	3.8	1.5	2	1	5.5	0.7	46.7	8
LAc8	Lower SuDS	4	1	1.0	0.0	11	1	1.4	0.5	36.4	9
LAc12	Lower SuDS POLL	4	1	1.0	0.0	11	1	1.4	0.5	36.4	10
LAc16	SPL FI	2	1	1.0	0.0	1	1	1.0		0.0	11
LAc12	Cornwallis St POLL	10	1	4.7	1.3	3	1	3.3	0.6	-29.1	12
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.0	0.0	-40.0	13
LAc12	Princes Av POLL					7	1	1.3	0.5		
LAc12	Princes roundabt POLL	5	1	1.2	0.4						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	2.0	0.0		
LAc13	St Johns GW					10	1	7.4	1.8		
LAc16	Wapping FI	1	1	2.0							

QUANTITATIVE DATA SUMMARY			
CH0412: Flower Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc12	Pollinator verges and spaces	510.8	1
LAc8	SuDs & Rain Garden	328.7	2
LAc13	Pollinator walls/vertical	228.8	3
LAc16	Floating gardens	-10.8	4

QUANTITATIVE DATA SUMMARY											
CH0412: Flower Count		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc 12	Bott SP Aig Dr POLL	3	1	28.0	14.8	7	1	528.1	935.8	1786.2	1
LAc 12	Park Lane POLL	3	1	37.3	24.9	7	1	401.3	470.9	974.9	2
LAc 12	Strand POLL	4	1	67.0	23.6	6	1	565.3	411.1	743.8	3

LAc 8	Lower SuDS	4	1	37.0	23.9	11	1	267.5	205.8	623.1	4
LAc 12	Lower SuDS POLL	4	1	37.0	23.9	11	1	267.5	205.8	623.1	5
LAc 13	Parr St GW	1	1	50.0		12	1	164.4	190.8	228.8	6
LAc 12	Cornwallis St POLL	10	1	84.8	124.6	3	1	233.3	182.4	175.2	7
LAc 12	Top SP Aig Dr POLL	4	1	660.3	1043.5	2	1	1487.5	1594.5	125.3	8
LAc 12	Wapping POLL	5	1	196.6	293.5	2	1	319.0	161.2	62.3	9
LAc 12	Ullet Rd POLL	3	1	170.7	246.3	5	1	269.4	92.6	57.9	10
LAc 12	Baltic Hub POLL	4	1	326.0	178.6	2	1	483.0	521.8	48.2	11
LAc 8	Upper Pitt St RG	6	1	94.8	58.7	3	1	127.3	42.1	34.3	12
LAc 16	SPL FI	2	1	115.5	92.6	1	1	103.0		-10.8	13
LAc 12	Princes Av POLL					7	1	402.3	563.9		
LAc 12	Princes roundabt POLL	5	1	98.2	144.5						
LAc 12	Top SP roundabt POLL	1	1	135.0							
LAc 13	L1 GW					2	1	206.0	217.8		
LAc 13	St Johns GW					10	1	378.2	368.5		
LAc 16	Wapping FI	1	1	162.0							

QUANTITATIVE DATA SUMMARY			
CH0502: PM 2.5			
NBS	NBS Name	% Change	Rank
LAc8	SuDs & Rain Garden	-62.6	1
LAc14	Pollinator roofs	-57.3	2
LAc4	Urban catchment forestry	-49.3	3
LAc17	Green filter area	-13.8	4
LAc13	Pollinator walls/vertical	-7.4	5
LAc12	Pollinator verges and spaces	9.0	6

QUANTITATIVE DATA SUMMARY											
CH0502: PM 2.5		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank

LAc8	Upper Pitt St RG	30	2	9.9	13.9	2	2	2.0	0.0	-79.8	1
LAc14	Royal Court GR	2	1	26.0	8.5	35	1	11.1	7.5	-57.3	2
LAc4	Strand Tree SuDS	110	4	11.7	13.1	40	4	6.0	6.1	-49.3	3
LAc8	Upper SuDS	18	2	9.2	5.5	22	2	5.0	3.0	-45.3	4
LAc13	Parr St GW	15	1	11.0	7.1	42	2	6.8	7.6	-37.9	5
LAc13	St Johns GW	29	2	15.6	8.5	47	5	9.9	6.8	-36.3	6
LAc17	Lime St TREES	86	3	10.0	8.3	10	3	6.8	7.2	-31.9	7
LAc17	Stafford St TREES	50	2	8.1	6.5	18	2	8.4	7.5	4.3	8
LAc12	Cornwallis St POLL	33	1	8.3	7.7	3	1	9.0	5.6	8.8	9
LAc12	Bott SP Aig Dr POLL	24	1	7.3	5.9	2	1	8.0	2.8	9.1	10
LAc13	L1 GW	30	3	5.3	2.8	70	7	8.1	8.7	52.0	11

QUANTITATIVE DATA SUMMARY			
CH0503: PM 10			
NBS	**NBS Name**	**% Change**	**Rank**
LAc14	Pollinator roofs	-49.3	1
LAc4	Urban catchment forestry	-36.7	2
LAc8	SuDs & Rain Garden	-27.7	3
LAc13	Pollinator walls/vertical	-14.1	4
LAc17	Green filter area	30.2	5
LAc12	Pollinator verges and spaces	32.8	6

QUANTITATIVE DATA SUMMARY											
CH0503: PM 10		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc 14	Royal Court GR	2	1	37.5	7.8	35	1	19.0	8.9	-49.3	1
LAc 8	Upper Pitt St RG	30	2	16.7	15.8	2	2	10.5	0.7	-37.1	2
LAc 4	Strand Tree SuDS	110	4	19.6	14.5	40	4	12.4	9.5	-36.7	3
LAc 13	Parr St GW	15	1	19.0	9.1	42	2	12.4	7.5	-34.8	4
LAc 13	St Johns GW	29	2	24.0	11.7	47	5	16.0	8.6	-33.5	5
LAc 8	Upper SuDS	18	2	16.8	5.9	22	2	13.7	7.7	-18.2	6

LAc 17	Lime St TREES	86	3	18.6	12.8	10	3	21.7	15.8	16.7	7
LAc 13	L1 GW	30	3	13.0	6.8	70	7	16.4	11.2	26.0	8
LAc 12	Bott SP Aig Dr POLL	24	1	15.0	9.0	2	1	19.5	9.2	30.0	9
LAc 12	Cornwallis St POLL	33	1	14.8	8.8	3	1	20.0	7.0	35.5	10
LAc 17	Stafford St TREES	50	2	14.5	7.4	18	2	20.8	17.4	43.7	11

QUANTITATIVE DATA SUMMARY			
CH0504: NO2			
NBS	**NBS Name**	**% Change**	**Rank**
LAc14	Pollinator roofs	-25.8	1
LAc8	SuDs & Rain Garden	-19.8	2
LAc13	Pollinator walls/vertical	-15.5	3
LAc4	Urban catchment forestry	-13.7	4
LAc17	Green filter area	-8.1	5
LAc12	Pollinator verges and spaces	-7.9	6

QUANTITATIVE DATA SUMMARY											
CH0504: NO2		Pre-Intervention				Post-Intervention				% Change	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc12	Ullet Rd POLL	105	4	26.6	6.5	57	4	24.2	5.9	-9.1	1
LAc12	Top SP Aig Dr POLL	101	3	29.1	5.6	20	3	26.5	5.8	-8.7	2
LAc12	Bott SP Aig Dr POLL	50	2	33.3	5.9	20	2	30.7	4.0	-8.0	3
LAc12	Top SP roundabt POLL	34	1	23.0	5.7	7	1	21.7	5.7	-5.9	4

EcoServR: CH0511: Air quality improvements			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6

lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements				
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**	**Rank**
A	Baltic POLL	20	17.4	1
A	Strand POLL	20	13.3	2
A	Cornwallis St POLL	20	12.1	3
C	Princes Av POLL	20	6.8	4
A	Pitt St POLL	20	2.9	5
C	Princes roundabt POLL	20	2.7	6
C	Ullet Rd POLL	20	2.5	7
C	Top SP Aig Dr POLL	20	2.0	8
C	Bott SP Aig Dr POLL	20	1.5	9
A	Baltic Hub POLL	20	0.6	10
A	Park Lane POLL	20	0.0	11
C	Lower SuDS POLL	20	-3.7	12
C	Upper SuDS POLL	20	-7.4	13
A	Wapping POLL	20		

EcoServR: CH0511: Air quality improvements				
Sub Demo Area	**Pollinator verges and spaces**	**radius (m)**	**% Change**	**Ran k**
A	Wapping POLL	100	177.1	1
A	Strand POLL	100	31.3	2
A	Cornwallis St POLL	100	9.3	3
A	Baltic POLL	100	8.6	4
C	Princes Av POLL	100	4.1	5
A	Pitt St POLL	100	2.9	6
C	Princes roundabt POLL	100	1.9	7
A	Baltic Hub POLL	100	1.8	8

C	Top SP Aig Dr POLL	100	1.0	9
C	Ullet Rd POLL	100	1.0	10
C	Bott SP Aig Dr POLL	100	0.6	11
A	Park Lane POLL	100	0.1	12
C	Lower SuDS POLL	100	-2.2	13
C	Upper SuDS POLL	100	-4.8	14

QUANTITATIVE DATA SUMMARY			
CH0902: Walking			
NBS	NBS Name	% Change	Rank
LAc5	shade trees	13.9	1
LAc6	cooling trees	13.9	1
LAc12	Pollinator verges and spaces	2.3	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY											
CH0902: Walking		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Baltic POLL	1090	2	541.5	398.8	468	2	642.8	433.4	18.7	1
LAc5	Shade_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	2
LAc6	Cooling_TREES	17	1	677.6	243.0	762	1	771.9	442.5	13.9	3
LAc12	Strand POLL	620	1	778.1	457.1	159	1	737.7	360.6	-5.2	4
LAc12	Ullet Rd POLL	411	1	1536.0	483.0	368	1	1433.0	441.8	-6.7	5
LAc1	Green_Route_1	2337	3	683.1	408.4						

QUANTITATIVE DATA SUMMARY			
CH0903: Cycling			
NBS	NBS Name	% Change	Rank
LAc5	shade trees	86.1	1
LAc6	cooling trees	86.1	1
LAc12	Pollinator verges and spaces	-5.7	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY											
CH0903: Cycling		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc5	Shade_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	1
LAc6	Cooling_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	2
LAc12	Baltic POLL	1090	2	48.6	41.1	468	2	54.8	28.0	12.7	3
LAc12	Ullet Rd POLL	411	1	311.7	157.5	368	1	285.8	123.0	-8.3	4
LAc12	Strand POLL	620	1	75.4	44.5	159	1	59.2	20.8	-21.4	5
LAc1	Green_Route_1	2337	3	105.1	108.7						

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon stored, temperature reduction, water slowed, green space accessibility, pollination capacity, and value of air pollution improvements.

Quantitative data results showed positive influences on pollinators, plant diversity and floral resources, as well as levels of Nitrogen dioxide, but negative influences for Particulate matter (PM2.5 and PM10).

A high order of ranking as opposed to other NBS were found for:

- carbon storage, particularly for large areas of planting
- temperature reduction, particularly at a close radius of influence
- water slowed down, particularly at close radii
- green space accessibility, particularly for large or linear areas
- pollinator count and diversity, particularly at Baltic sites
- plant diversity, particularly at Baltic sites
- flower count, especially for the larger planted sites

Low rankings were seen for:

- air quality, including particulate matter and Nitrogen dioxide. Larger areas of planting did best for Nitrogen dioxide and values of air quality improvement.
- walking and cycling, although the pollinator pillars (Baltic POLL) seem to have a consistently greater positive effect than the Strand and Ullet road pollinator planting (which showed negative changes for both walking and cycling). The pollinator planting had much less effect than the shade and cooling trees.

As expected, the highest percentage changes creating a positive effect were for floral diversity, floral counts and consequent pollinator populations and diversities.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic).

Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Road traffic orders were required for some sites Ullet road site had concrete 'top' to be removed Ullet road site needed to deter cars from parking on it	Licence applied for by contractor Specialist contractor required Trees planted, high curb installed, soft earth mounded
Economical barriers	How they have been addressed
First contractor refused to complete the works after covid and went into administration	Delayed delivery on site and remaining works were re-tendered at extra costs
Social barriers	How they have been addressed
Reduced consultation with community due to covid	Consultation with key groups
Environmental (including COVID)	How they have been addressed
Delay in delivery Increased costs	Delayed Use of contingency

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Contractor for groundworks and planting was not adequately skilled and works were extended	Pressure to complete and eventual removal of contractor from works.
Economical barriers	How they have been addressed
None	
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Delay to delivery and poor communications between operational staff (highways and contractor)	Works were delayed.

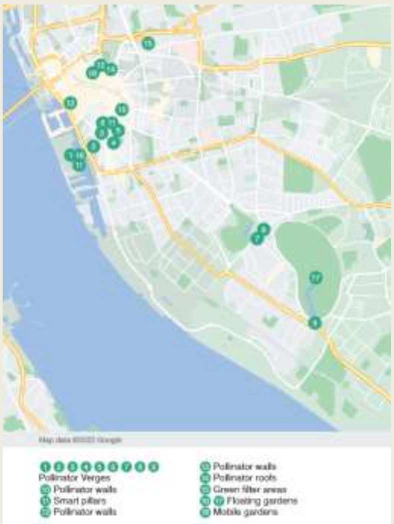
2.2.14 Lac13 Pollinator walls vertical

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0108; CH0111; CH0404; CH0410; CH0411; CH0412; CH0413; CH0501; CH0502; CH0503; CH0504; CH0505; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0703; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Lac13 Pollinator walls vertical	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	St Johns - May 2020 Parr Street - June 2020 Liverpool One – March 2022 Smart Pillars - July 2021	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location of Vertical Pollinating walls



Location of smart pillars

St Johns Green wall - 23 species, 200m2 and 65m long

Parr St Green Wall - 18 species, 132m2

Liverpool ONE green wall - 8000 plants, 27m long

Smart pollinator pillar – solar powered irrigation

There were three green walls, with the site names St Johns GW (St Johns Shopping Centre green wall), Parr St GW (Parr Street green wall in the Baltic) and L1 GW (Liverpool One green wall), as in the tables below.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	4.0	yes	yes
01	CH0104	CARBON SEQUESTRATION	4.0	yes	yes
01	CH0105	TEMPERATURE DECREASE	4.0	yes	yes
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	4.5	yes	yes
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.6	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	3.3	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	2.0	yes	no
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	2.2	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	2.2	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	2.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	4.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	4.5	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	4.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	5.0	yes	yes
04	CH0411	PLANT SPECIES INCREASE	5.0	yes	yes
04	CH0412	FLORAL RESOURCES INCREASE	5.0	yes	yes
04	CH0413	INSECTIVORE INCREASE	3.8	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.2	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	yes
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	yes
05	CH0504	NOx TRENDS	3.7	yes	yes
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	yes
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	3.5	yes	
07	CH0703	SOCIAL LEARNING	3.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	3.5	yes	

08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	3.0	yes	
09	CH0903	CYCLING AREA INCREASE	3.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	3.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	NBS name	EcoServR: CH0103: Carbon storage (tC)	Rank
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

Pollinator walls/vertical	EcoServR: CH0103: Carbon storage (tC)	Rank
St Johns GW	0.11	1
Parr St GW	0.08	2
L1 GW	0.04	3

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	NBS	EcoServR: CH0104: Carbon sequestration	Rank
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3

lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

EcoServR: CH0104: Carbon sequestration (tCO2e)		
Pollinator walls/vertical	Carbon sequestration (tCO2e)	Rank
St Johns GW	-0.05	1
Parr St GW	-0.04	2
L1 GW	-0.02	3

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			
LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		
LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0106: Temperature reduction			
ranked NBS	**NBS Name**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2
lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4
lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0106: Temperature reduction			
Pollinator walls/vertical	**radius (m)**	**% Change**	**Rank**
L1 GW	20	5.30	
Parr St GW	20		
St Johns GW	20		
L1 GW	100	0.72	
Parr St GW	100		
St Johns GW	100		

EcoServR: CH0204: Water slowed down			
ranked NBS	**NBS**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6

lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down			
Pollinator walls/vertical	**radius (m)**	**% Change**	**Rank**
L1 GW	20	-2.6	
Parr St GW	20		
St Johns GW	20		

EcoServR: CH0204: Water slowed down			
Pollinator walls/vertical	**radius (m)**	**% Change**	**Rank**
Parr St GW	100	0.0	1
L1 GW	100	-0.4	2
St Johns GW	100		

EcoServR: CH0403: Green Space Accessibility				
NBS	**NBS Name**	**households**	**population**	**Rank**
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

EcoServR: CH0403: Green Space Accessibility			
Pollinator walls/vertical	**households**	**population**	**Rank**
Parr St GW	1422	2557	1
St Johns GW	806	1307	2

L1 GW	538	877	3

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Count			
NBS	NBS Name	% Change	Rank
LAc8	SuDs & Rain Garden	448.6	1
LAc12	Pollinator verges and spaces	286.6	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Count		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	3.4	2.2	928.6	1
LAc8	Upper Pitt St RG	6	1	2.3	2.1	3	1	22.3	19.3	857.1	2
LAc12	Strand POLL	4	1	3.3	2.9	6	1	29.3	24.3	802.6	3
LAc12	Park Lane POLL	3	1	2.0	3.5	7	1	12.4	11.6	521.4	4
LAc12	Top SP Aig Dr POLL	4	1	3.8	2.2	2	1	10.5	0.7	180.0	5
LAc12	Ullet Rd POLL	3	1	5.3	8.4	5	1	12.2	13.2	128.8	6
LAc12	Baltic Hub POLL	4	1	11.0	7.7	2	1	20.0	15.6	81.8	7
LAc8	Lower SuDS	4	1	6.8	5.4	11	1	9.5	11.7	40.1	8
LAc12	Lower SuDS POLL	4	1	6.8	5.4	11	1	9.5	11.7	40.1	9
LAc12	Cornwallis St POLL	10	1	5.2	9.0	3	1	3.0	5.2	-42.3	10
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	11
LAc12	Wapping POLL	5	1	2.6	5.8	2	1	1.0	1.4	-61.5	12
LAc12	Princes Av POLL					7	1	14.9	21.2		
LAc12	Princes roundabt POLL	5	1	2.8	5.7						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	12.0	15.6		
LAc13	Parr St GW	1	1	0.0		12	1	6.3	9.7		
LAc13	St Johns GW					10	1	1.9	2.7		

LAc16	Wapping FI	1	1	3.0							

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Diversity			
NBS	**NBS Name**	**% Change**	**Rank**
LAc12	Pollinator verges and spaces	77.7	1
LAc8	SuDs & Rain Garden	41.8	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Diversity		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	1.7	0.8	414.3	1
LAc12	Park Lane POLL	3	1	1.0	1.7	7	1	2.9	2.5	185.7	2
LAc8	Upper Pitt St RG	6	1	1.2	1.0	3	1	2.3	2.1	100.0	3
LAc12	Strand POLL	4	1	1.3	1.0	6	1	2.5	2.2	100.0	4
LAc12	Top SP Aig Dr POLL	4	1	2.3	0.5	2	1	3.0	0.0	33.3	5
LAc12	Baltic Hub POLL	4	1	3.8	1.0	2	1	4.5	0.7	20.0	6
LAc12	Ullet Rd POLL	3	1	1.0	1.0	5	1	1.2	1.3	20.0	7
LAc8	Lower SuDS	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	8
LAc12	Lower SuDS POLL	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	9
LAc12	Wapping POLL	5	1	0.6	1.3	2	1	0.5	0.7	-16.7	10
LAc12	Cornwallis St POLL	10	1	1.7	2.6	3	1	1.0	1.7	-41.2	11
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	12
LAc12	Princes Av POLL					7	1	1.6	1.6		
LAc12	Princes roundabt POLL	5	1	0.8	1.3						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	2.0	1.4		
LAc13	Parr St GW	1	1	0.0		12	1	1.3	1.2		
LAc13	St Johns GW					10	1	1.1	1.4		
LAc16	Wapping FI	1	1	1.0							

EcoServR: CH0410: Pollinator increase			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2
lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase		
Pollinator walls/vertical	**% Change**	**Rank**
St Johns GW	21.05	1
L1 GW	16.83	2
Parr St GW	0.47	3

EcoServR: CH0410: Pollinator increase			
Pollinator walls/vertical	**radius (m)**	**% Change**	**Rank**
St Johns GW	20	24.43	1
L1 GW	20	19.95	2
Parr St GW	20	0.78	3

EcoServR: CH0410: Pollinator increase			
Pollinator walls/vertical	**radius (m)**	**% Change**	**Rank**
St Johns GW	100	17.66	1
L1 GW	100	13.71	2
Parr St GW	100	0.15	3

QUANTITATIVE DATA SUMMARY			
CH0411: Plant Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc13	Pollinator walls/vertical	1108.3	1
LAc12	Pollinator verges and spaces	77.4	2
LAc8	SuDs & Rain Garden	68.4	3
LAc16	Floating gardens	33.3	4

QUANTITATIVE DATA SUMMARY											
CH0411: Plant Count		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc13	Parr St GW	1	1	1.0		12	1	12.1	4.7	1108.3	1
LAc12	Strand POLL	4	1	3.3	0.5	6	1	12.3	3.7	279.5	2
LAc12	Park Lane POLL	3	1	4.3	2.3	7	1	9.6	5.5	120.9	3
LAc12	Wapping POLL	5	1	4.4	2.3	2	1	9.0	4.2	104.5	4
LAc8	Upper Pitt St RG	6	1	4.2	2.6	3	1	7.7	2.3	84.0	5
LAc12	Baltic Hub POLL	4	1	7.3	2.5	2	1	11.5	0.7	58.6	6
LAc8	Lower SuDS	4	1	1.3	0.5	11	1	1.9	0.5	52.7	7
LAc12	Lower SuDS POLL	4	1	1.3	0.5	11	1	1.9	0.5	52.7	8
LAc12	Bott SP Aig Dr POLL	3	1	1.3	0.6	7	1	2.0	0.0	50.0	9
LAc12	Top SP Aig Dr POLL	4	1	1.5	0.6	2	1	2.0	0.0	33.3	10
LAc16	SPL FI	2	1	1.5	0.7	1	1	2.0		33.3	11
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.8	0.4	8.0	12
LAc12	Cornwallis St POLL	10	1	5.6	2.3	3	1	5.0	1.0	-10.7	13
LAc12	Princes Av POLL					7	1	1.9	0.4		
LAc12	Princes roundabt POLL	5	1	1.4	0.5						
LAc12	Top SP roundabt POLL	1	1	2.0							
LAc13	L1 GW					2	1	2.0	0.0		
LAc13	St Johns GW					10	1	12.4	3.2		
LAc16	Wapping FI	1	1	4.0							

QUANTITATIVE DATA SUMMARY			
CH0411: Plant diversity			
NBS	**NBS Name**	**% Change**	**Rank**

LAc13	Pollinator walls/vertical	541.7	1
LAc12	Pollinator verges and spaces	55.0	2
LAc8	SuDs & Rain Garden	52.4	3
LAc16	Floating gardens	0.0	4

QUANTITATIVE DATA SUMMARY											
CH0411: Plant diversity		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc13	Parr St GW	1	1	1.0		12	1	6.4	2.4	541.7	1
LAc12	Park Lane POLL	3	1	2.7	0.6	7	1	6.3	3.5	135.7	2
LAc12	Strand POLL	4	1	3.3	0.5	6	1	7.5	2.1	130.8	3
LAc12	Wapping POLL	5	1	3.0	1.6	2	1	5.5	0.7	83.3	4
LAc12	Bott SP Aig Dr POLL	3	1	1.0	0.0	7	1	1.7	0.5	71.4	5
LAc8	Upper Pitt St RG	6	1	3.2	1.6	3	1	5.3	1.2	68.4	6
LAc12	Top SP Aig Dr POLL	4	1	1.3	0.5	2	1	2.0	0.0	60.0	7
LAc12	Baltic Hub POLL	4	1	3.8	1.5	2	1	5.5	0.7	46.7	8
LAc8	Lower SuDS	4	1	1.0	0.0	11	1	1.4	0.5	36.4	9
LAc12	Lower SuDS POLL	4	1	1.0	0.0	11	1	1.4	0.5	36.4	10
LAc16	SPL FI	2	1	1.0	0.0	1	1	1.0		0.0	11
LAc12	Cornwallis St POLL	10	1	4.7	1.3	3	1	3.3	0.6	-29.1	12
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.0	0.0	-40.0	13
LAc12	Princes Av POLL					7	1	1.3	0.5		
LAc12	Princes roundabt POLL	5	1	1.2	0.4						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	2.0	0.0		
LAc13	St Johns GW					10	1	7.4	1.8		
LAc16	Wapping FI	1	1	2.0							

QUANTITATIVE DATA SUMMARY			
CH0412: Flower Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc12	Pollinator verges and spaces	510.8	1
LAc8	SuDs & Rain Garden	328.7	2
LAc13	Pollinator walls/vertical	228.8	3
LAc16	Floating gardens	-10.8	4

QUANTITATIVE DATA SUMMARY											
CH0412: Flower Count		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc 12	Bott SP Aig Dr POLL	3	1	28.0	14.8	7	1	528.1	935.8	1786.2	1
LAc 12	Park Lane POLL	3	1	37.3	24.9	7	1	401.3	470.9	974.9	2
LAc 12	Strand POLL	4	1	67.0	23.6	6	1	565.3	411.1	743.8	3
LAc 8	Lower SuDS	4	1	37.0	23.9	11	1	267.5	205.8	623.1	4
LAc 12	Lower SuDS POLL	4	1	37.0	23.9	11	1	267.5	205.8	623.1	5
LAc 13	Parr St GW	1	1	50.0		12	1	164.4	190.8	228.8	6
LAc 12	Cornwallis St POLL	10	1	84.8	124.6	3	1	233.3	182.4	175.2	7
LAc 12	Top SP Aig Dr POLL	4	1	660.3	1043.5	2	1	1487.5	1594.5	125.3	8
LAc 12	Wapping POLL	5	1	196.6	293.5	2	1	319.0	161.2	62.3	9
LAc 12	Ullet Rd POLL	3	1	170.7	246.3	5	1	269.4	92.6	57.9	10
LAc 12	Baltic Hub POLL	4	1	326.0	178.6	2	1	483.0	521.8	48.2	11
LAc 8	Upper Pitt St RG	6	1	94.8	58.7	3	1	127.3	42.1	34.3	12
LAc 16	SPL FI	2	1	115.5	92.6	1	1	103.0		-10.8	13
LAc 12	Princes Av POLL					7	1	402.3	563.9		
LAc 12	Princes roundabt POLL	5	1	98.2	144.5						
LAc 12	Top SP roundabt POLL	1	1	135.0							
LAc 13	L1 GW					2	1	206.0	217.8		
LAc 13	St Johns GW					10	1	378.2	368.5		
LAc 16	Wapping FI	1	1	162.0							

QUANTITATIVE DATA SUMMARY			
CH0502: PM 2.5			
NBS	NBS Name	% Change	Rank

LAc8	SuDs & Rain Garden	-62.6	1
LAc14	Pollinator roofs	-57.3	2
LAc4	Urban catchment forestry	-49.3	3
LAc17	Green filter area	-13.8	4
LAc13	Pollinator walls/vertical	-7.4	5
LAc12	Pollinator verges and spaces	9.0	6

QUANTITATIVE DATA SUMMARY											
CH0502: PM 2.5		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc8	Upper Pitt St RG	30	2	9.9	13.9	2	2	2.0	0.0	-79.8	1
LAc14	Royal Court GR	2	1	26.0	8.5	35	1	11.1	7.5	-57.3	2
LAc4	Strand Tree SuDS	110	4	11.7	13.1	40	4	6.0	6.1	-49.3	3
LAc8	Upper SuDS	18	2	9.2	5.5	22	2	5.0	3.0	-45.3	4
LAc13	Parr St GW	15	1	11.0	7.1	42	2	6.8	7.6	-37.9	5
LAc13	St Johns GW	29	2	15.6	8.5	47	5	9.9	6.8	-36.3	6
LAc17	Lime St TREES	86	3	10.0	8.3	10	3	6.8	7.2	-31.9	7
LAc17	Stafford St TREES	50	2	8.1	6.5	18	2	8.4	7.5	4.3	8
LAc12	Cornwallis St POLL	33	1	8.3	7.7	3	1	9.0	5.6	8.8	9
LAc12	Bott SP Aig Dr POLL	24	1	7.3	5.9	2	1	8.0	2.8	9.1	10
LAc13	L1 GW	30	3	5.3	2.8	70	7	8.1	8.7	52.0	11

QUANTITATIVE DATA SUMMARY			
CH0503: PM 10			
NBS	NBS Name	% Change	Rank
LAc14	Pollinator roofs	-49.3	1
LAc4	Urban catchment forestry	-36.7	2
LAc8	SuDs & Rain Garden	-27.7	3
LAc13	Pollinator walls/vertical	-14.1	4
LAc17	Green filter area	30.2	5
LAc12	Pollinator verges and spaces	32.8	6

QUANTITATIVE DATA SUMMARY

CH0503: PM 10		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc14	Royal Court GR	2	1	37.5	7.8	35	1	19.0	8.9	-49.3	1
LAc8	Upper Pitt St RG	30	2	16.7	15.8	2	2	10.5	0.7	-37.1	2
LAc4	Strand Tree SuDS	110	4	19.6	14.5	40	4	12.4	9.5	-36.7	3
LAc13	Parr St GW	15	1	19.0	9.1	42	2	12.4	7.5	-34.8	4
LAc13	St Johns GW	29	2	24.0	11.7	47	5	16.0	8.6	-33.5	5
LAc8	Upper SuDS	18	2	16.8	5.9	22	2	13.7	7.7	-18.2	6
LAc17	Lime St TREES	86	3	18.6	12.8	10	3	21.7	15.8	16.7	7
LAc13	L1 GW	30	3	13.0	6.8	70	7	16.4	11.2	26.0	8
LAc12	Bott SP Aig Dr POLL	24	1	15.0	9.0	2	1	19.5	9.2	30.0	9
LAc12	Cornwallis St POLL	33	1	14.8	8.8	3	1	20.0	7.0	35.5	10
LAc17	Stafford St TREES	50	2	14.5	7.4	18	2	20.8	17.4	43.7	11

QUANTITATIVE DATA SUMMARY			
CH0504: NO2			
NBS	NBS Name	% Change	Rank
LAc14	Pollinator roofs	-25.8	1
LAc8	SuDs & Rain Garden	-19.8	2
LAc13	Pollinator walls/vertical	-15.5	3
LAc4	Urban catchment forestry	-13.7	4
LAc17	Green filter area	-8.1	5
LAc12	Pollinator verges and spaces	-7.9	6

QUANTITATIVE DATA SUMMARY											
CH0504: NO2		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc 13	Parr St GW	85	5	30.6	6.8	112	5	25.6	5.0	-16.3	1
LAc 13	St Johns GW	29	2	39.0	12.9	36	2	32.7	11.2	-14.7	2
LAc 13	L1 GW	89	3	38.8	8.7	17	3	39.1	8.3	5.2	3

EcoServR: CH0511: Air quality improvements			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements		
Pollinator walls/vertical	**% Change**	**Rank**
St Johns GW	54.45	1
Parr St GW	5.49	2
L1 GW	0.00	3

EcoServR: CH0511: Air quality improvements			
Pollinator walls/vertical	**radius (m)**	**% Change**	**Rank**
L1 GW	20	0.0	
Parr St GW	20		
St Johns GW	20		

EcoServR: CH0511: Air quality improvements			
Pollinator walls/vertical	**radius (m)**	**% Change**	**Rank**
St Johns GW	100	54.5	1
Parr St GW	100	5.5	2
L1 GW	100	0.0	3

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon stored, temperature reduction, green space accessibility, pollination capacity, and value of air pollution improvements, but not for water slowed. For instance, the EcoServR model showed all green walls as having a carbon storage capacity, with St Johns green wall as having the most important effect.

Quantitative data results showed positive influences on pollinators, plant diversity and floral resources, as well as levels of Nitrogen dioxide and Particulate matter (PM2.5 and PM10).

A high order of ranking as opposed to other NBS were found for:

- Pollinator increase (modelled), particularly for the larger St Johns green wall, both at 20 and 100m radii. However, the quantitative data showed inconclusive results.
- Plant count and diversity, particularly for the Parr Street green wall
- Floral abundance, where the Parr Street green wall did best out of the green walls, although these results were not as high as for the horizontal planted areas
- Air quality improvements (modelled), particularly shown by St Johns green wall.

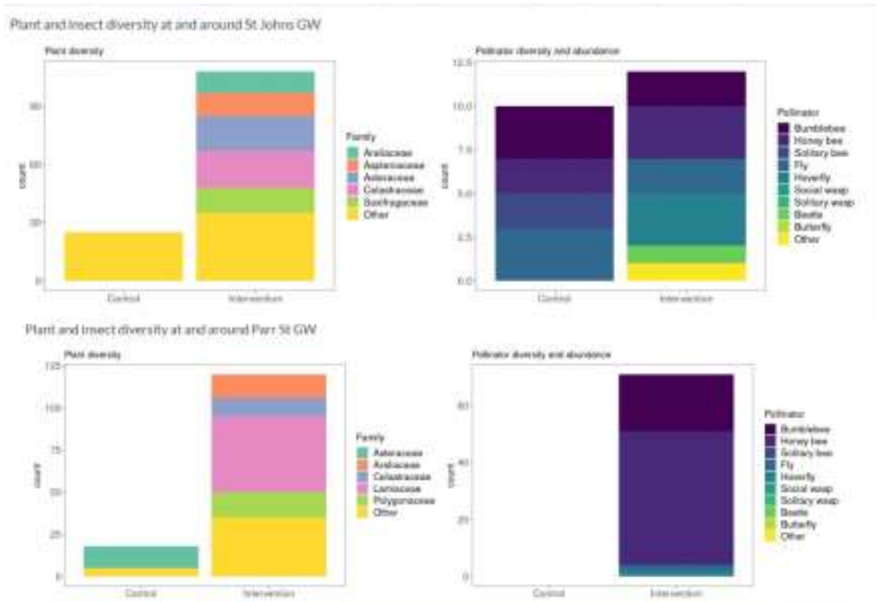
Lower rankings were found for:

- Carbon storage, although larger walls provided more carbon storage
- Carbon sequestration, although larger walls provided more carbon sequestration
- Temperature reduction, with LiverpoolOne green wall providing more at closer radii,
- Green space accessibility, with the Parr Street green wall demonstrating the most benefit
- Pollinator counts and diversities.
- Particulate matter 2.5 and 10, with positive influences especially for Parr Street and St Johns green walls
- Nitrogen dioxide, with the Liverpool One green wall showing a slight negative influence, but this may be accounted for by other external factors.

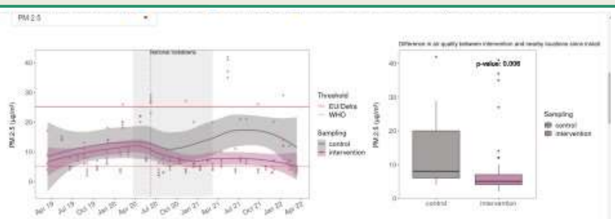
The highest percentage changes creating a positive effect were for the Baltic area Parr Street green wall plant counts and diversity, although all green walls did well for these biodiversity measures.

Example plots of biodiversity data associated with the green walls. Please see portal (see note below) for further plot examples.

Biodiversity associated with Green Walls



St Johns Green Wall is close to other pollinator sources(pollinator roof, park, planted containers)

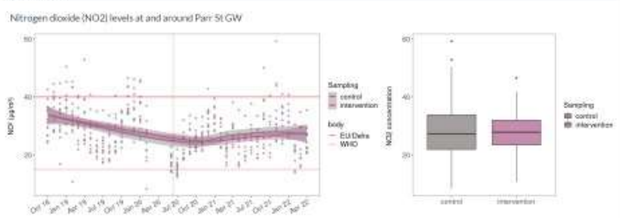


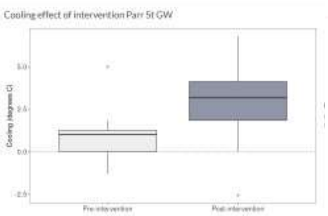
Data Grab Green Walls

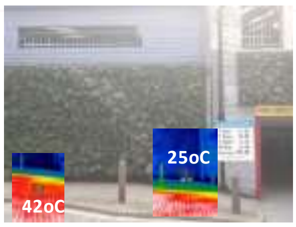
PM 2.5 local improvement

NO2 less clear

Thermoregulation improvement







Overall, all the green walls did well for floral abundance and plant diversities, although not so well for pollinator levels (quantitative), although the high potential was shown by the high modelled pollinator capacities. The larger area green walls showed greater benefits, particularly the Parr St green wall. The Liverpool One green wall had some irrigation and hence drying out problems, so this may have affected the data obtained.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
St Johns – structural issues with weight bearing Fire calculations needed at Parr Street following procurement challenge and change in the law Solar panel and materials issues with smart pillars	Additional steel supports Specialist appointed Delayed works on site
Economical barriers	How they have been addressed
Additional costs for st Johns extra support Additional costs for Parr st during covid and additional fire calculations	Project contingency budget Project contingency budget
Social barriers	How they have been addressed

Intermittent delivery of smart pillars due to furlough/covid	Consultation with residents
Environmental (including COVID)	How they have been addressed
Delayed works due to social distancing and furlough etc	Delayed works on site

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Solar panels on smart pillars insufficient on cloudy days Plant failures on smart pillars several times Some minor vandalism to Parr St wall Some plant deaths and mildew at Parr St wall Loss of plants at Liverpool ONE due to irrigation failure	Application for UMSUG code to connect to street lighting, but took too long to be operational Contractor to replant Replacement planting Replacement planting and eco treatments Replanted and new irrigation system installed
Economical barriers	How they have been addressed
Price of steel increased for Liverpool ONE wall	Accommodated through competitive quotes and contingency
Social barriers	How they have been addressed
None	
Environmental (including COVID)	How they have been addressed
Long drawn out installation of pillars with poor after care	Replanted by contractor on several ocassions

2.2.15 Lac 14 Pollinator roof

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0111; CH0212; CH0404; CH0410; CH0411; CH0412; CH0413; CH0501; CH0502; CH0503; CH0504; CH0505; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Lac 14 Pollinator roof	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	June 2019	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location pollinator roof number 14

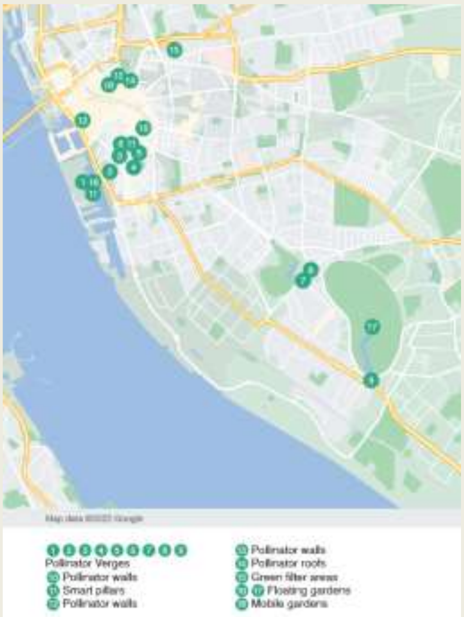


Image pollinator roof

The pollinator roof site was called Royal Count GR as in the tables below.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	4.0	yes	yes
01	CH0104	CARBON SEQUESTRATION	4.0	yes	yes
01	CH0105	TEMPERATURE DECREASE	4.0	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	4.5	yes	
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.6	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	3.3	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	2.0	yes	yes
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	2.2	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	2.2	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	2.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	4.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	4.5	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	4.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	5.0	yes	yes

04	CH0411	PLANT SPECIES INCREASE	5.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	5.0	yes	
04	CH0413	INSECTIVORE INCREASE	3.8	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.2	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	yes
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	yes
05	CH0504	NOx TRENDS	3.7	yes	yes
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	yes
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	3.5	yes	
07	CH0703	SOCIAL LEARNING	3.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	3.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	3.0	yes	
09	CH0903	CYCLING AREA INCREASE	3.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	3.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	**NBS name**	**EcoServR: CH0103: Carbon storage (tC)**	**Rank**
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6

lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	NBS	EcoServR: CH0104: Carbon sequestration	Rank
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			
LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		

LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0204: Water slowed down			
ranked NBS	NBS	% Change	Rank
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0403: Green Space Accessibility				
NBS	NBS Name	households	population	Rank
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

EcoServR: CH0410: Pollinator increase			
NBS	NBS Name	% Change	Rank
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2

lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

QUANTITATIVE DATA SUMMARY			
CH0502: PM 2.5			
NBS	**NBS Name**	**% Change**	**Rank**
LAc8	SuDs & Rain Garden	-62.6	1
LAc14	Pollinator roofs	-57.3	2
LAc4	Urban catchment forestry	-49.3	3
LAc17	Green filter area	-13.8	4
LAc13	Pollinator walls/vertical	-7.4	5
LAc12	Pollinator verges and spaces	9.0	6

QUANTITATIVE DATA SUMMARY											
CH0502: PM 2.5		Pre-Intervention				Post-Intervention				% Change	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc8	Upper Pitt St RG	30	2	9.9	13.9	2	2	2.0	0.0	-79.8	1
LAc14	Royal Court GR	2	1	26.0	8.5	35	1	11.1	7.5	-57.3	2
LAc4	Strand Tree SuDS	110	4	11.7	13.1	40	4	6.0	6.1	-49.3	3
LAc8	Upper SuDS	18	2	9.2	5.5	22	2	5.0	3.0	-45.3	4
LAc13	Parr St GW	15	1	11.0	7.1	42	2	6.8	7.6	-37.9	5
LAc13	St Johns GW	29	2	15.6	8.5	47	5	9.9	6.8	-36.3	6
LAc17	Lime St TREES	86	3	10.0	8.3	10	3	6.8	7.2	-31.9	7
LAc17	Stafford St TREES	50	2	8.1	6.5	18	2	8.4	7.5	4.3	8
LAc12	Cornwallis St POLL	33	1	8.3	7.7	3	1	9.0	5.6	8.8	9
LAc12	Bott SP Aig Dr POLL	24	1	7.3	5.9	2	1	8.0	2.8	9.1	10
LAc13	L1 GW	30	3	5.3	2.8	70	7	8.1	8.7	52.0	11

QUANTITATIVE DATA SUMMARY			
CH0503: PM 10			
NBS	NBS Name	% Change	Rank
LAc14	Pollinator roofs	-49.3	1
LAc4	Urban catchment forestry	-36.7	2
LAc8	SuDs & Rain Garden	-27.7	3
LAc13	Pollinator walls/vertical	-14.1	4
LAc17	Green filter area	30.2	5
LAc12	Pollinator verges and spaces	32.8	6

QUANTITATIVE DATA SUMMARY											
CH0503: PM 10		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc14	Royal Court GR	2	1	37.5	7.8	35	1	19.0	8.9	-49.3	1
LAc8	Upper Pitt St RG	30	2	16.7	15.8	2	2	10.5	0.7	-37.1	2
LAc4	Strand Tree SuDS	110	4	19.6	14.5	40	4	12.4	9.5	-36.7	3
LAc13	Parr St GW	15	1	19.0	9.1	42	2	12.4	7.5	-34.8	4
LAc13	St Johns GW	29	2	24.0	11.7	47	5	16.0	8.6	-33.5	5
LAc8	Upper SuDS	18	2	16.8	5.9	22	2	13.7	7.7	-18.2	6
LAc17	Lime St TREES	86	3	18.6	12.8	10	3	21.7	15.8	16.7	7
LAc13	L1 GW	30	3	13.0	6.8	70	7	16.4	11.2	26.0	8
LAc12	Bott SP Aig Dr POLL	24	1	15.0	9.0	2	1	19.5	9.2	30.0	9
LAc12	Cornwallis St POLL	33	1	14.8	8.8	3	1	20.0	7.0	35.5	10
LAc17	Stafford St TREES	50	2	14.5	7.4	18	2	20.8	17.4	43.7	11

QUANTITATIVE DATA SUMMARY			
CH0504: NO2			
NBS	NBS Name	% Change	Rank
LAc14	Pollinator roofs	-25.8	1
LAc8	SuDs & Rain Garden	-19.8	2
LAc13	Pollinator walls/vertical	-15.5	3

LAc4	Urban catchment forestry	-13.7	4
LAc17	Green filter area	-8.1	5
LAc12	Pollinator verges and spaces	-7.9	6

EcoServR: CH0511: Air quality improvements			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon storage, carbon sequestration, water slowed, green space accessibility, pollinator capacity, air quality and value of air pollution reduction.

Quantitative data results positive influences on thermal cooling (slight influence), and air quality (PM2.5, PM10 and NO2). The biodiversity data need further analyses to assess if any changes were found for the pollinators and floral abundance, but there will be an increase from zero.

A high order of ranking as opposed to other NBS were found for:

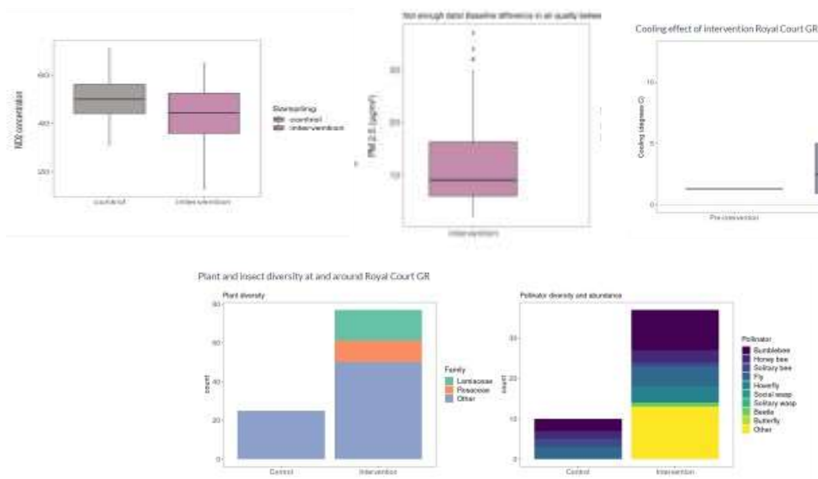
- Air quality (PM2.5, PM10 and NO2)
- Air quality (modelled)

Lower rankings were found for:

- carbon storage
- carbon sequestration
- water slowed (modelled)
- green space accessibility

High percentages of positive change were found for pollinator capacity (modelled), air quality (modelled and quantitative).

An example of data plots for this NBS are as shown below.



Data Grab Pollinator Roof Terrace
Potential local air quality improvement
Increased cooling effect
Enhanced biodiversity

Overall, the pollinator roof showed great benefits, particularly for air quality and pollinator capacity.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
None	N/A
Economical barriers	How they have been addressed

None reported	N/A
Social barriers	How they have been addressed
None reported	N/A
Environmental (including COVID)	How they have been addressed
None reported	N/A

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
None reported	N/A
Economical barriers	How they have been addressed
None reported	N/A
Social barriers	How they have been addressed
None reported	N/A
Environmental (including COVID)	How they have been addressed
Some losses of plants during covid lockdown as no irrigation was possible	Replacement planting

2.2.16 Lac15 Mobile Gardens

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0106; CH0108; CH0111; CH0403;; CH0410; CH0411; CH0412; CH0413; CH0501 CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0703; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Lac15 Mobile Gardens	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	

LIV	June 2019	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Developed by BCA Landscape and taking inspiration from the ideas from Japanese medicine about the benefits of forest bathing this pod creates the sense of being in a forest, in a city. Mirrored walls reflect the trees to create the “in the forest” effect, birdsong and the smell of bark add to the sensory experience. In June 2019, the Mersey Forest set up the Forest Bathing Pod in Williamson Square. The Forest Bathing Pod was designed by bcal, a local landscape architecture firm and assembled by the Royal Court. The concept is derived from the Japanese practice of ‘shirin-yoku’ which roughly translates to forest bathing. Research has shown proven physiological and psychological benefits of spending time in forests. The purpose of the pod was to demonstrate the benefits of shirin-yoku on a micro-scale, in an urban context. In this way, it would show how forest bathing can be considered a nature-based solution to improving mental wellbeing.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	3.5	yes	
01	CH0104	CARBON SEQUESTRATION	3.5	yes	
01	CH0105	TEMPERATURE DECREASE	3.8	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	3.8	yes	
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.6	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	0.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	0.0	yes	

02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	1.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	1.0	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	0.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	1.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	4.5	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	4.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	3.0	yes	
04	CH0411	PLANT SPECIES INCREASE	3.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	3.0	yes	
04	CH0413	INSECTIVORE INCREASE	1.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	2.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	
05	CH0504	NOx TRENDS	3.7	yes	
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	1.0	yes	
05	CH0509	Energy savings	1.0	yes	
05	CH0510	Increase in property value	1.0	yes	
05	CH0511	Value of air quality improvements	1.0	yes	
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	1.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	3.5	yes	
07	CH0703	SOCIAL LEARNING	3.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	3.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	1.0	yes	
09	CH0903	CYCLING AREA INCREASE	1.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	3.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

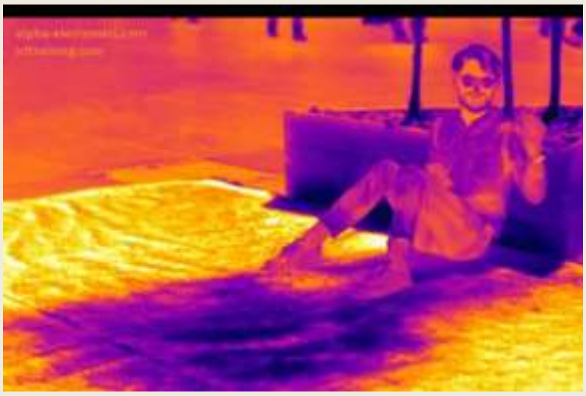
We have used the mobile forest to stimulate conversation about greening the city to tackle projected climate change and raise aspirations about "what could be", greener more sustainable cities.

Overview

- Benefits of shirin-yoku well demonstrated
- Practical engagement worked well e.g. participants reported feeling more relaxed after even 5-10 mins in the pod
- Potentially better than NBS being described conceptually e.g. meaning sinks in better when people experience benefits first hand
- A reoccurring theme in verbal responses reflected concern over loss of green space in the city to development – some were confused about why URBAN Green UP is going ahead at the same time as extant green space is being sold to developers.

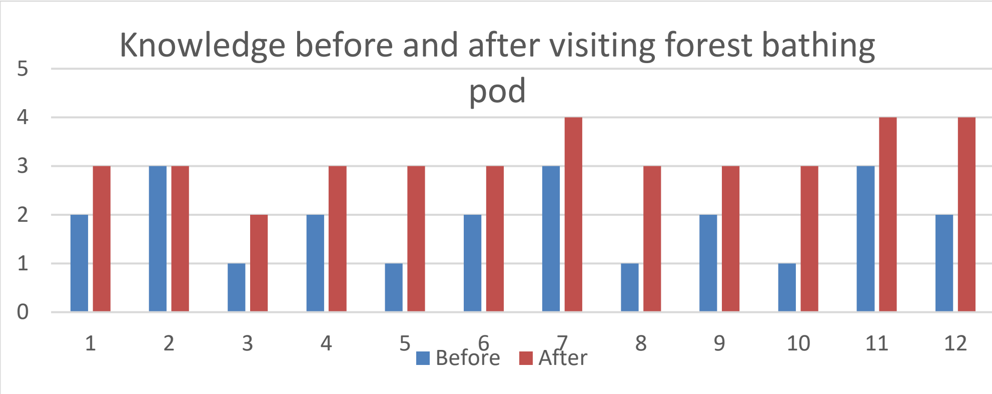
Earlier trial of a pop-up forest

Cooling impact of pop-up trees



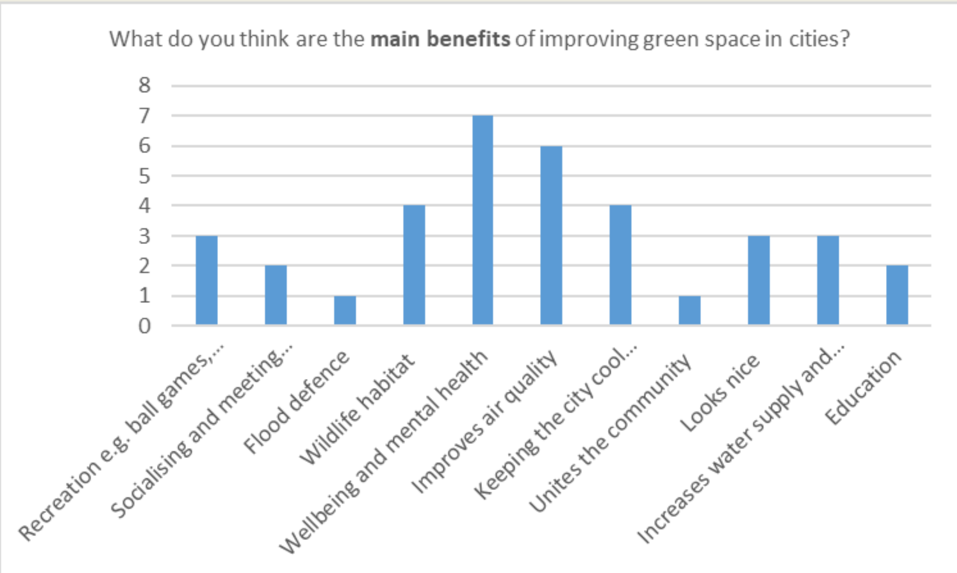
Selected comments from people attending trial pop-up forest:

- "Our trees are our future. They sustain our wellbeing. We need to bring back the elegance and beauty nature provides -Naturally!"
- "Fabulous to see this initiative. The city centre needs greening-up"
- "It will make Liverpool city centre a more attractive place to visit or go around in"
- "Is it staying? It's beautiful"
- "That looks great...should be permanent"
- "What a great idea"
- "Good idea, bet the shade was welcome today!"



Feedback for forest bathing pod was extremely positive overall. Respondents reported feeling relaxed, calm and peaceful. Some noted the physical benefits in addition to mental wellbeing - cooling, shading of trees being beneficial in hot weather.

- I loved trees being in the city and being able to have a calming space.
- relaxing, reflecting mirrors enhanced the experience
- pleasant and peaceful
- genuinely peaceful experience let's see more of this :)
- Relaxing, mirrors gave the illusion of more space.
- relaxing and calming
- Beautiful, cooling on a hot day. I didn't want to come out!
- it's very tranquil and relaxing, very cool in temperature. Would benefit form a water feature to drown out urban sounds
- It made me feel very calm. I could have spent longer in there than I did.
- it was so relaxing and serene. It was nice to be around nature
- beautiful, cooling on a very hot day! I didn’t want to come out
- peace, quiet and calming



Therefore, lots of positive comments were gathered. Many requests for various locations were received. Plans to proceed with setting up the forest bathing pod were disrupted by Covid distancing rules, but there is still continued interest and a permanent home is found at a nearby forest school.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Construction that could be assembled and taken down for storage Storage location	Design Support from the city council
Economical barriers	How they have been addressed
None	N/A
Social barriers	How they have been addressed
None	N/A
Environmental (including COVID)	How they have been addressed
Pre-covid installation	N/A

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Requires 2 day location to make it effective	Overnight security required

Locating trees in containers Miscellaneous items such as sand/cones /collection times etc Permanent home required	Hired from nursery Liaised with city council Permanent home at forest school
Economical barriers	How they have been addressed
None	N/A
Social barriers	How they have been addressed
Covid prevented additional events	Did not take place
Environmental (including COVID)	How they have been addressed
Mobile forest was stored during covid	Now at Forest School location

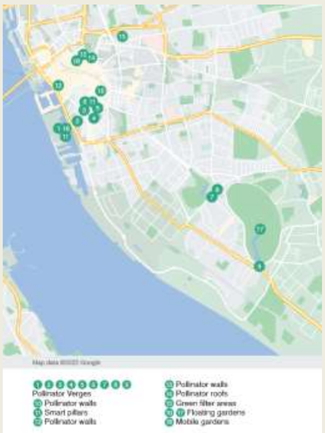
2.2.17 Lac16 Floating Gardens/Ecosystems

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0108; CH0111; CH0201; CH0207; CH0209; CH0404; CH0410; CH0411; CH0412; CH0413; CH0501; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Lac16 Floating Gardens/Ecosystems	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	June 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location of floating gardens and ecosystems numbers 16 and 17



Images Wapping dock floating garden

Images Sefton Park floating garden

The two floating garden ecosystem sites were labelled SP FI (Sefton park floating island) and Wapping Dock FI (Wapping Dock Floating island) as in the tables below.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	3.5	yes	yes
01	CH0104	CARBON SEQUESTRATION	3.5	yes	
01	CH0105	TEMPERATURE DECREASE	3.8	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	3.8	yes	yes
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.6	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	0.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	0.0	yes	yes
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	1.0	Inconclusive	Inconclusive
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	1.0	Inconclusive	yes
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	0.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	1.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	4.5	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	4.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	4.2	yes	inconclusive
04	CH0411	PLANT SPECIES INCREASE	4.2	yes	yes
04	CH0412	FLORAL RESOURCES INCREASE	4.2	yes	no
04	CH0413	INSECTIVORE INCREASE	1.0	yes	yes
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	2.0	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	
05	CH0504	NOx TRENDS	3.7	yes	
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	1.0	yes	
05	CH0509	Energy savings	1.0	yes	
05	CH0510	Increase in property value	1.0	yes	
05	CH0511	Value of air quality improvements	1.0	yes	yes
05	CH0512	Value of air pollution reduction	1.0	n/a	

05	CH0513	Total monetary value of urban forests including air quality	1.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	3.5	yes	
07	CH0703	SOCIAL LEARNING	3.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	3.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	1.0	yes	
09	CH0903	CYCLING AREA INCREASE	1.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	3.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	NBS name	EcoServR: CH0103: Carbon storage (tC)	Rank
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

Floating gardens	EcoServR: CH0103: Carbon storage (tC)	Rank
Wapping FI	0.15	1
SPL FI	0.06	2

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	NBS	EcoServR: CH0104: Carbon sequestration	Rank
lac17	Green filter area	-0.87	1

lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

EcoServR: CH0106: Temperature reduction			
ranked NBS	**NBS Name**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2
lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4
lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0106: Temperature reduction			
Floating gardens	**radius (m)**	**% Change**	**Rank**
SPL FI	100	0.06	1
Wapping FI	100	0.01	2
SPL FI	20	0.00	3
Wapping FI	20	0.00	3

EcoServR: CH0204: Water slowed down			
ranked NBS	**NBS**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	11.2	1

lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down			
Floating gardens	**radius (m)**	**% Change**	**Rank**
Wapping Fl	100	22.0	1
SPL Fl	20	0.0	2
SPL Fl	100	0.0	2
Wapping Fl	20		

QUANTITATIVE DATA SUMMARY						
CH0207 Water		**% Change**				
NBS	**NBS name**	**Specific Conductivity**	**Dissolved Oxygen**	**Combined Nitrogen**	**Phosphate**	**All metals**
LAc4	Urban catchment forestry	57.8	26.2	90.0	510.0	-13.2
LAc8	SuDs & Rain Garden	-15.1	-4.6	-8.8	76.9	21.1
LAc16	Floating gardens	13.8	-5.2	-43.1	48.9	29.3

QUANTITATIVE DATA SUMMARY											
CH0207 Water % Change Metals in Solution											
NBS	**NBS Name**	**Arsenic**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**	**Iron**	**Manganese**	**Nickel**	**Lead**	**Zinc**
LAc4	**Strand Tree SuDS**	119		-41	-8	-17	-49	-61	-17	-41	-37
LAc8	**Lower SuDS**			-89		489	186	66	38		-63
LAc8	**Upper Pitt St RG**										

LAc8	**Upper SuDS**			-92		10	18	10	-55	-8	9
LAc16	**SPL FI**			-99		0	35	23	-16	48	11

QUANTITATIVE DATA SUMMARY					
CH0207 Water % Change Nutrients in Solution					
NBS	**NBS Name**	**Ammonium (N-NH4)**	**Nitrite (N-NO2)**	**Nitrate (N-NO3)**	**Phosphate (SRP)**
LAc4	**Strand Tree SuDS**	19.2	-64.7	251.5	510.0
LAc8	**Lower SuDS**	-59.9	-6.3	214.7	94.8
LAc8	**Upper Pitt St RG**				
LAc8	**Upper SuDS**	-23.8	16.6	0.1	59.0
LAc16	**SPL FI**	-20.6	-56.9	-69.4	48.9

QUANTITATIVE DATA SUMMARY				
CH0209 Suspended Sediment Water		**% Change**		
NBS	**NBS name**	**Organic Matter**	**Suspended Sediment**	**All Suspended Metals**
LAc4	Urban catchment forestry	118.4	-74.6	8.4
LAc8	SuDs & Rain Garden	296.3	-53.8	59.8
LAc16	Floating gardens	1095.1	47.0	-6.9

QUANTITATIVE DATA SUMMARY										
CH0209 Suspended Sediment Water % Change Metals										
NBS	**NBS name**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Nickel**	**Lead**	**Zinc**
LAc4	**Strand Tree SuDS**	12	160	-64	-78	-27	26	51	-26	31
LAc8	**Upper SuDS**	185	224	23	-16	34	29	48	41	51
LAc16	**SPL FI**	-59	207	51	-41	-43	-48	-5	-31	-29

EcoServR: CH0403: Green Space Accessibility				
NBS	**NBS Name**	**households**	**population**	**Rank**
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3

lac12	Pollinator verges and spaces	1314	2651	4
lac8	SuDs & Rain Garden	1161	2491	5
lac13	Pollinator walls/vertical	922	1580	6
lac14	Pollinator roofs	764	1247	7
lac4	Urban catchment forestry	454	670	8
lac16	Floating gardens	306	545	9

EcoServR: CH0403: Green Space Accessibility			
Floating gardens	**households**	**population**	**Rank**
SPL FI	360	658	1
Wapping FI	252	431	2

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc8	SuDs & Rain Garden	448.6	1
LAc12	Pollinator verges and spaces	286.6	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Count		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	3.4	2.2	928.6	1
LAc8	Upper Pitt St RG	6	1	2.3	2.1	3	1	22.3	19.3	857.1	2
LAc12	Strand POLL	4	1	3.3	2.9	6	1	29.3	24.3	802.6	3
LAc12	Park Lane POLL	3	1	2.0	3.5	7	1	12.4	11.6	521.4	4
LAc12	Top SP Aig Dr POLL	4	1	3.8	2.2	2	1	10.5	0.7	180.0	5

LAc12	Ullet Rd POLL	3	1	5.3	8.4	5	1	12.2	13.2	128.8	6
LAc12	Baltic Hub POLL	4	1	11.0	7.7	2	1	20.0	15.6	81.8	7
LAc8	Lower SuDS	4	1	6.8	5.4	11	1	9.5	11.7	40.1	8
LAc12	Lower SuDS POLL	4	1	6.8	5.4	11	1	9.5	11.7	40.1	9
LAc12	Cornwallis St POLL	10	1	5.2	9.0	3	1	3.0	5.2	-42.3	10
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	11
LAc12	Wapping POLL	5	1	2.6	5.8	2	1	1.0	1.4	-61.5	12
LAc12	Princes Av POLL					7	1	14.9	21.2		
LAc12	Princes roundabt POLL	5	1	2.8	5.7						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	12.0	15.6		
LAc13	Parr St GW	1	1	0.0		12	1	6.3	9.7		
LAc13	St Johns GW					10	1	1.9	2.7		
LAc16	Wapping FI	1	1	3.0							

QUANTITATIVE DATA SUMMARY			
CH0410: Pollinator Diversity			
NBS	NBS Name	% Change	Rank
LAc12	Pollinator verges and spaces	77.7	1
LAc8	SuDs & Rain Garden	41.8	2
LAc16	Floating gardens	-60.0	3
LAc13	Pollinator walls/vertical		

QUANTITATIVE DATA SUMMARY											
CH0410: Pollinator Diversity		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc12	Bott SP Aig Dr POLL	3	1	0.3	0.6	7	1	1.7	0.8	414.3	1
LAc12	Park Lane POLL	3	1	1.0	1.7	7	1	2.9	2.5	185.7	2

LAc8	Upper Pitt St RG	6	1	1.2	1.0	3	1	2.3	2.1	100.0	3
LAc12	Strand POLL	4	1	1.3	1.0	6	1	2.5	2.2	100.0	4
LAc12	Top SP Aig Dr POLL	4	1	2.3	0.5	2	1	3.0	0.0	33.3	5
LAc12	Baltic Hub POLL	4	1	3.8	1.0	2	1	4.5	0.7	20.0	6
LAc12	Ullet Rd POLL	3	1	1.0	1.0	5	1	1.2	1.3	20.0	7
LAc8	Lower SuDS	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	8
LAc12	Lower SuDS POLL	4	1	2.5	2.1	11	1	2.1	1.7	-16.4	9
LAc12	Wapping POLL	5	1	0.6	1.3	2	1	0.5	0.7	-16.7	10
LAc12	Cornwallis St POLL	10	1	1.7	2.6	3	1	1.0	1.7	-41.2	11
LAc16	SPL FI	2	1	2.5	2.1	1	1	1.0		-60.0	12
LAc12	Princes Av POLL					7	1	1.6	1.6		
LAc12	Princes roundabt POLL	5	1	0.8	1.3						
LAc12	Top SP roundabt POLL	1	1	1.0							
LAc13	L1 GW					2	1	2.0	1.4		
LAc13	Parr St GW	1	1	0.0		12	1	1.3	1.2		
LAc13	St Johns GW					10	1	1.1	1.4		
LAc16	Wapping FI	1	1	1.0							

EcoServR: CH0410: Pollinator increase			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2
lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8

lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase			
Floating gardens	**radius (m)**	**% Change**	**Rank**
Wapping FI	20	15.35	1
Wapping FI	100	12.98	2
SPL FI	20	0.00	3
SPL FI	100	0.00	4

QUANTITATIVE DATA SUMMARY			
CH0411: Plant Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc13	Pollinator walls/vertical	1108.3	1
LAc12	Pollinator verges and spaces	77.4	2
LAc8	SuDs & Rain Garden	68.4	3
LAc16	Floating gardens	33.3	4

QUANTITATIVE DATA SUMMARY											
CH0411: Plant Count		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc13	Parr St GW	1	1	1.0		12	1	12.1	4.7	1108.3	1
LAc12	Strand POLL	4	1	3.3	0.5	6	1	12.3	3.7	279.5	2
LAc12	Park Lane POLL	3	1	4.3	2.3	7	1	9.6	5.5	120.9	3
LAc12	Wapping POLL	5	1	4.4	2.3	2	1	9.0	4.2	104.5	4
LAc8	Upper Pitt St RG	6	1	4.2	2.6	3	1	7.7	2.3	84.0	5
LAc12	Baltic Hub POLL	4	1	7.3	2.5	2	1	11.5	0.7	58.6	6
LAc8	Lower SuDS	4	1	1.3	0.5	11	1	1.9	0.5	52.7	7
LAc12	Lower SuDS POLL	4	1	1.3	0.5	11	1	1.9	0.5	52.7	8
LAc12	Bott SP Aig Dr POLL	3	1	1.3	0.6	7	1	2.0	0.0	50.0	9
LAc12	Top SP Aig Dr POLL	4	1	1.5	0.6	2	1	2.0	0.0	33.3	10
LAc16	SPL FI	2	1	1.5	0.7	1	1	2.0		33.3	11
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.8	0.4	8.0	12
LAc12	Cornwallis St POLL	10	1	5.6	2.3	3	1	5.0	1.0	-10.7	13
LAc12	Princes Av POLL					7	1	1.9	0.4		

LAc12	Princes roundabt POLL	5	1	1.4	0.5						
LAc12	Top SP roundabt POLL	1	1	2.0							
LAc13	L1 GW					2	1	2.0	0.0		
LAc13	St Johns GW					10	1	12.4	3.2		
LAc16	Wapping FI	1	1	4.0							

QUANTITATIVE DATA SUMMARY			
CH0411: Plant diversity			
NBS	NBS Name	% Change	Rank
LAc13	Pollinator walls/vertical	541.7	1
LAc12	Pollinator verges and spaces	55.0	2
LAc8	SuDs & Rain Garden	52.4	3
LAc16	Floating gardens	0.0	4

QUANTITATIVE DATA SUMMARY											
CH0411: Plant diversity		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc13	Parr St GW	1	1	1.0		12	1	6.4	2.4	541.7	1
LAc12	Park Lane POLL	3	1	2.7	0.6	7	1	6.3	3.5	135.7	2
LAc12	Strand POLL	4	1	3.3	0.5	6	1	7.5	2.1	130.8	3
LAc12	Wapping POLL	5	1	3.0	1.6	2	1	5.5	0.7	83.3	4
LAc12	Bott SP Aig Dr POLL	3	1	1.0	0.0	7	1	1.7	0.5	71.4	5
LAc8	Upper Pitt St RG	6	1	3.2	1.6	3	1	5.3	1.2	68.4	6
LAc12	Top SP Aig Dr POLL	4	1	1.3	0.5	2	1	2.0	0.0	60.0	7
LAc12	Baltic Hub POLL	4	1	3.8	1.5	2	1	5.5	0.7	46.7	8
LAc8	Lower SuDS	4	1	1.0	0.0	11	1	1.4	0.5	36.4	9
LAc12	Lower SuDS POLL	4	1	1.0	0.0	11	1	1.4	0.5	36.4	10
LAc16	SPL FI	2	1	1.0	0.0	1	1	1.0		0.0	11
LAc12	Cornwallis St POLL	10	1	4.7	1.3	3	1	3.3	0.6	-29.1	12
LAc12	Ullet Rd POLL	3	1	1.7	0.6	5	1	1.0	0.0	-40.0	13
LAc12	Princes Av POLL					7	1	1.3	0.5		
LAc12	Princes roundabt POLL	5	1	1.2	0.4						
LAc12	Top SP roundabt POLL	1	1	1.0							

LAc13	L1 GW					2	1	2.0	0.0		
LAc13	St Johns GW					10	1	7.4	1.8		
LAc16	Wapping FI	1	1	2.0							

QUANTITATIVE DATA SUMMARY			
CH0412: Flower Count			
NBS	**NBS Name**	**% Change**	**Rank**
LAc12	Pollinator verges and spaces	510.8	1
LAc8	SuDs & Rain Garden	328.7	2
LAc13	Pollinator walls/vertical	228.8	3
LAc16	Floating gardens	-10.8	4

QUANTITATIVE DATA SUMMARY											
CH0412: Flower Count		Pre-Intervention				Post-Intervention				% Change	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc12	Bott SP Aig Dr POLL	3	1	28.0	14.8	7	1	528.1	935.8	1786.2	1
LAc12	Park Lane POLL	3	1	37.3	24.9	7	1	401.3	470.9	974.9	2
LAc12	Strand POLL	4	1	67.0	23.6	6	1	565.3	411.1	743.8	3
LAc8	Lower SuDS	4	1	37.0	23.9	11	1	267.5	205.8	623.1	4
LAc12	Lower SuDS POLL	4	1	37.0	23.9	11	1	267.5	205.8	623.1	5
LAc13	Parr St GW	1	1	50.0		12	1	164.4	190.8	228.8	6
LAc12	Cornwallis St POLL	10	1	84.8	124.6	3	1	233.3	182.4	175.2	7
LAc12	Top SP Aig Dr POLL	4	1	660.3	1043.5	2	1	1487.5	1594.5	125.3	8
LAc12	Wapping POLL	5	1	196.6	293.5	2	1	319.0	161.2	62.3	9
LAc12	Ullet Rd POLL	3	1	170.7	246.3	5	1	269.4	92.6	57.9	10
LAc12	Baltic Hub POLL	4	1	326.0	178.6	2	1	483.0	521.8	48.2	11
LAc8	Upper Pitt St RG	6	1	94.8	58.7	3	1	127.3	42.1	34.3	12
LAc16	SPL FI	2	1	115.5	92.6	1	1	103.0		-10.8	13
LAc12	Princes Av POLL					7	1	402.3	563.9		
LAc12	Princes roundabt POLL	5	1	98.2	144.5						
LAc12	Top SP roundabt POLL	1	1	135.0							
LAc13	L1 GW					2	1	206.0	217.8		

LAc13	St Johns GW					10	1	378.2	368.5		
LAc16	Wapping FI	1	1	162.0							

EcoServR: CH0511: Air quality improvements			
NBS	**NBS Name**	**% Change**	**Rank**
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements			
Floating gardens	**radius (m)**	**% Change**	**Rank**
SPL FI	20	0.2	1
SPL FI	100	0.1	2
Wapping FI	20		
Wapping FI	100		

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon storage, temperature reduction, water slowed, green space accessibility, pollinator capacity and value of air quality improvements.

Quantitative data results positive influences on combined Nitrogen in water solution and on metals within the suspended sediment, but a negative influence on the change in metals in solution However, a positive influence was found on suspended sediment metals. Positive influences were seen for plant diversity, but not for floral resources and pollinator increase.

Positive influences were found for the combined nutrients, although not for Phosphate of the combined metals in solution. Sefton Park island was found to reduce the Chromium and Nickel ion levels after installation. In addition, Sefton Park island was found to reduce the Ammonium, Nitrite and Nitrate ions, but not the Phosphate ions.

For the metals within the suspended sediment, a positive influence was found, particularly for Sefton Park for Arsenic, Copper, Manganese, Nickel and Lead.

A high order of ranking as opposed to other NBS were found for:

- Water slowed (modelled), with the greatest benefit for Wapping Dock at larger radii
- Chromium and Nickel metal ions in water
- Nutrient levels in water (Ammonium, Nitrite and Nitrate), but not Phosphate
- Metals in suspended sediments
- Pollinator capacity (modelled), particularly for Wapping Dock at small and large radii distances.

Lower rankings were seen for:

- Carbon storage, although the larger Wapping Dock island did better than the smaller Sefton Park island,
- Carbon sequestration
- Temperature reduction (modelled), although more influence was found at larger radii distances,
- Green space accessibility
- Pollinator increase and diversity
- Plant count and diversity
- Floral abundance
- Air quality improvements (modelled)

High positive changes with installation were found for some metals and the majority of nutrients in solution, metals in suspended sediments, as well as water slowed (modelled).

For the Sefton Park Island, macroinvertebrate surveys demonstrated increasing diversity, from 7 families in 2021 to 12 families (plus class oligochaete) being present in 2022. However, ecological metrics (WHPT ASPT) for the ponds demonstrate that the waters are still in poor condition (ASPT 2021: 3.19 and 2022: 3.27).

Vegetation surveys of the floating ecosystems were performed in July 2021 and 2022. It was found that overall species diversity for vegetation on the freshwater ecosystem has increased slightly since first planting. From 10 species in June 2020 to 18 species in June 2021, with 20 species as of June 2022. Within the estuarine ecosystem, there was a sharp increase in plant colonisation, followed by a marked decline in plant species richness over time, with only 27 species present in 2022 (an increase from 10 in 2020) vs 34 in 2021.

In summary, the floating islands demonstrated great potential and realised benefits, particularly for the water contaminants. Establishment of plant and invertebrate communities needed time, together with targeted selection of plants.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Launching and construction of islands Irrigation for saltwater island plants Anchorage as close to navigable channel	Permissions agreed to build on site Shallow water retention trays for some species 4 robust anchors
Economical barriers	How they have been addressed
Retrospective licence fee requested Additional costs for legal support	Agreed to pay Within budget contingency
Social barriers	How they have been addressed
Fewer opportunities to engage residents	Filming of work and release on twitter
Environmental (including COVID)	How they have been addressed
Letter required for permission to travel from scotland	Letter provided

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Large number of mussels attached to underside of saltwater island and reduced buoyancy Long delay with licence agreements	Additional buoyancy added Patience and perseverance
Economical barriers	How they have been addressed
Long term sponsorship needed	Pursuing options for sponsorship
Social barriers	How they have been addressed
Covid prevented planting on site due to social distancing	Low numbers of well spaced people involved
Environmental (including COVID)	How they have been addressed
Maintenance visits were postphoned (no travel)	Carried over into following year on extended contract.

2.2.18 Lac17 Green Filter

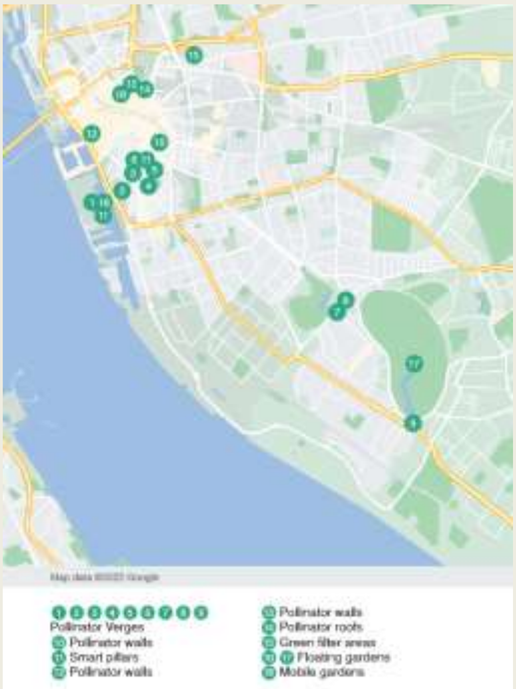
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0111; CH0501; CH0502; CH0503; CH0504; CH0505; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Lac17 Green Filter	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Strand- June 2021 Stafford Street – June 2021	

	Lime Street – summer 2022	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location of Green Filter area Stafford Street (15) and Strand (2)



Images Stafford Street Filter Trees

Images Strand Filter trees


Images Lime Street Filter Trees


The green filter trees category had two main sites: Stafford St TREES and Lime St TREES.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences. The further tables below are the known results relating to this particular NBS for each KPI, ranked in order of importance. Socio-economic data could not be separated sufficiently in order to assess the influences of individual NBS so are not included.

Challenge	KPI	KPI NAME	Weight	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	4.0	yes	yes
01	CH0104	CARBON SEQUESTRATION	4.0	yes	yes
01	CH0105	TEMPERATURE DECREASE	4.8	yes	yes
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	4.8	yes	yes
01	CH0108	HEATWAVE RISK	2.7	yes	
01	CH0111	SPECIES MOVEMENT	4.4	Inconclusive	

02	CH0201	RUN-OFF COEFFICIENT	2.0	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	2.0	yes	yes
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	3.0	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	3.0	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	2.0	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	1.0	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	4.5	yes	yes
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	4.5	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	3.0	yes	yes
04	CH0411	PLANT SPECIES INCREASE	3.0	yes	
04	CH0412	FLORAL RESOURCES INCREASE	3.0	yes	
04	CH0413	INSECTIVORE INCREASE	1.0	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	4.2	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	3.7	yes	yes
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	3.7	yes	no
05	CH0504	NOx TRENDS	3.7	yes	yes
05	CH0505	Sox TRENDS	3.7	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	3.0	yes	
05	CH0509	Energy savings	3.0	yes	
05	CH0510	Increase in property value	3.0	yes	
05	CH0511	Value of air quality improvements	3.0	yes	yes
05	CH0512	Value of air pollution reduction	1.0	n/a	
05	CH0513	Total monetary value of urban forests including air quality	3.0	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	3.5	yes	
07	CH0702	CITIZEN PERCEPTION	2.5	yes	
07	CH0703	SOCIAL LEARNING	2.5	yes	
07	CH0705	ENGAGEMENT WITH NBS	2.5	yes	
08	CH0801	CRIME REDUCTION	2.0	yes	
09	CH0902	WALKING AREA INCREASE	2.0	yes	
09	CH0903	CYCLING AREA INCREASE	2.0	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	2.5	yes	
10	CH1002	JOB CREATION	1.0	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	1.0	yes	
10	CH1005	NEW BUSINESSES	1.0	yes	

Ranked NBS	NBS name	EcoServR: CH0103: Carbon storage (tC)	Rank
lac4	Urban catchment forestry	13.41	1
lac17	Green filter area	13.41	1
lac6	cooling trees	9.52	2
lac12	Pollinator verges and spaces	8.87	3
lac5	shade trees	7.10	4
lac8	SuDs & Rain Garden	0.75	5
lac14	Pollinator roofs	0.24	6
lac16	Floating gardens	0.10	7
lac13	Pollinator walls/vertical	0.07	8

EcoServR: CH0104: Carbon sequestration (tCO2e)			
ranked NBS	NBS	EcoServR: CH0104: Carbon sequestration	Rank
lac17	Green filter area	-0.87	1
lac8	SuDs & Rain Garden	-0.83	2
lac6	cooling trees	-0.62	3
lac5	shade trees	-0.45	4
lac4	Urban catchment forestry	-0.13	5
lac13	Pollinator walls/vertical	-0.04	6
lac14	Pollinator roofs	-0.01	7
lac12	Pollinator verges and spaces		
lac16	Floating gardens		

EcoServR: CH0104: Carbon sequestration (tCO2e)			
NBS	NBS Name	Carbon sequestration (tCO2e)	Rank
lac17	Green filter area	-0.87	1
lac6	cooling trees	-0.62	2

lac5	shade trees	-0.45	3
lac4	Urban catchment forestry	-0.13	4

QUANTITATIVE DATA SUMMARY											
CH0105: Temperature Decrease											
CH0105		Pre-Intervention				Post-Intervention				% Change	
NBS	inter_code	n_obs	n_sites	estimate	sd	n_obs	n_sites	estimate	sd	% Change	Rank
LAc4	Strand Tree SuDS	1	1	16.3		3	1	4.7	2.8	-70.9	1
LAc17	Stafford St TREES	7	4	2.0	1.2	11	4	3.4	3.5	64.5	2
LAc13	Parr St GW	16	6	0.8	1.8	27	5	2.7	2.5	226.4	3
LAc5	Shade_TREES					24	10	5.5	2.9		
LAc6	Cooling_TREES					43	18	7.2	4.4		
LAc8	Upper Pitt St RG					5	1	6.2	3.7		
LAc12	Baltic POLL					2	2	6.3	0.7		
LAc12	Cornwallis St POLL					1	1	9.0			
LAc12	Park Lane POLL					2	1	6.4	1.4		
LAc13	L1 GW					12	3	5.8	3.5		
LAc13	St Johns GW	11	4	0.0	1.9	33	5	3.1	3.0		
LAc14	Royal Court GR					22	5	2.6	2.9		
LAc17	Lime St TREES					1	1	6.5			

EcoServR: CH0106: Temperature reduction			
ranked NBS	NBS Name	% Change	Rank
lac12	Pollinator verges and spaces	76.3	1
lac5	shade trees	59.7	2
lac6	cooling trees	46.7	3
lac17	Green filter area	44.7	4
lac4	Urban catchment forestry	24.2	5
lac13	Pollinator walls/vertical	3.0	6
lac8	SuDs & Rain Garden	0.2	7
lac16	Floating gardens	0.0	8
lac14	Pollinator roofs		

EcoServR: CH0106: Temperature reduction				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac5	shade trees	20	109.98	
lac6	cooling trees	20		
lac17	Green filter area	20		

EcoServR: CH0106: Temperature reduction				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac6	cooling trees	100	46.66	1
lac17	Green filter area	100	44.67	2
lac5	shade trees	100	9.36	3

EcoServR: CH0204: Water slowed down			
ranked NBS	**NBS**	**% Change**	**Rank**
lac12	Pollinator verges and spaces	11.2	1
lac16	Floating gardens	7.3	2
lac6	cooling trees	2.3	3
lac17	Green filter area	1.5	4
lac5	shade trees	1.0	5
lac4	Urban catchment forestry	0.0	6
lac14	Pollinator roofs	0.0	6
lac13	Pollinator walls/vertical	-1.0	7
lac8	SuDs & Rain Garden	-10.2	8

EcoServR: CH0204: Water slowed down				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac6	cooling trees	20	4.4	1
lac17	Green filter area	20	2.6	2
lac5	shade trees	20	1.7	3
lac4	Urban catchment forestry	20		

EcoServR: CH0204: Water slowed down				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	100	0.4	1
lac5	shade trees	100	0.2	2
lac6	cooling trees	100	0.1	3
lac4	Urban catchment forestry	100	0	4

EcoServR: CH0403: Green Space Accessibility				
NBS	Site	households	population	Rank
lac5	shade trees	3413	5817	1
lac6	cooling trees	2910	5031	2
lac17	Green filter area	2538	4409	3
lac4	Urban catchment forestry	454	670	4

EcoServR: CH0410: Pollinator increase			
NBS	NBS Name	% Change	Rank
lac14	Pollinator roofs	23.13	1
lac13	Pollinator walls/vertical	12.78	2
lac16	Floating gardens	7.08	3
lac17	Green filter area	1.78	4
lac6	cooling trees	1.74	5
lac12	Pollinator verges and spaces	1.73	6
lac8	SuDs & Rain Garden	1.17	7
lac4	Urban catchment forestry	0.70	8
lac5	shade trees	0.22	9

EcoServR: CH0410: Pollinator increase				
NBS	NBS Name	radius (m)	% Change	Rank
lac6	cooling trees	20	1.71	1
lac17	Green filter area	20	1.65	2

lac5	shade trees	20	0.21	3
lac4	Urban catchment forestry	20	0.16	4

EcoServR: CH0410: Pollinator increase				
NBS	**NBS Name**	**radius (m)**	**% Change**	**Rank**
lac17	Green filter area	100	1.91	1
lac6	cooling trees	100	1.76	2
lac4	Urban catchment forestry	100	1.23	3
lac5	shade trees	100	0.22	4

QUANTITATIVE DATA SUMMARY			
CH0502: PM 2.5			
NBS	**NBS Name**	**% Change**	**Rank**
LAc8	SuDs & Rain Garden	-62.6	1
LAc14	Pollinator roofs	-57.3	2
LAc4	Urban catchment forestry	-49.3	3
LAc17	Green filter area	-13.8	4
LAc13	Pollinator walls/vertical	-7.4	5
LAc12	Pollinator verges and spaces	9.0	6

QUANTITATIVE DATA SUMMARY											
CH0502: PM 2.5		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc8	Upper Pitt St RG	30	2	9.9	13.9	2	2	2.0	0.0	-79.8	1
LAc14	Royal Court GR	2	1	26.0	8.5	35	1	11.1	7.5	-57.3	2
LAc4	Strand Tree SuDS	110	4	11.7	13.1	40	4	6.0	6.1	-49.3	3
LAc8	Upper SuDS	18	2	9.2	5.5	22	2	5.0	3.0	-45.3	4
LAc13	Parr St GW	15	1	11.0	7.1	42	2	6.8	7.6	-37.9	5
LAc13	St Johns GW	29	2	15.6	8.5	47	5	9.9	6.8	-36.3	6
LAc17	Lime St TREES	86	3	10.0	8.3	10	3	6.8	7.2	-31.9	7
LAc17	Stafford St TREES	50	2	8.1	6.5	18	2	8.4	7.5	4.3	8
LAc12	Cornwallis St POLL	33	1	8.3	7.7	3	1	9.0	5.6	8.8	9

LAc12	Bott SP Aig Dr POLL	24	1	7.3	5.9	2	1	8.0	2.8	9.1	10
LAc13	L1 GW	30	3	5.3	2.8	70	7	8.1	8.7	52.0	11

QUANTITATIVE DATA SUMMARY			
CH0503: PM 10			
NBS	**NBS Name**	**% Change**	**Rank**
LAc14	Pollinator roofs	-49.3	1
LAc4	Urban catchment forestry	-36.7	2
LAc8	SuDs & Rain Garden	-27.7	3
LAc13	Pollinator walls/vertical	-14.1	4
LAc17	Green filter area	30.2	5
LAc12	Pollinator verges and spaces	32.8	6

QUANTITATIVE DATA SUMMARY											
CH0503: PM 10		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc14	Royal Court GR	2	1	37.5	7.8	35	1	19.0	8.9	-49.3	1
LAc8	Upper Pitt St RG	30	2	16.7	15.8	2	2	10.5	0.7	-37.1	2
LAc4	Strand Tree SuDS	110	4	19.6	14.5	40	4	12.4	9.5	-36.7	3
LAc13	Parr St GW	15	1	19.0	9.1	42	2	12.4	7.5	-34.8	4
LAc13	St Johns GW	29	2	24.0	11.7	47	5	16.0	8.6	-33.5	5
LAc8	Upper SuDS	18	2	16.8	5.9	22	2	13.7	7.7	-18.2	6
LAc17	Lime St TREES	86	3	18.6	12.8	10	3	21.7	15.8	16.7	7
LAc13	L1 GW	30	3	13.0	6.8	70	7	16.4	11.2	26.0	8
LAc12	Bott SP Aig Dr POLL	24	1	15.0	9.0	2	1	19.5	9.2	30.0	9
LAc12	Cornwallis St POLL	33	1	14.8	8.8	3	1	20.0	7.0	35.5	10
LAc17	Stafford St TREES	50	2	14.5	7.4	18	2	20.8	17.4	43.7	11

QUANTITATIVE DATA SUMMARY			
CH0504: NO2			
NBS	**NBS Name**	**% Change**	**Rank**
LAc14	Pollinator roofs	-25.8	1

LAc8	SuDs & Rain Garden	-19.8	2
LAc13	Pollinator walls/vertical	-15.5	3
LAc4	Urban catchment forestry	-13.7	4
LAc17	Green filter area	-8.1	5
LAc12	Pollinator verges and spaces	-7.9	6

EcoServR: CH0511: Air quality improvements			
NBS	NBS Name	% Change	Rank
lac14	Pollinator roofs	31.2	1
lac17	Green filter area	16.3	2
lac13	Pollinator walls/vertical	15.0	3
lac12	Pollinator verges and spaces	10.5	4
lac6	cooling trees	8.4	5
lac5	shade trees	1.4	6
lac16	Floating gardens	0.1	7
lac8	SuDs & Rain Garden	-1.6	8
lac4	Urban catchment forestry		

EcoServR: CH0511: Air quality improvements				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	20	21.7	1
lac6	cooling trees	20	10.0	2
lac5	shade trees	20	1.7	3
lac4	Urban catchment forestry	20		

EcoServR: CH0511: Air quality improvements				
NBS	NBS Name	radius (m)	% Change	Rank
lac17	Green filter area	100	11.0	1
lac6	cooling trees	100	6.8	2
lac5	shade trees	100	1.1	3
lac4	Urban catchment forestry	100		

The ranked data tables above show a variety of effects of this NBS on the various KPIs.

Modelling results showed positive influences on carbon storage, carbon sequestration, temperature reduction, water slowed, green space accessibility, pollinator capacity and value of air quality improvements.

Quantitative data results positive influences on thermal cooling, and air quality (although not PM10).

A high order of ranking as opposed to other NBS were found for:

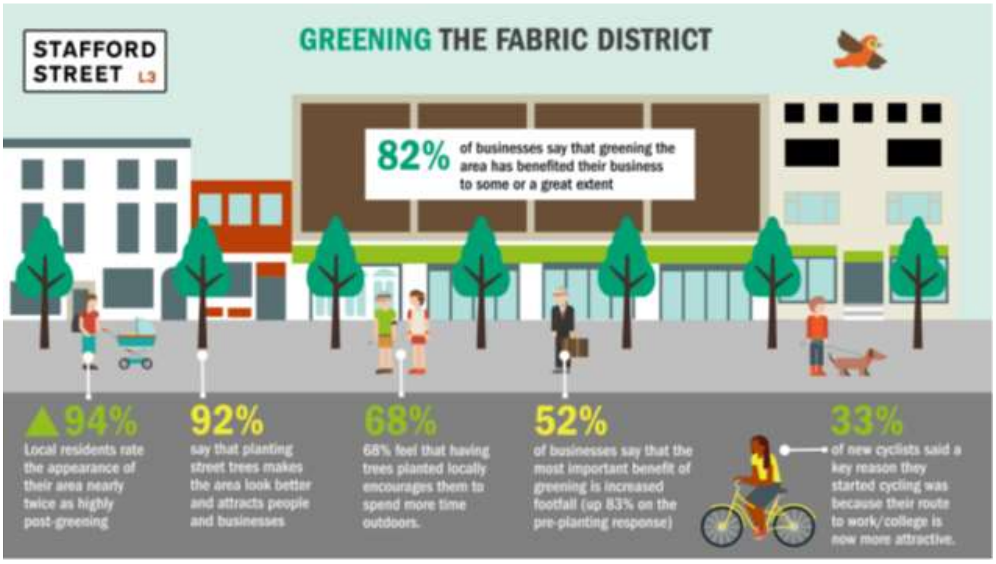
- Carbon storage
- Carbon sequestration, together with other tree-based interventions
- Thermal cooling
- Temperature decrease (modelled), particularly at greater radii distances
- Water slowed, particularly at close radii distances
- Green space accessibility
- PM2.5 particulate matter particles, particularly at the Lime Street site
- Air quality improvements (modelled), particularly at close radii

Lower rankings were found for:

- Pollinator increase (modelled), although higher at greater radii distances
- PM10 air particules, although better at the Lime Street site
- Nitrogen dioxide, although still a positive influence

The greatest positive changes with installation were found for carbon storage and sequestration, temperature reduction (modelled) and PM2.5 air quality.

A summary of interview data in relation to this NBS for the Stafford Street site is as in the infographic below:



Overall, this intervention had positive benefits for all KPIs, particularly for carbon storage and sequestration, temperature reduction and air quality.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Please note that all data discussed within these reports do not account for other external factors, such as traffic levels, Covid lockdowns, wind direction, etc. Further data analyses will be required for greater accuracy in the assessment of the benefits of these nature-based solutions.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Unmapped voids on Stafford Street	Fill in at extra cost

Economical barriers	How they have been addressed
Additional costs and variances on Stafford st works	Accommodated from external partner budgets
Contractor at Lime Street went into administration	Reappointed new contractor
Social barriers	How they have been addressed
Delays to works	Delays were unavoidable
Environmental (including COVID)	How they have been addressed
Delays in agreements and delivery	Delays were unavaoidable

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
3 trees had to be located in adjacent green space as there was not enough space on the roads for Stafford Street works	Planted in adjacent green space
Economical barriers	How they have been addressed
Legal costs to resolve dispute on additional works on Stafford Street	Settled without accessing project budget
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

2.2.19 Lac18 - Lac 27 Non-technical interventions

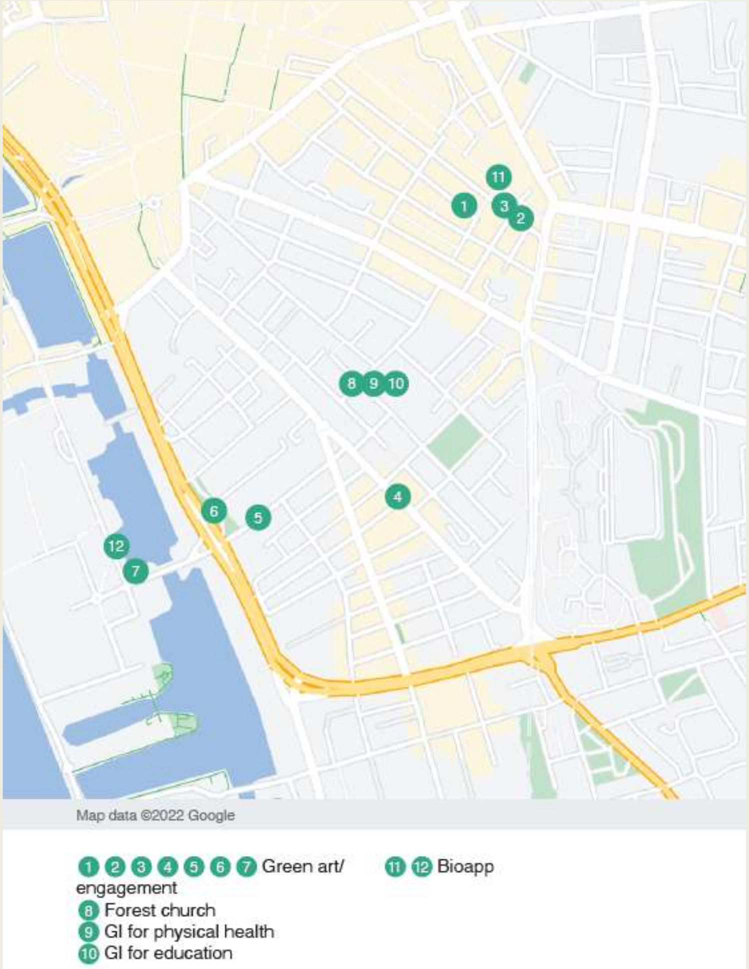
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*

CH0104; CH0111; CH0501; CH0513; CH0514; CH0515; CH0516; CH0517; CH0518; CH0602; CH0703; CH0704; CH0707; CH0801; CH0902; CH0903; CH0904; CH1003; CH1004; CH1005; CH1007	Lac 18 Wood allotment Lac 19 GI for education Lac 20 Forest School Lac 21 Engagement portal for citizens Lac 23 Forest Church Lac 25 GI physical health Lac 26 GI mental health Lac 27 promotion of ecological reasoning	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Lac 18 – cancelled; Lac 19 – 2020; Lac 20 – 2020; Lac21 – 2020 ; Lac23 – 2020 ; Lac 25 - 2020 ; Lac 26 - 2020 ; Lac 27 - 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location of non technical interventions

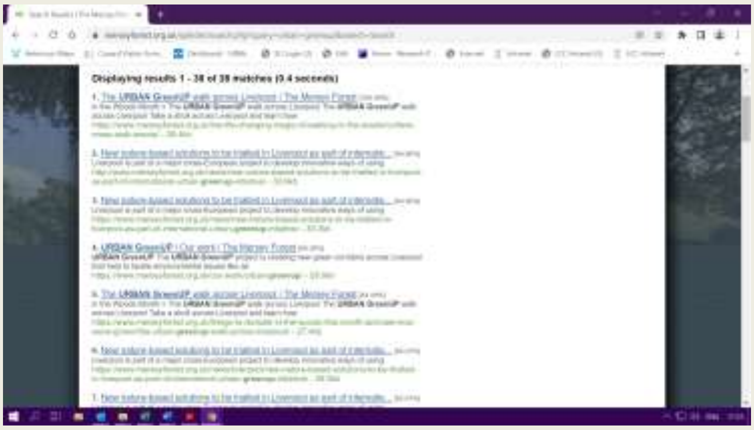


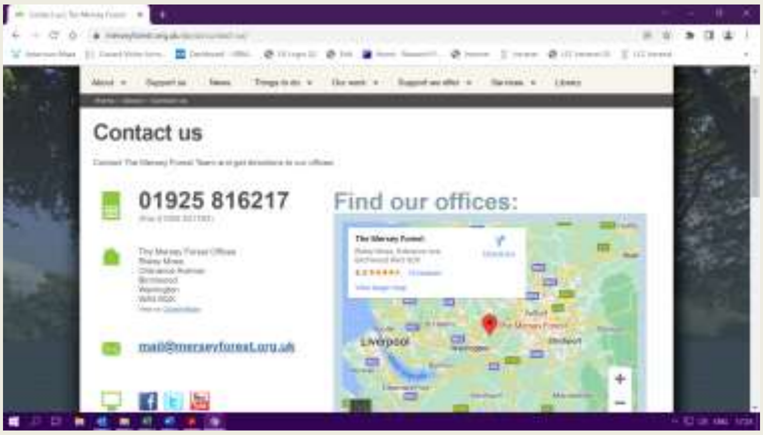
Lab 18 – Wood Allotments – Cancelled

Lac 19 –GI for Education

Lac 20 – Forest School

Lac 21 – Engagement portal

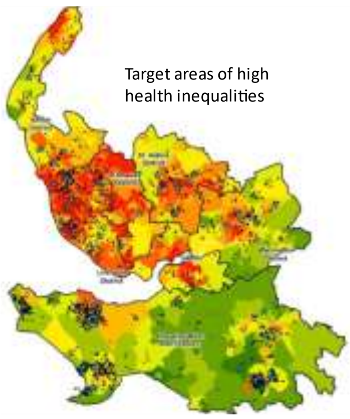




Lac 23 – Forest Church

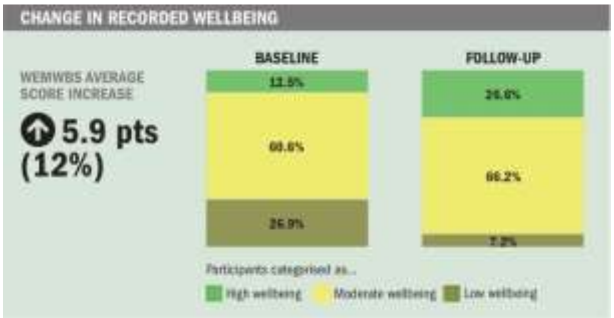
Lac 25 GI physical health - Lac 26 GI mental health

The Natural Health Service

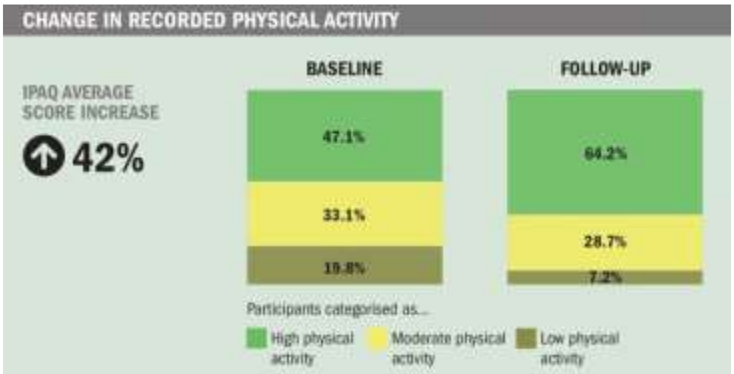


- Use the **natural environment** as a health asset
- **Reducing inequalities – big issue**
- **8-12 week programmes – a “dose” of nature**
- **Evidence based products** and interventions
- **Targeted at areas of need**
- **Long term partnership** with universities to develop evidence and improve practice.

Wellbeing - Adults



Physical Activity - Adults



Impact – in their own words

Feeling a lot better, my breathing rate is much better and I feel energised and exhilarated - Alan

The mindfulness in nature course has helped me be more confident and my anxiety is not as bad now. I have started walking and I am now more aware of nature. Agnes

More exercise is the clue for me to feel better. JG

Without exception, the participating children exhibited improvements in confidence, understanding, interest, listening abilities, understanding of boundaries and reflection

I have found myself much more aware of my mood, as well as now having developed some coping strategies for helping me feel better - Dorothy

Lac 27 promotion of ecological reasoning

For further data and reports on the Natural Health Service, please see KPI CH0703 Social Learning.

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences.

Challenge	KPI	KPI NAME	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	yes	
01	CH0104	CARBON SEQUESTRATION	yes	
01	CH0105	TEMPERATURE DECREASE	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	yes	
01	CH0108	HEATWAVE RISK	yes	
01	CH0111	SPECIES MOVEMENT	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	yes	
04	CH0411	PLANT SPECIES INCREASE	yes	
04	CH0412	FLORAL RESOURCES INCREASE	yes	
04	CH0413	INSECTIVORE INCREASE	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	yes	
05	CH0504	NOx TRENDS	yes	
05	CH0505	Sox TRENDS	yes	

05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	yes	
05	CH0509	Energy savings	yes	
05	CH0510	Increase in property value	yes	
05	CH0511	Value of air quality improvements	yes	
05	CH0512	Value of air pollution reduction	n/a	
05	CH0513	Total monetary value of urban forests including air quality	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	yes	
07	CH0702	CITIZEN PERCEPTION	yes	
07	CH0703	SOCIAL LEARNING	yes	
07	CH0705	ENGAGEMENT WITH NBS	yes	
08	CH0801	CRIME REDUCTION	yes	
09	CH0902	WALKING AREA INCREASE	yes	
09	CH0903	CYCLING AREA INCREASE	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	yes	
10	CH1002	JOB CREATION	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	yes	
10	CH1005	NEW BUSINESSES	yes	

The NBS in the table above were not monitored directly, so have minimal related data.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
None	N/A
Economical barriers	How they have been addressed
None	N/A

Social barriers	How they have been addressed
Some works ceased during lockdown so there was less social engagement	Regular online contact during lockdown

Environmental (including COVID)	How they have been addressed
Delayed activities and events	Delayed

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Wood allotment concerns re air quality and issues from burning together with ongoing lockdown prevented delivery	Funding was relocated to other non technical interventions
Economical barriers	How they have been addressed
None	N/A
Social barriers	How they have been addressed
Unable to engage residents during lockdown despite high levels of interest	Variation to intended works and relocation of funding to another non technical intervention
Environmental (including COVID)	How they have been addressed
Wood allotments not possible due to lockdown periods	Not delivered and resources used elsewhere on community engagement initiatives

2.2.20 Lac 22 Green Arts Engagement

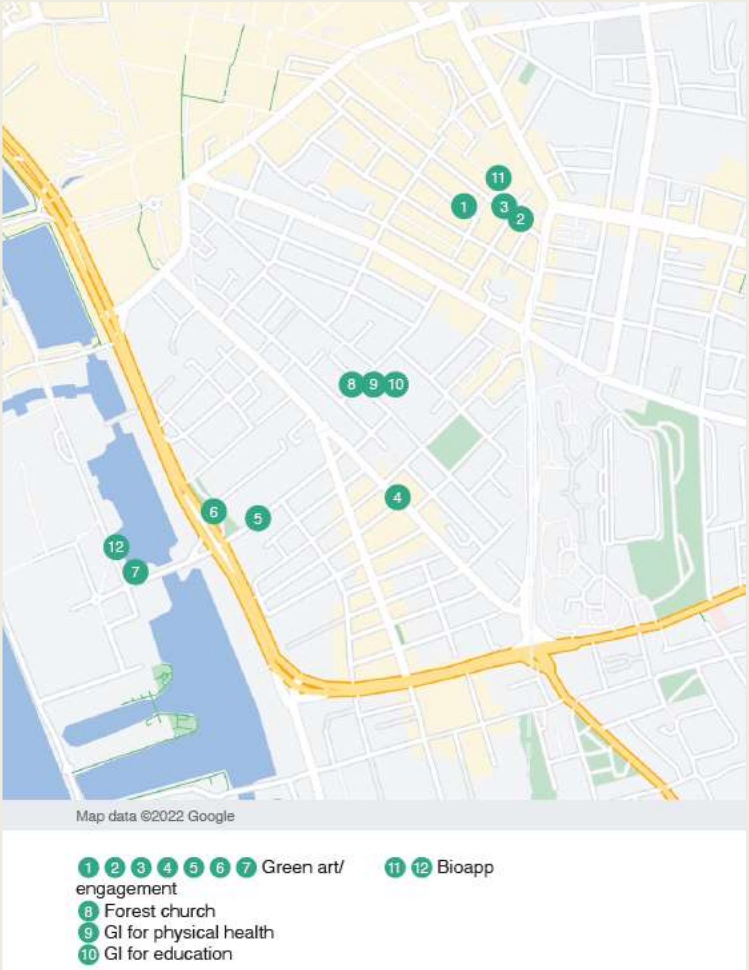
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0111; CH0501; CH0513; CH0514; CH0515; CH0516; CH0517; CH0518; CH0602;	Lac 22 Green Arts Engagement	LIV/UoL/CFT

CH0703; CH0704; CH0707; CH0801; CH0904; CH1003; CH1004; CH1005; CH1007		
CITY	*DATE OF IMPLEMENTATION*	
LIV	May 2021	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location of non technical interventions - Art habitat trail for Green Art Engagement



Images – Green Art engagement

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences.

Challenge	KPI	**KPI NAME**	**If overall effect of interventions had a positive effect on KPI**	**If NBS positively influenced KPI**
01	CH0103	CARBON STORED	yes	
01	CH0104	CARBON SEQUESTRATION	yes	
01	CH0105	TEMPERATURE DECREASE	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	yes	
01	CH0108	HEATWAVE RISK	yes	
01	CH0111	SPECIES MOVEMENT	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	yes	

02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	yes	
04	CH0411	PLANT SPECIES INCREASE	yes	
04	CH0412	FLORAL RESOURCES INCREASE	yes	
04	CH0413	INSECTIVORE INCREASE	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	yes	
05	CH0504	NOx TRENDS	yes	
05	CH0505	Sox TRENDS	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	yes	
05	CH0509	Energy savings	yes	
05	CH0510	Increase in property value	yes	
05	CH0511	Value of air quality improvements	yes	
05	CH0512	Value of air pollution reduction	n/a	
05	CH0513	Total monetary value of urban forests including air quality	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	yes	
07	CH0702	CITIZEN PERCEPTION	yes	
07	CH0703	SOCIAL LEARNING	yes	
07	CH0705	ENGAGEMENT WITH NBS	yes	
08	CH0801	CRIME REDUCTION	yes	
09	CH0902	WALKING AREA INCREASE	yes	
09	CH0903	CYCLING AREA INCREASE	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	yes	
10	CH1002	JOB CREATION	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	yes	
10	CH1005	NEW BUSINESSES	yes	

The NBS in the table above were not monitored directly, so have minimal related data.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Sculptures needed to be designed to be fixed at height and on walls etc Access to smart phone/camera needed to access QR codes for videos	Artist brief Some guided tours at launch
Economical barriers	How they have been addressed
Designs re scoped due to costs and budget limitations	Rescoped
Social barriers	How they have been addressed
Simple signage included Covid delayed installation	Signage installed Installed to coincide with city opening back up
Environmental (including COVID)	How they have been addressed
None	None

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Quarterly assessment surveys needed for risk	Assessed and records kept quarterly

Bee sculpture moved due to vandalism and eventually damaged	Removed from site
Economical barriers	How they have been addressed
Specialist installation needed at additional cost Planning permission needed for 2 sculptures	Accommodated within wider budget Planning permission obtained
Social barriers	How they have been addressed
Hard to engage people during covid	Promotion and correspondence to building owners.
Environmental (including COVID)	How they have been addressed
Delayed introduction due to covid	Delayed delivery but installed to coincide with city reopening after covid.

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

Several interventions were not in place (delayed due to covid) when the bioapp monitoring was taking place, so there was less opportunity to identify biodiversity records pre and post all the NBS interventions.

2.2.21 Lac 24 Bioapp

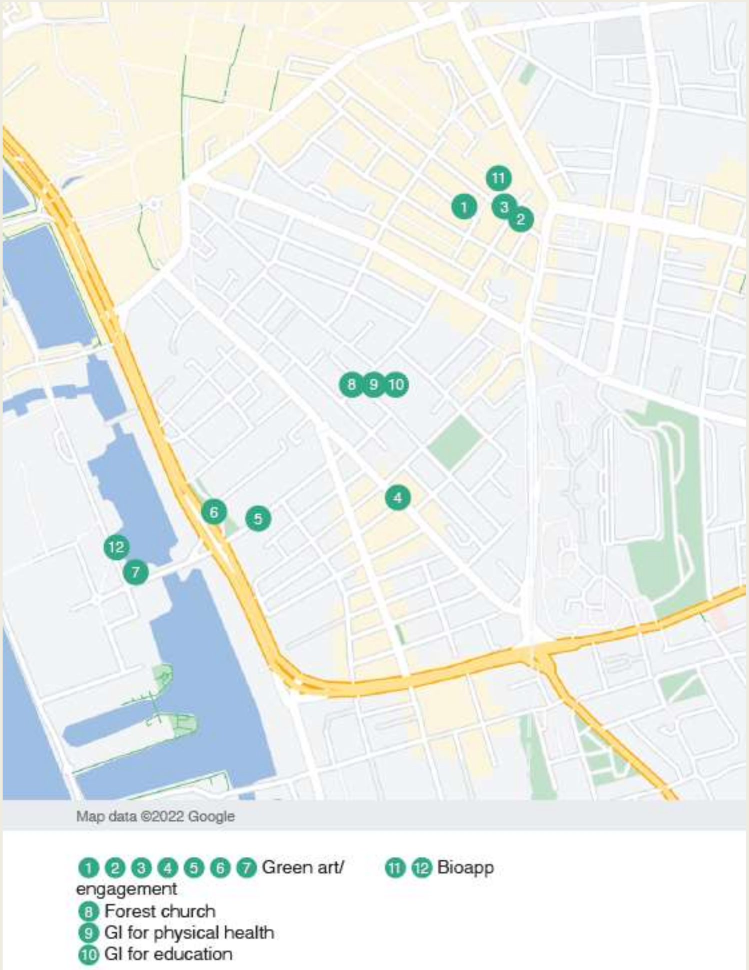
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0111; CH0501; CH0513; CH0514; CH0515; CH0516; CH0517; CH0518; CH0602; CH0703; CH0704; CH0707; CH0801; CH0904; CH1003; CH1004; CH1005; CH1007	Lac 24 Bioapp	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	

LIV	March 2021	

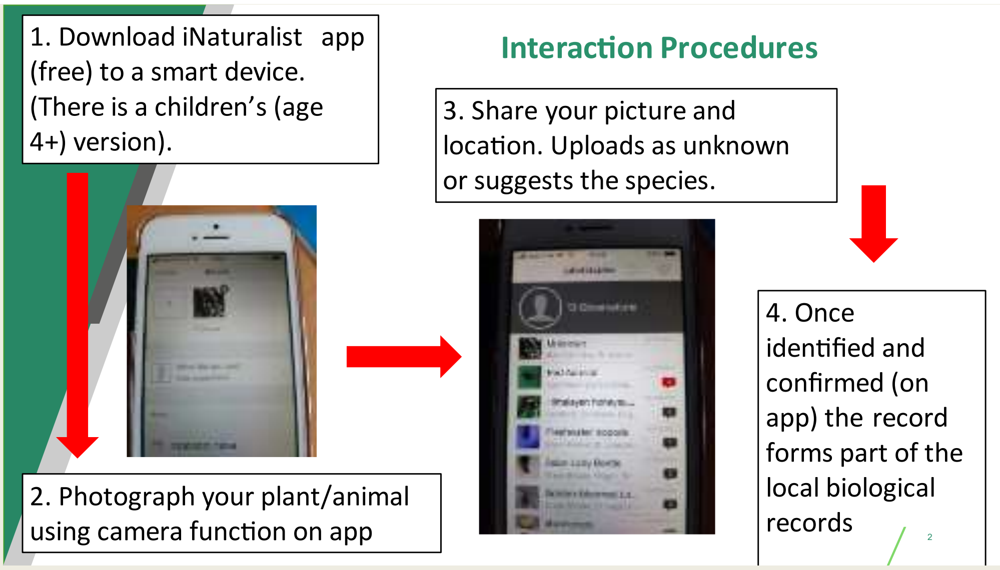
Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

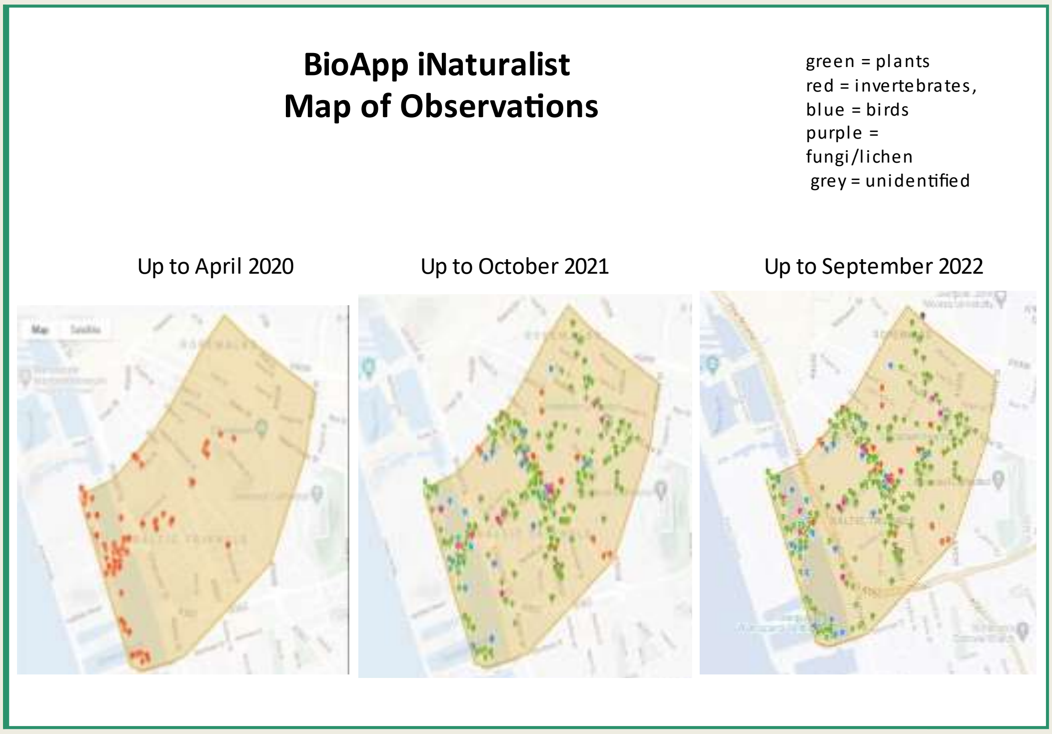
Location of non technical interventions bioapp



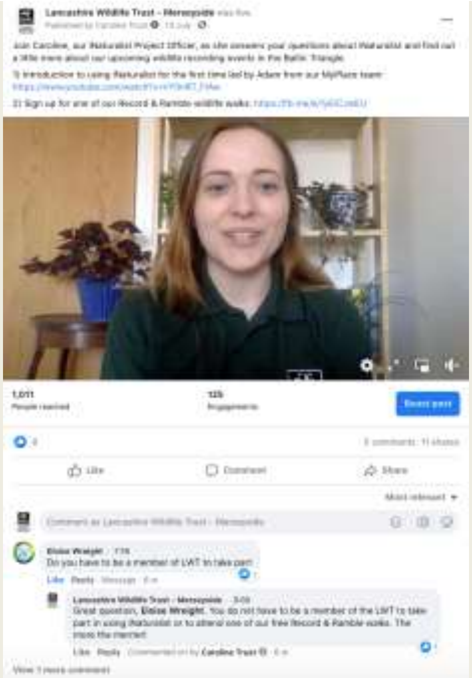
Images – use of bioapp



Map of observations and survey area



Surveying with groups and online/twitter updates during covid pandemic



The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences.

Challenge	KPI	KPI NAME	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	yes	
01	CH0104	CARBON SEQUESTRATION	yes	
01	CH0105	TEMPERATURE DECREASE	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	yes	
01	CH0108	HEATWAVE RISK	yes	
01	CH0111	SPECIES MOVEMENT	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	yes	

04	CH0410	POLLINATOR SPECIES INCREASE	yes	
04	CH0411	PLANT SPECIES INCREASE	yes	
04	CH0412	FLORAL RESOURCES INCREASE	yes	
04	CH0413	INSECTIVORE INCREASE	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	yes	
05	CH0504	NOx TRENDS	yes	
05	CH0505	Sox TRENDS	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	yes	
05	CH0509	Energy savings	yes	
05	CH0510	Increase in property value	yes	
05	CH0511	Value of air quality improvements	yes	
05	CH0512	Value of air pollution reduction	n/a	
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06	CH0602	BENEFITS FROM INTERVENTIONS	yes	
07	CH0702	CITIZEN PERCEPTION	yes	
07	CH0703	SOCIAL LEARNING	yes	
07	CH0705	ENGAGEMENT WITH NBS	yes	
08	CH0801	CRIME REDUCTION	yes	
09	CH0902	WALKING AREA INCREASE	yes	
09	CH0903	CYCLING AREA INCREASE	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	yes	
10	CH1002	JOB CREATION	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	yes	
10	CH1005	NEW BUSINESSES	yes	

Please see KPI CH0705 Engagement with NBS for more information.

The Biodiversity Information Report 3604-UGU (Appendix 2) showed a notable increase in both recording effort, number of individuals and the diversity of species being recorded compared to before the start of the project. 16% of all the species recorded in the project area have been reported during the life of the project (2019-2021). Of 1,115 total recorded species in the project area, 181 have been reported for the first time since 2019.

The knowledge of biodiversity in the Baltic Triangle area has increased by 16%, due to increased awareness and recording, demonstrating the benefits of the citizen science approach.

For further information, please see following documents:

20220406 Urban Green up inaturalist re

Appendix 1 – Biodiversity Informati

Appendix 2 – Biodiversity Informati

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Access to smart phone/camera needed Ability to download and use app	Engagement officer assisted and hosted walks
Economical barriers	How they have been addressed
Furlough reduced time of project to hosting for 9 months	Reduced time of promotion
Social barriers	How they have been addressed
Used twitter etc to engage observers	Promoted widely, public talks, socially distanced events etc

Environmental (including COVID)	How they have been addressed
Delayed activities and events and reduced in scope	Delayed

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Mainly had to be delivered online or with socially distanced events. No large activities.	Twitter and media posts kept people engaged and updated etc
Economical barriers	How they have been addressed
Small budget	Focus on summer months for maximum engagement
Social barriers	How they have been addressed
Hard to engage people during covid	Promotion and talks and promotion of national recording challenge with the biobank
Environmental (including COVID)	How they have been addressed
Delayed and reduced activities due to lockdown	Delayed delivery and reduced participation for some elements of the original program

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

Several interventions were not in place (delayed due to covid) when the bioapp monitoring was taking place, so there was less opportunity to identify biodiversity records pre and post all the NBS interventions.

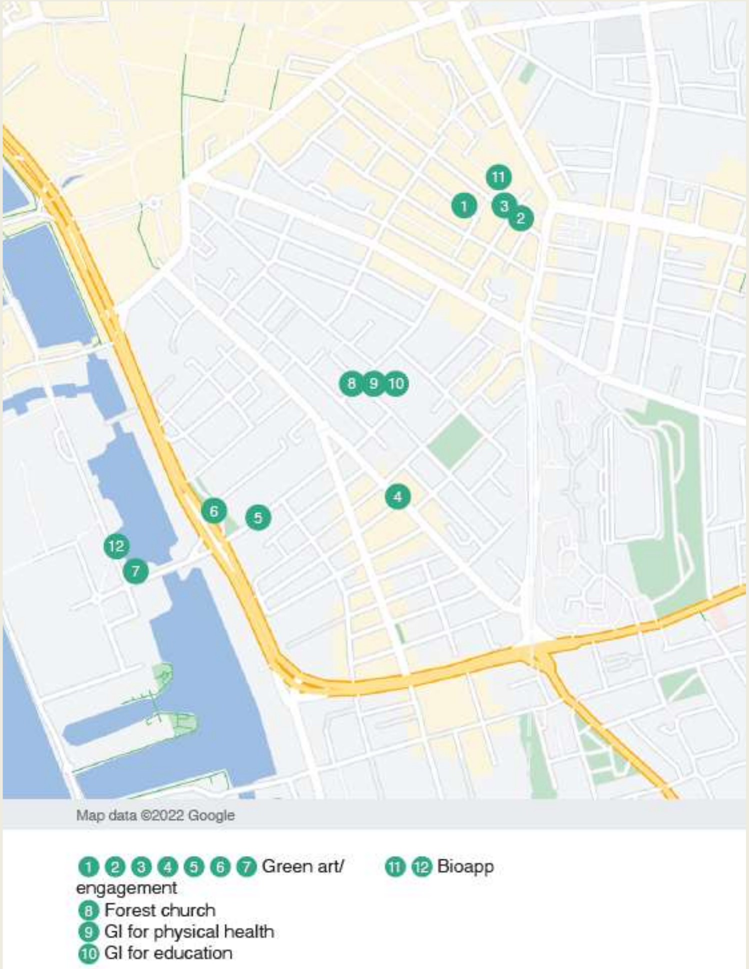
2.2.22 Lac 28 – Lac 30 Non-technical actions

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0111; CH0501; CH0513; CH0514; CH0515; CH0516; CH0517; CH0518; CH0602; CH0703; CH0704; CH0707; CH0801; CH0904; CH1003; CH1004; CH1005; CH1007	Lac 28 Single window RUP Lac 29 Support to citizen projects Lac 30 city mentoring strategy	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Lac 28 2018-ongoing Lac 29 2018-ongoing Lac 30 2018-ongoing	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Location of non technical interventions



Helping to deliver the RUP and public real masterplanning workshop

Liverpool speakers sharing NBS knowledge at the First Green Infrastructure Conference in Izmir, Turkey 2018

Liverpool representatives sharing NBS knowledge with follower cities and their leaders, Valladolid, Spain 2017.

Urban GreenUP meeting and knowledge sharing between global cities Brussels 2019

Urban GreenUP meeting and knowledge sharing between global cities

The summary table below shows the influence of the NBS on the different KPIs, as a whole and individually. These are colour-coded as green for positive, orange for inconclusive or unknown and red for negative influences.

Challenge	KPI	KPI NAME	If overall effect of interventions had a positive effect on KPI	If NBS positively influenced KPI
01	CH0103	CARBON STORED	yes	
01	CH0104	CARBON SEQUESTRATION	yes	
01	CH0105	TEMPERATURE DECREASE	yes	
01	CH0106	TEMPERATURE REDUCTION (PROJECTION)	yes	
01	CH0108	HEATWAVE RISK	yes	
01	CH0111	SPECIES MOVEMENT	Inconclusive	
02	CH0201	RUN-OFF COEFFICIENT	yes	
02	CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	yes	
02	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	Inconclusive	
02	CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	Inconclusive	
02	CH0211	WATER REMOVED FROM THE WATER TREATMENT	yes	
02	CH0212	SAVINGS IN TREATMENT OF STORMWATER	yes	
04	CH0403	GREEN SPACE ACCESSIBILITY	yes	
04	CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	yes	
04	CH0410	POLLINATOR SPECIES INCREASE	yes	
04	CH0411	PLANT SPECIES INCREASE	yes	
04	CH0412	FLORAL RESOURCES INCREASE	yes	
04	CH0413	INSECTIVORE INCREASE	yes	
05	CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	yes	
05	CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	yes	
05	CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	yes	
05	CH0504	NOx TRENDS	yes	
05	CH0505	Sox TRENDS	yes	
05	CH0508	Run-off Mitigation/ Mitigation through cooling and sequestration	yes	
05	CH0509	Energy savings	yes	
05	CH0510	Increase in property value	yes	
05	CH0511	Value of air quality improvements	yes	
05	CH0512	Value of air pollution reduction	n/a	

05	CH0513	Total monetary value of urban forests including air quality	yes	
06	CH0602	BENEFITS FROM INTERVENTIONS	yes	
07	CH0702	CITIZEN PERCEPTION	yes	
07	CH0703	SOCIAL LEARNING	yes	
07	CH0705	ENGAGEMENT WITH NBS	yes	
08	CH0801	CRIME REDUCTION	yes	
09	CH0902	WALKING AREA INCREASE	yes	
09	CH0903	CYCLING AREA INCREASE	Inconclusive	
09	CH0904	HEALTH QUALITY PERCEPTION	yes	
10	CH1002	JOB CREATION	yes	
10	CH1004	LAND AND PROPERTY PRICE CHANGE	yes	
10	CH1005	NEW BUSINESSES	yes	

The NBS in the table above were not monitored directly, so have minimal related data.

For individual interventions and effects on the KPIs and other plots and reports, please see portal: https://ecoservr.shinyapps.io/UrbanGreenUP (Username: ugu; Password: Baltic). Please see individual KPI reports for overall assessments of the interventions on each key performance indicator.

Conclusions and recommendations.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
IT connections have sometimes failed during online sessions	Patience and sharing copies of presentations before and after
Economical barriers	How they have been addressed
None	N/A
Social barriers	How they have been addressed
English language used is not everyones first lamguage	Clear and simple English has bene used in speech and reporting
Environmental (including COVID)	How they have been addressed

Delayed activities and events	Delayed

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
None	N/A
Economical barriers	How they have been addressed
None	N/A
Social barriers	How they have been addressed
Face to face meetings were restricted for many months	Additional online webinars were scheduled
Environmental (including COVID)	How they have been addressed
None	N/A

2.3 Izmir

2.3.1 IAc1 Cycle and Pedestrian Route in New Green Corridor

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0102; CH0103; CH0104; CH0403; ~~CH0406~~; CH0410; CH0601; CH0902; CH0903; CH1002	Cycle and Pedestrian Route in New Green Corridor	IZM, Ege Landscape and IYTE (monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

Table of results of each Challenge scoring that applies to this NBS. The final output is a final scoring for each Challenge.

Bicycle and pedestrian green route offer a more comfortable, greener and sustainable connection at the northern end of the city. The coastal promenades and linear parks that encompass the Izmir Bay all the all way from north to south would be linked to Sasalı Natural Life Park and Southern Gediz Delta through cycling and pedestrian friendly greener route.

The green corridor includes sustainable transportation options (cycling and walking) and special sections like the Bio-boulevard. Although the ultimate purpose of the corridor is to revise and improve the existing one and provide more bike and pedestrian friendly route, it also links several NBSs in the project and serves the purposes of carbon sequestration and pollutant's removal with its tree cover.

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

As a response to the COVID-19 outbreak in March 2020, countries across the world took various measures to slow the spread of the virus, including social distancing and lockdown measures, closures of schools and workplaces, and limits on travel. People around the world experienced dramatic disruptions in daily routines and were exposed to several risk factors for psychological distress, including enduring social isolation, loss of income, and increased family stress.

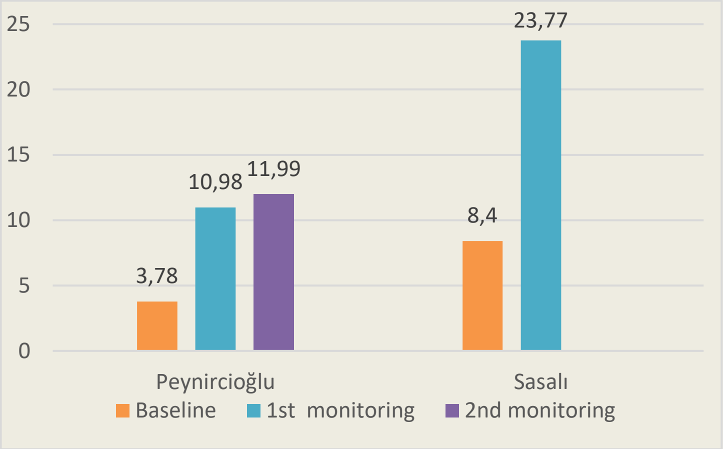
Outdoor green spaces were one of the few recreational places that remained accessible during lockdown periods. The increase of pedestrian and cycle routes combined with increased greenery especially around the Peynircioğlu stream helped the citizens cope with the pandemic.

Two of the neighbourhoods are selected to see the increase in pedestrian and cycle routes. In Mavisehir neighbourhood it is calculated that the green areas increased form 16 % to 17% while in Yalı neighbourhood the increase is from 9% to 10%.

Mavisehir Neighbourhood

Yalı Neighbourhood

The carbon sequestration potential of plant cover in ha/year in Peynircioğlu increased up to 190 % in the 1st monitoring and 217 % in the 2nd monitoring period compared to baseline value.



Carbon sequestered by vegetation in Peynircioğlu and Sasalı.

Oriental plane *(Platanus orientalis*), Turkey oak (Quercus cerris), Mediterranean cypress (*Cupressus sempervirens*) and Cherry plum (*Prunus cerasifera*) had high contribution for carbon sequestration.

In Sasalı; planting climate-resilient high numbers of native tree and shrub species provide contribution to carbon sequestration in ha/year (Figure 2). Based on monitoring outcomes, Eucalyptus trees (*Eucalyptus cameldulensis*), Strawberry tree (*Arbutus unedo*) and Goat willow (*Salix caprea*) support carbon sequestration in the site.

	
Peynircioglu	Sasalı

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected	-
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
There were a bit complaints during the construction works.	Signs put around the area for explanations
Environmental (including COVID)	How they have been addressed
No barriers detected.	-

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*

The maintenance of the area was not done properly since the priorities of local governments have changed during the beginning of the pandemic and several other events that occurred in Izmir (flood disaster in Feb 21, earthquake in Oct 21, etc). Some of the trees were pruned after the implementations.	The Parks and Gardening Dept of Izmir Municipality had increased their efforts around the area. The departments are working better and in collaboration now.
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
Most number of users of the area increased significantly, especially during the pandemic the area was very important for the citizens.	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

2.3.2 IAc2 Planting Cool & Shady Trees

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0102; CH0103; CH0104; CH0403; ~~CH0406;~~ CH0601	Planting Cool & Shady Trees	IZM, Ege Lanscape (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

Table of results of each Challenge scoring that applies to this NBS. The final output is a final scoring for each Challenge.

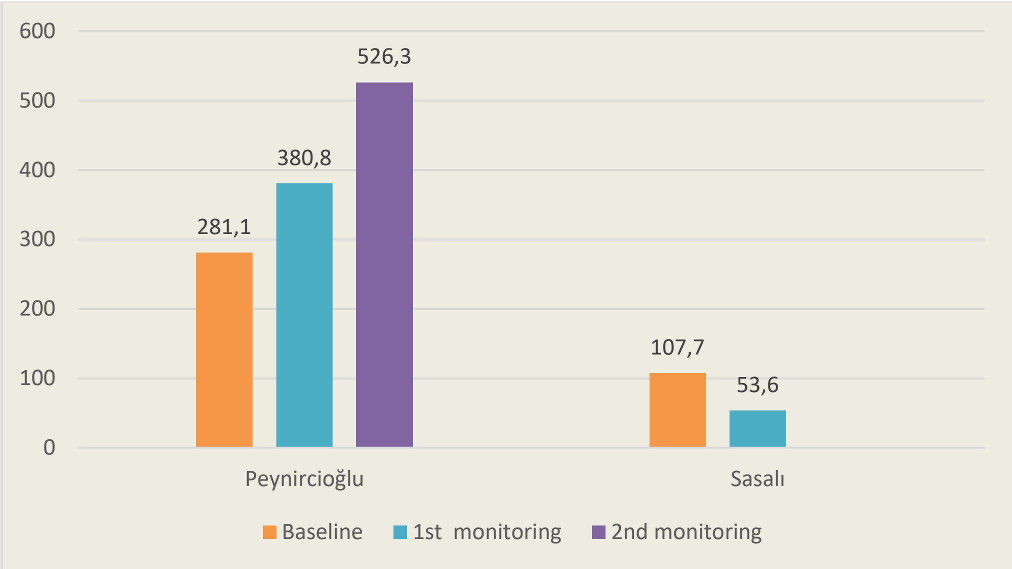
A large number of trees are planted along the new green corridors and Peynircioğlu Stream. The main purpose is to increase the number of wide canopy trees so that carbon sequestration and pollutant's removal level could be maximized. They will improve user's well-being as well as connection to nature. Besides, they will serve as a shady bike and pedestrian route, habitat for insects and birds and stormwater interceptor. Mostly native tree species are preferred because they are already adapted to ecological conditions such as climate and soil regardless of their advantages of attracting birds and insect species.

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Increasing number of trees and expanding canopy cover in Peynircioğlu enhanced carbon sequestration ecosystem service in the site. In Sasalı; planting climate-resilient high numbers of native tree and shrub species provide contribution to carbon sequestration in ha/year.

Monitoring results showed that carbon storage function of plants in Peynircioğlu increased more than 80%. Oriental plane (*Platanus orientalis*), Turkey oak (*Quercus cerris*), Mediterranean cypress (*Cupressus sempervirens*), Cherry plum (*Prunus cerasifera*) had high contribution for carbon storage. Considering that the plants used are quite young, the carbon storage amount of these plants will increase over time.

The calculated decline for carbon storage potential of plants in Sasalı is related to tree cover reduction after the implementation. Based on monitoring outcomes, Eucalyptus trees (*Eucalyptus cameldulensis*), Strawberry tree (Arbutus unedo) and Goat willow (*Salix caprea*) greatly support carbon storage. The reason of the decline is the removal of some of the grown up eucalyptus trees which are not native and consume excessive amount of water.



Carbon stored by plants in Peynircioğlu and Sasalı

Green Space Quantity

The following maps shows 1st Mavisehir, 2nd Yali neighbourhoods' boundry. The green space quantity has increased from %16 to %17 in Mavisehir, from %9 to %10 in Yali neighbourhood according to calculations made by

Mavisehir Neighborhood

Yalı Neighborhood

There has been a significant use of the green areas especially during the pandemic the number of users increased significantly.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The planned area for the trees had to be changed since it was the migration pathway for certain birds. With appropriate intervals there are less trees planted than planned during the proposal phase due to lack of space.	Project team did not want to plant trees to other parts of the city which has no connection to the green corridor planned.
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
Green space accessibility is low for general public as they are insufficient comparing by population.	It is necessary to increase green areas and expand them by integrating with NBS throughout the whole city. The local government is trying to increase NBS according to the characteristics of different neighbourhoods witihn the GI Strategy.
Environmental (including COVID)	How they have been addressed
No barriers detected.	-

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The maintenance of the area is challenging. Some unnecessary pruning activities occurred during the monitoring period.	Parks and Gardening Department of the Municipality took the responsibility for the maintenance.
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed

Especially the trees planted around Peynircioglu stream are highly appreciated by the public.	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

2.3.3 IAc3 Arboreal areas around car parks

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0106; CH0107; CH0108; CH0109; CH0110; CH0502; CH0503; CH0504; CH0505;	Arboral Areas Around Car Parks	IZM, IYTE and BIT (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	November 2019	

Results and Discussion

Table of results of each Challenge scoring that applies to this NBS. The final output is a final scoring for each Challenge.

In the case of Izmir demo, in order to strengthen the cooling effect of the green-resting units and green shady structures, 26 wide canopy and tall trees are planted around them. These trees are providing shady spaces for city dwellers especially in hot summer months, habitat for insects and birds and also serve as stormwater interceptors.

This NBS implemented in three different locations. One of the locations is Girne Avenue which the parklets were implemented. The other locations for arboreal areas are around the car parking areas in Sasalı Natural Life Park and VilayetlerEvi.

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Figure: Arboral areas around Girne Avenue and Vilayetler Evi

For temperature decrease KPI a small positive change was observed in all three demo areas in the post-implementation measurements (2020-2021-2022). But significant changes were calculated in the future simulation of 2050 by using Envi-met software.

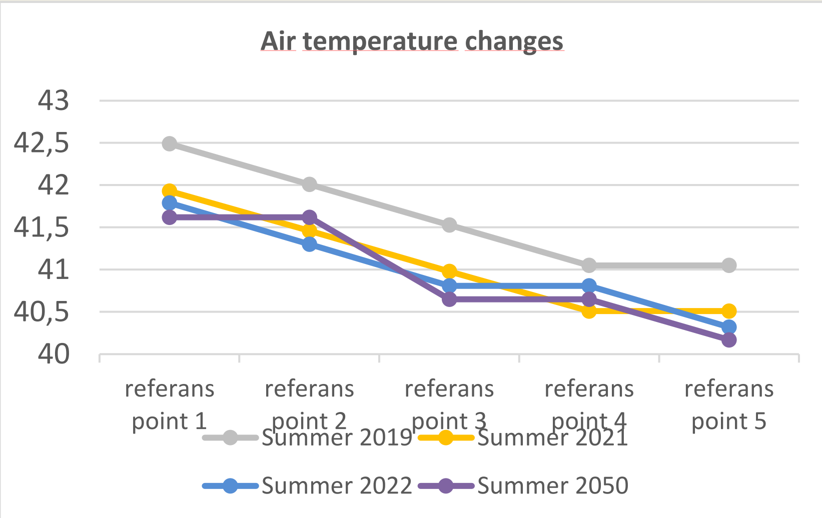
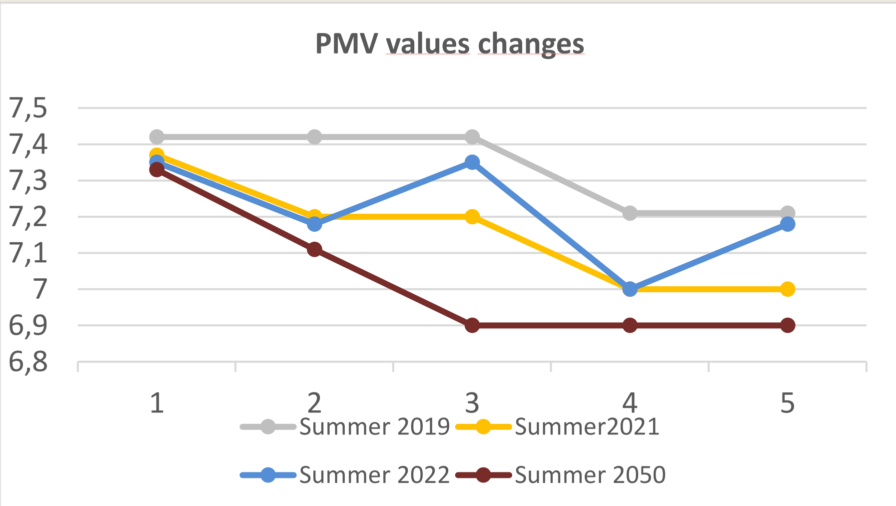
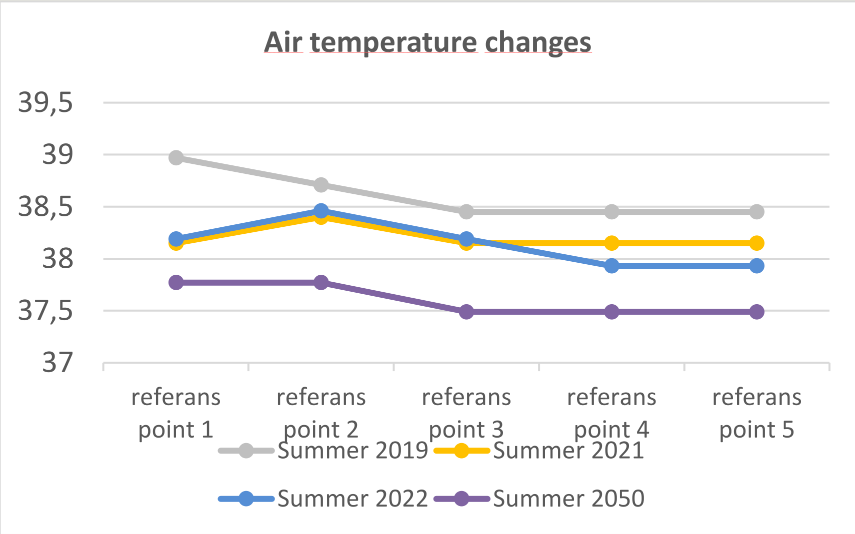


Figure: Air temperature changes and expectations for Vilayetler Evi

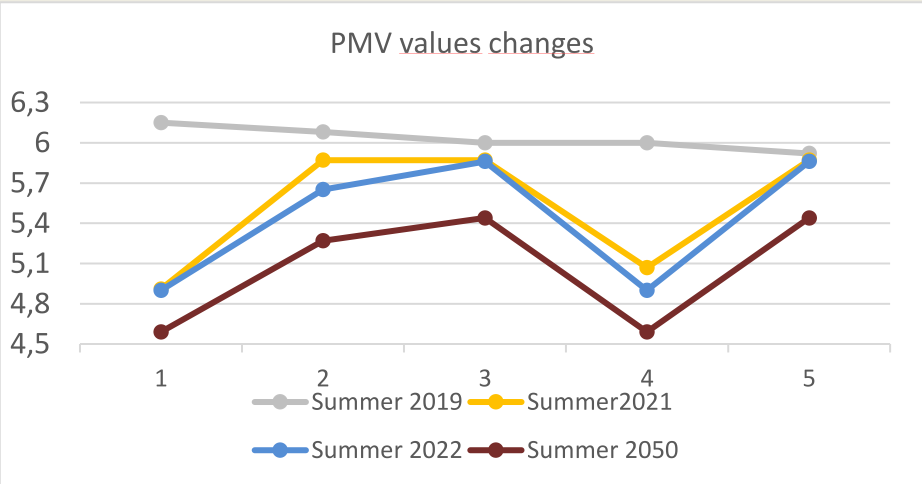
Also, thermal comfort values of the demo areas were calculated with the envi-met software.



Thermal comfort parameter changes baseline, after implementations and 2050 for Vilayetler Evi.



Air temperature changes and expectations for Sasalı



Thermal comfort parameter changes baseline, after implementations and 2050 for Sasali

As can be seen in the tables and graphs above, there are small positive changes between the 2019 measurements, which are baseline measurements, and the monitoring (2021, 2022) measurements. However, the most obvious differences were observed in the simulations of the future projection, 2050.

Heatwave Risk

It is worth to note that decrease in heatwave occurrences at Vilayetler Evi (dense urban area) is 3 times higher than Sasalı Natural Life Park (rural area) for 2019 (ex-ante) and 2022 (ex-post). This result emphasizes the powerful impact of NBS implementations on decreasing temperatures in urban areas over the rural areas. Maximum air temperatures in urban area are approximately 2°C higher than the rural area at daytime and as high as 4.6°C at night time. This is an indication of urban heat island effect.

Year	Vilayetler Evi		Sasalı	
	No. of days	No. of days change based on 2019 (%)	No. of days	No. of days change based on 2019 (%)
Ex-ante (2019)	59	-	35	-
Ex-post (2020)	47	-20.3	32	-8.6
Ex-post (2021)	41	-30.5	39	+11.4
Ex-post (2022)	39	-33.9	31	-11.4

Comparison of heatwave risk of demo sites.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
It was not easy to find qualified subcontractors to implement NBS properly. Most of the contractors are used to doing business without taking into consideration climate change or other environmental issues.	The control and supervision mechanisms organized although the personnel of Municipality did not have enough experience. Got some support from consultants.

Economical barriers	How they have been addressed
No barriers detected	-

Social barriers	How they have been addressed

No barriers detected	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The maintenance of especially the ivies were not done properly during the beginning of the pandemic since the priorities of the local government changed dramatically.	One of the reasons of the late growth of the ivies. They had grown better in 2022.
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
No barriers detected	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

2.3.4 IAc4 Installation of parklets

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; ch0106; CH0107; CH01002	Installation of Parklets	IZM, IYTE and BIT (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	End of 2019	

Results and Discussion

Table of results of each Challenge scoring that applies to this NBS. The final output is a final scoring for each Challenge.

Parklets, as a part of Sub Demo A, are on-street units with siting equipment and plant containers. They are primarily designed to increase the amount of carbon sequestration as well as pollutant’s removal with their plant cover. As some co-benefits, they are attracting people to spend some time in a green space on a busy and dense urban fabric in Karşıyaka. They also serve as somewhat cool spots through shading.

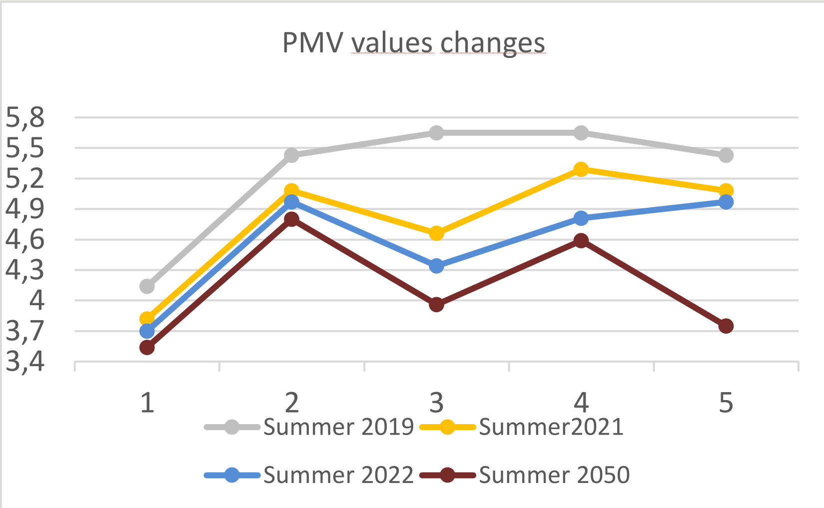
Parklets deployed in Girne Avenue, which is one of the crowded shopping streets in highly urbanized Karşıyaka Metropolitan District. Girne Avenue is surrounded by high-rise buildings on both sides. There is always a busy vehicle and pedestrian traffic flowing both ways throughout the day. It is also connected to tram system.

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

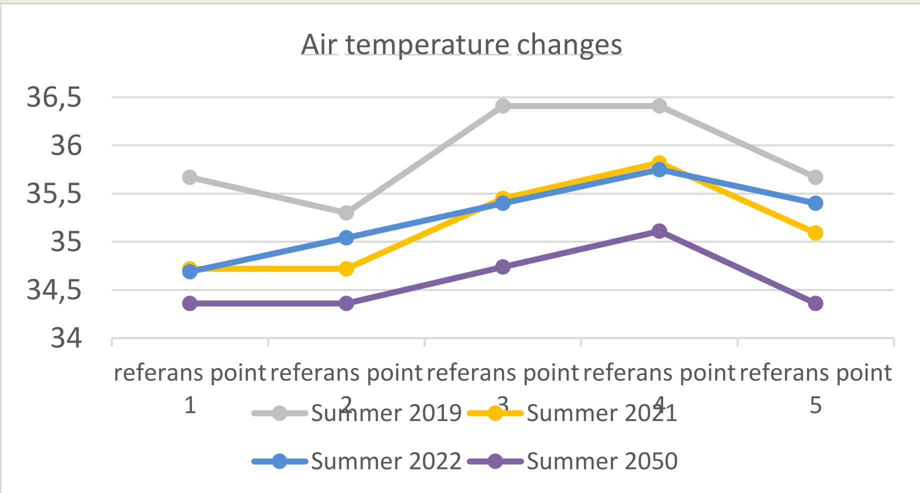
Thermal comfort values of the demo areas were calculated with the envi-met software.

For temperature decrease KPI a small positive change was observed in all three demo areas in the post-implementation measurements (2020-2021-2022). But significant changes were calculated in the future simulation of 2050 by using Envi-met software.

GİRNE								
		1	2	3	4	5	max	min
2019	Air temperature	35.30-35.67	34.93-35.30	36.04-36.41	36.04-36.41	35.30-35.67	38.25	34.56
	PMV	3.92-4.14	5.22-5.43	5.43-5.65	5.43-5.65	5.22-5.43	6.08	3.92
	TMRT	52.87-55.21	71.57-73.91	71.57-73.91	71.57-73.91	71.57-73.91	76.25	52.87
2021	Air temperature	34.72-35.09	34.72-35.09	35.45-35-82	35.82-36.19	35.09-35.45	38.03	34.35
	PMV	3.82-4.03	5.08-5.29	4.66-4.87	5.29-5.50	5.08-5.29	5.92	3.82
	TMRT	50.60-52.99	69.75-72.15	60.18-62.57	69.75-72.15	69.75-72.15	74.54	50.60
2022	Air temperature	34.69-35.04	35.04-35.40	35.04-35.40	35.75-36.10	35.40-35.75	38.21	34.69
	PMV	3.70-3.86	4.97-5.13	4.34-4.50	4.81-4.97	4.97-5.13	5,59	3,70
	TMRT	49.52	64.10-65.92	56.81-58.63	64.10-65.92	60.45-62.28	65,92	47,70
2050	Air temperature	34.36-34.74	34.36-34.74	34.74-35.11	35.11-35.48	34.36-34.74	37.72	33.99
	PMV	3.54-3.75	4.80-5.01	3.96-4.17	4.59-4.80	3.75-3.96	5.65	3.54
	TMRT	47.31-49.78	67.11-69.58	54.73-57.21	67.11-69.58	52.26-54.73	72.06	47.31



PMV value changes for Girne Avenue (parklets' location)



Air temperature changes for Girne Avenue

As can be seen in the tables and graphs above, there are small positive changes between the 2019 measurements (baseline), and the monitoring (2021, 2022) measurements. However, the most obvious differences were observed in the simulations of the future projection, 2050.

In 2022 Izmir team planned other parklets for other neighbourhoods apart from URBAN GREENUP project. The implementations are finalised in Alsancak another heavily urbanised busy area of the city.

Parklets in Alsancak

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Electricity need for the irrigation system had to be met from the lighting in the middle of the street (a busy street around a highly populated area).	The works needed to be done during night hours when there were no traffic.
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed

There were objections to the parklets from the small businesses that preferred car park instead. Also citizens claimed there would too much noise and inappropriate behaviour by the people who use the parklets.	-
Environmental (including COVID)	How they have been addressed
Most of the materials, components were chosen to be resistant to outdoor conditions. Steel and plastic had been used. The embedded carbon is quite high.	The materials are chosen to be resilient to high heat and heavy rains which is usually the case for Izmir.

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
There was a leakage because of the irrigation system within the planting areas	. It had been insulated again by emptying the relevant plant pots immediately.
Economical barriers	How they have been addressed
No barriers detected.	-
Social barriers	How they have been addressed
No barriers detected	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

2.3.5 IAc5 Urban Carbon sink

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0102; CH0104; CH0601	Urban Carbon Sink	IZM, Ege Landscape (monitoring)
CITY	*DATE OF IMPLEMENTATION*	

IZM	February 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

This is related to planting trees around Peynircioğlu Stream. In the selection process, fast growing and large canopy trees with a large leaf area are mostly preferred, such as Platanus orientalis, Tilia argentea, Pistacia terebithus, Creatonia siliqua, Lourus nobilis. The purpose is planting large canopy trees to maximize carbon sequestration. Installation of urban woodland with appropriate species adapted to capture carbon CO_2 maximizing carbon sequestration. The trees were allocated in specific arboreal series as to form a new urban ecosystem to preserve and improve the biodiversity. The location of the NBS is the coastline and its surroundings of Peynircioğlu.

Carbon Stored by Vegetation

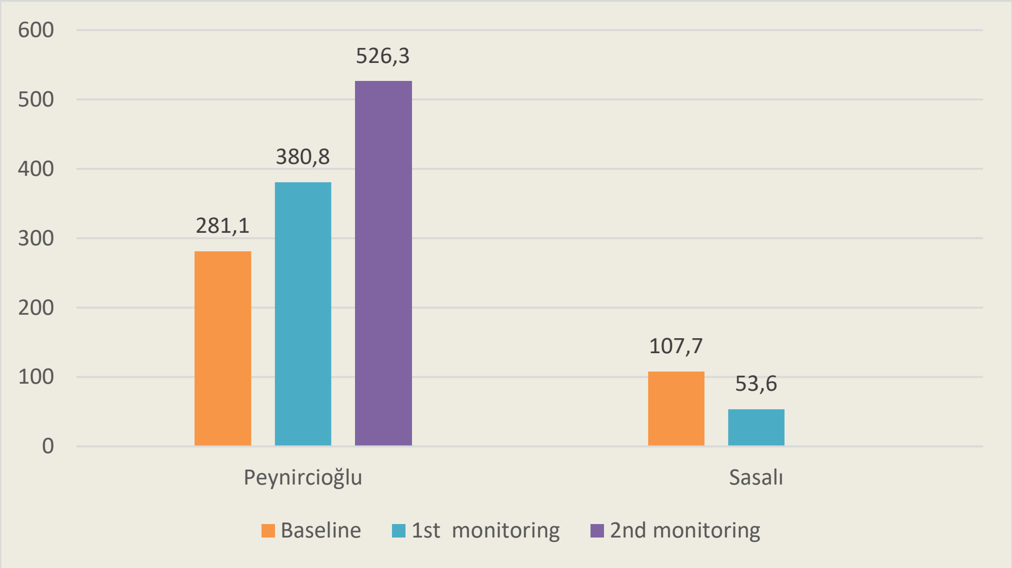
Carbon storage capacity of plant cover in Peynircioğlu increased up to 35 % in the 1st monitoring and 87 % in the 2nd monitoring period compared to baseline value (Table 1).

Before implementation trees in Sasalı estimated to store 107,7 carbon ton/year. After implementation as a result of removing many large trees from the site, this number reduced 50 % (Table 2).

Number of plant species	**Baseline**	**1st monitoring**	**2nd monitoring**
PEynircioğlu	306	,3966	3,936
Sasalı	299	3,936	

Table 1: Number of plant species by vegetation in Peynircioğlu and Sasalı

Monitoring results showed that carbon storage function of plants in Peynircioğlu increased more than 80%. Considering that the plants used are quite young, the carbon storage amount of these plants will increase over time. The calculated decline for carbon storage potential of plants in Sasalı is related to tree cover reduction after the implementation.



Carbon stored by plants in Peynircioğlu and Sasalı.

Some of the KPI's are mentioned in other related NBS's like IAc1, IAc2

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The site previously defined for the implementation of trees had to be changed because it was located at bird immigration route. There were not enough spaces for all the trees to be implemented. Also, non native eucalyptus trees needed to be removed and it affected the carbon sink capacity compared to baseline.	Large canopy trees are selected to be able to capture more carbon.

Economical barriers	How they have been addressed

Social barriers	How they have been addressed

Environmental (including COVID)	How they have been addressed

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Miscommunication between different departments resulted in pruning of some of the trees. This affected the result.	There is more coordination between the project and the maintenance team now.

Economical barriers	How they have been addressed

Social barriers	How they have been addressed

Environmental (including COVID)	How they have been addressed

2.3.6 IAc6 Grasses Swales and Water retention ponds

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0213; CH0410;	Grasses Swales and Water Retention Ponds Around Bio-boulevard	IZM
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Grassed swales installed in Bio-Boulevard (Sub Demo B) as a system that slow down and collect surface runoff directed from impervious surfaces mainly and function as a collector for a while until the soil is ready to infilter the water again. Most of all collected stormwater is drain away through the soil within several hours or days.

The swales, vegetated with flood tolerant and native plants. Cleaning the collected water via bio filtering by these plants before allowing it to be released back into the groundwater system is one another purpose of this NBS.

Swale systems are planned as a part of a theme route explaining biodiversity and impacts of climate change on nature due to their characteristics of enhancing biodiversity by vegetation consisting of and managing the stormwater.

Run-off Estimation

A GIS based analysis is made to predict runoff by using the most common method called The Runoff Curve Number (CN), developed for ungauged basins to calculate runoff from rainfall data by USDA NRCS (United States Department of Agriculture Natural Resources Conservation Service) formerly known as the Soil Conservation Service (SCS). ArcMap 10.3 is the GIS software used in İzmir. Calculations for baseline values were carried out based on satellite images using GIS techniques. Land cover information is taken on site by visits.

	Peak Discharge	Hyd. Volume
Baseline	0.213 cms	563.9 cum
Post Intervention	0.245 cms	641.5 cum

There is 15% increase on peak discharge and 13.7% increase on hyd. Volume.

The plants in the pond also had an impact on pollinator species increase.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers	
Economical barriers	How they have been addressed
No barriers	
Social barriers	How they have been addressed
No barriers	
Environmental (including COVID)	How they have been addressed
No barriers	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers	
Economical barriers	How they have been addressed
No barriers	
Social barriers	How they have been addressed
No barriers	
Environmental (including COVID)	How they have been addressed
No barriers	

2.3.7 IAc7 Culvert Works on Peynircioğlu Stream

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0403; CH0601; CH01002	Culvert Works on Peynircioğlu Stream	IZM, IYTE (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Culvert works include an approximately 1km length of Peynircioğlu Stream riverbank restoration that will transform the unnatural and impermeable present riverbank infrastructure into a re-natured riverbank with green pavements besides green fences, fruit walls at the edges of the riverbank.

Concrete walls of the riverbank replaced by an eco-friendly alternative of terramesh wall which is also easy to construct.

New green areas around the stream are implemented by so, natural vegetation cover installed contribute to the number of species as they raise the biodiversity level. The results will be given in Polinator Species NBS.

Green Space Accessibility and Walking Area Increase

Two of the neighbourhoods are selected to see the increase in pedestrian and cycle routes with the green space accessibility. In Mavişehir neighbourhood it is calculated that the accessibility to green areas increased from 96% to 100% while in Yalı neighbourhood it is 100%. Also in Mavişehir there are 17% of new pedestrians and bicycle paths with 7,345 potential users. In Yalı neighbourhood there are 0.7% of new pedestrians and bicycle paths with 16,381 potential users.

Mavişehir

Yalı

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	-

Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
The implementation was finalized just before COVID. The activities planned need to be cancelled. The flood disaster and the earthquakes of prevented similar actions in the project areas.	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
During the COVID the maintenance of the area could not be done properly since the priorities of the local government changed dramatically.	The Parks and Gardens Department did the maintenance
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
The areas is sed actively during the pandemic.	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

2.3.8 IAc8 Green Pavements for Peynircioğlu Stream

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
	Green Pavements for Peynircioğlu Stream	IZM
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

In the case of Izmir demo, the main purpose of the green pavement is creating a permeable surface along the riverbank. Conventional pavements such as impervious concrete and asphalt can reach quite high surface temperatures in summer. These surfaces can transfer heat downward to be stored in the pavement subsurface, where it is re-released as heat at night. These effects contribute to the Urban Heat Island effect.

Green pavement added at the edges of Peynircioğlu Stream. The Peynircioğlu Stream flowing in a south-north direction through the high-rise and high-end apartments in Mavişehir Mass Housing Area in Karşıyaka district. Mavişehir is a neighbourhood where mostly residential and commercial land uses such as shopping malls are dominant.

Monitoring for temperature decrease and PMV values have taken place in more densely populated areas like car parks, avenues. There is not much KPIs monitored around Peynircioğlu other than carbon removal and pollinator species.

The intervention is located in an area where there are many interventions implemented at the same time so measurements would not be meaningful and no monitoring done for this one.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected	-
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
No barriers detected	-
Environmental (including COVID)	How they have been addressed
No barriers detected	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected	
Economical barriers	How they have been addressed
No barriers detected	
Social barriers	How they have been addressed
No barriers detected	

Environmental (including COVID)	How they have been addressed
No barriers detected	

2.3.9 IAc9 Smart Soil Production in Climate-Smart Urban Farming Precinct

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0112	Smart Soil Production in Climate-Smart Urban Farming Precinct	IZM, Ege Soil (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM		

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Within the study, the construction of a strategic pathway to utilize pyrolysis technology and biochar use in agriculture actualized with potential and feasible utilization techniques.

In climate-smart urban farming precinct there are smart soil production area targeting dense urban areas, poor with soil and leftover spaces near urban areas. This type of soils has a combined or individual application of different types of biochar. With this NBS there are water and carbon savings per unit area and eliminated discontinuity risk of agricultural production due to climate change.

As a result of this field applications, the physical (i.e. surface area and porosity, bulk density) and chemical (i.e. nutrient content, cation exchange capacity, pH value, and carbon content) properties of the soils are improved; the initially increased microbial activity becomes stabilized after a while which will cause the amount of organic matter to increase over time due to the degradation process slows down; decreases in the CO_2 emission by biodegradation, decreases in the nitrous oxide emission by denitrification and reduction of methane release by methanogenesis at a rate of 5%, 5%, 1% respectively, are expected during the experimental period.

In total 500 kg of biochar has been produced.

The KPI relevant is explained under IAC10.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
There is a need to get relevant permits for the use of sludgefrom the waste treatment centre. It took longer than expected but still the implementation was on time.	-
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed

No barriers detected	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected	-
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
No barriers detected	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

2.3.10 IAc10 Smart Soil (Biochar) into Green Shady Structures Report on NBS

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0112	Smart Soil (Biochar) into Green Shady Structures	IZM, Ege Soil (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	November 2019	

Results and Discussion

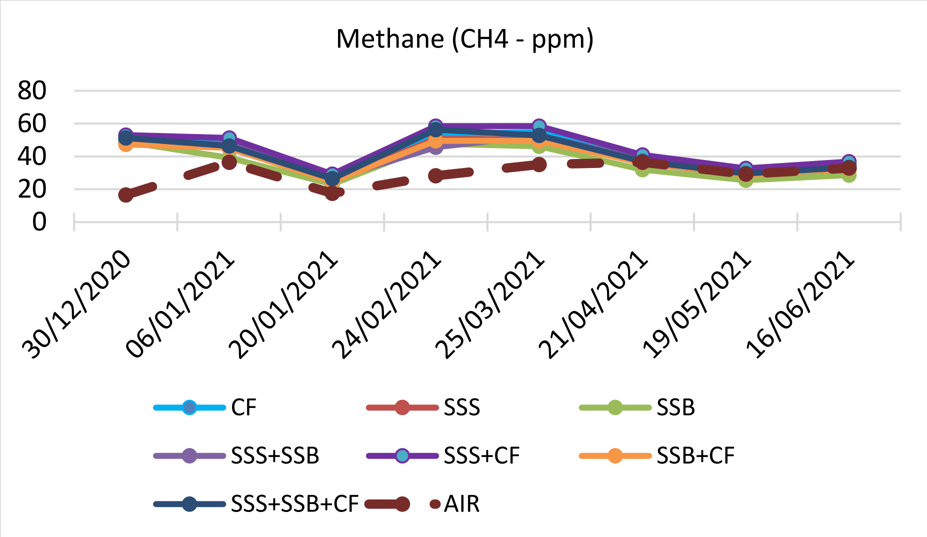
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

This NBS is directly related to “smart soil production” and “Green Covering Shelter for car parking area construction” actions. After smart soil production, this material applied to create fertile medium for vegetation on green shade structures and another GI. Smart soil provided a growing medium for the plants.

Green shady structures that cover of bus stations or car parks etc. which have vegetative layer grown on it. Smart soil was used in these areas and also in Bio-boulevard and other green infrastructures (GI). In this way, smart soil reduced the heat island effect as well as carbon emissions besides improving urban air quality through carbon dioxide-oxygen exchange and creating little ecosystems by increasing green areas in cities are the main expected impacts of this action.

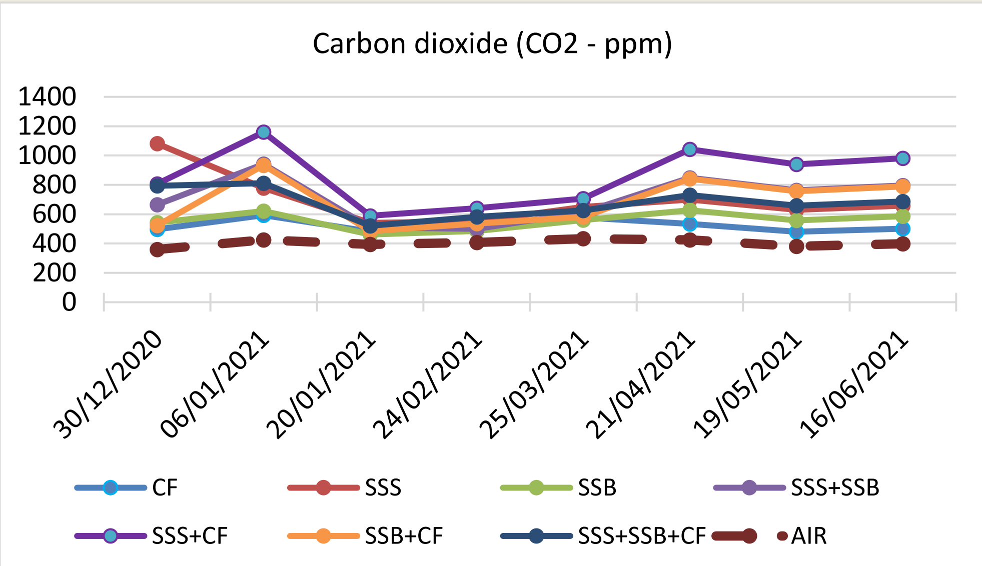
The application of biochar to the soils appears to be one of the ways of atmospheric CO2 sequestration. In this process, carbon is separated from its rapid ecological cycle and participates in a much slower and more stable biochar cycle (Lehmann, 2007). The construction of a strategic pathway to utilize pyrolysis technology and biochar use in agriculture have been realised with potential and feasible utilization techniques.

While the lowest methane value was 36.4 ppm for SSB treatment, the highest value occurred in SSS+CF soils (45.1 ppm). Although the methane emission of biochar-treated soils was closest to that of atmospheric air, methane emission of biochar-treated soils decreased below that in atmospheric air 4 months after the biochar was incorporated into the soil.



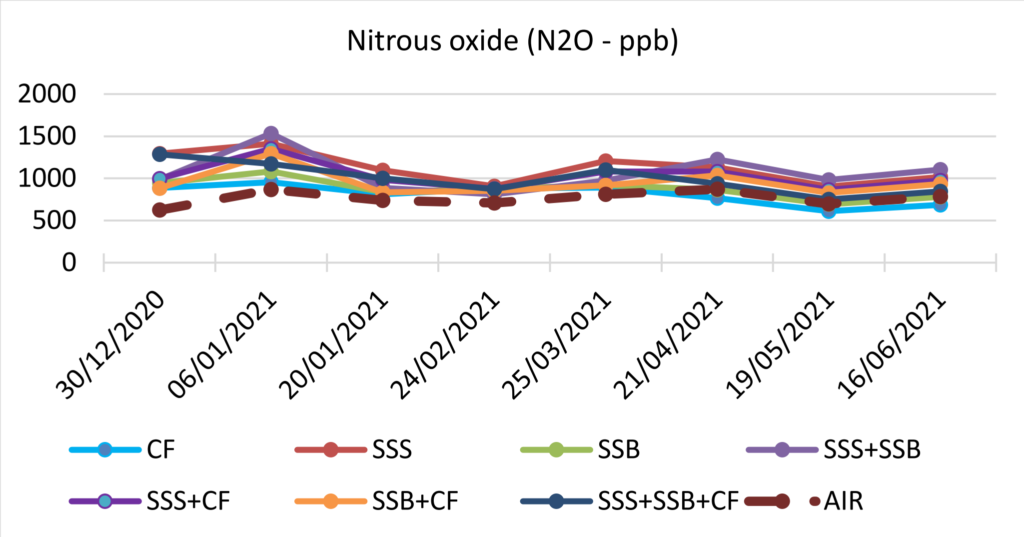
Methane change

In the field experiment in which 25 t/ha of organic material was applied, it was determined that the CO_2 concentration released to the atmosphere increased due to SSS applications. The sewage sludge, which is ready for agricultural use by the anaerobic stabilization method, caused an average of 26% more C-emissions than the biochar application.



Carbon dioxide change (CO2 – ppm)

Since the physical conditions of the soil have a great effect on the N_2O release from the soil, we were able to reduce the N_2O emissions by 28% with biochar applications. The emission, which was 1120 ppb in SSS soils, decreased to 875 ppb due to SSB applications.



Nitrous Oxide (N2O – ppb)

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
There is a need to get relevant permits for the use of sludgefrom the waste treatment centre. It took longer than expected but still the implementation was on time.	-
Economical barriers	How they have been addressed
No technical barriers	
Social barriers	How they have been addressed
No technical barriers	
Environmental (including COVID)	How they have been addressed
No technical barriers	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers	-
Economical barriers	How they have been addressed
No technical barriers	-
Social barriers	How they have been addressed
No technical barriers	-
Environmental (including COVID)	How they have been addressed
No technical barriers	-

2.3.11 IAc11 Natural Pollinator's Modules

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0410; CH0411; CH0508	Natural Pollinator's Modules	IZM, Ege Landscape (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM		

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Pollinator's modules or houses are proposed to attract more pollinator insects by proving shelter. Modules are uniquely designed for this purpose and placed in the settings where many pollinator friendly flowering plants are abundant. Although the primary purpose with these modules is attracting more pollinator's species to increase biodiversity, getting people' attention to biodiversity issues should be considered as a co-benefit.

There are 10 natural pollinator modules alongside Bio-Boulevard in climate-smart urban farming precinct. Since the boulevard, as a learning lab, has been designed in a way that it is considered the epicentre of several activities including a path to learn urban bio-diversity, climate change effects and sustainable stormwater management, the modules play an important part in this process.

In Peynircioğlu; pollinator species observed and recorded increased dramatically up to 357% in the 1st monitoring period and 385% in the 2nd monitoring period compared to baseline values.

In Sasalı; pollinator species observed and recorded increased dramatically up to 40% in the 1st monitoring period and 30% in the 2nd monitoring period compared to baseline values.

	Baseline	1st monitoring	2nd monitoring
Number of plant species	306	3966	3936
Number of pollinator species	7	25	27
Pollutant Removed	51,51 kg/year	85,37 kg/year	90,15 kg/year

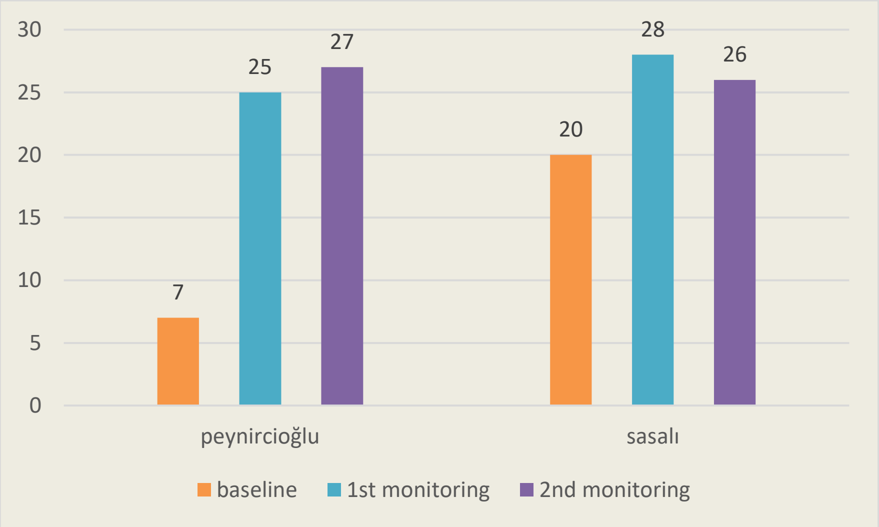
Pollinator species in Peynircioğlu

	Baseline	1st monitoring	2nd monitoring
Number of plant species	299	3936	3936
Number of pollinator species	20	28	26
Pollutant Removed	33,81 kg/year	16,83 kg/year	

Pollinator species in Sasalı

Based on the field observations in Peynircioğlu, the most favorite plants for the pollinators are Linden tree (*Tilia argentea*), Tree germander (*Teucricum fruticans*), Lavender (*Lavandula angustifolia and stoechas*), Sage (*Salvia microphylla*), Butterly bush (*Buddleja davidii*), Lilac (*Syringa vulgaris*), Judas tree (*Cercis siliquastrum*), Vitex (*Vitex agnus-castus*). Carpenter bees, flower flies, flower bees, butterflies, wasps increased dramatically in Peynircioğlu after the implementation. Honeybees stayed the same. This dramatic increase of pollinator species in Peynircioğlu In two years time showed that a successful pollinator friendly habitat was created. As the plants get older and mature and a sustainable habitat is achieved, it is expected to have more pollinator species (Figure 3).

In Sasali, Honeybees, flower bees, butterflies, wasps end carpenter bees increased. Lavender (*Lavandula angustifolia*), sage (*Salvia microphylla*), Butterly bush (*Buddleja davidii*), Lilac (*Syringa vulgaris*), Vitex (*Vitex agnus-castus*). Redroot pigweed (*Amaranthus retroflexsus*), (Rosemary (*Rosmarinus officinalis*) and Mallow (*Malva sylvestris*) seem to be the most favorable plants for the pollinator species.



The number of pollinator species observed in Peynircioğlu and Sasalı

As a result of pollinators implemented there is also a contribution to the Pollutants Reoved by Vegetation as can be seen in the tables above.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
The maintenance of the areas, especially just after they were planted. There was a little bit of delays because of the pandemic. Local governments do mowing and weeding frequently which sometimes hinders the data collection process.	There was a good communication with the Parks and Gardens Dept who are in charge of maintenance of green areas.
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	

Environmental (including COVID)	How they have been addressed
No barriers detected.	

2.3.12 IAc12 Green Fences

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0410; CH0411 CH0508	Green Fences	IZM, Ege Landscape (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Green fences or walls are installed alongside the Peynircioğlu Stream to allow development of new green areas and hence rising bio-diversity since the existing stream corridor is now mostly an open space with little or no vegetation except a linear green space on the western side of the Stream. Moreover, the Stream is fenced with a metal enclosure on both sites. Existing enclosure replaced with green fences or walls to provide more attractive environment both for people and pollinating insects. The green area created by this NBS will be 1600 sqm. Green fences, together with fruit walls and green pavements become a good example of re-naturing riversides in Izmir.

Table 1: Pollinator species in Peynircioğlu

	Baseline	1st monitoring	2nd monitoring
Number of plant species	306	3966	3936
Number of pollinator species	7	25	27

Most of the KPIs calculated for the total green route and the culvert works done all together across Peynircioglu stream there is no specific KPI related with green fences.

Green fences are assumed to have contribution to the Pollutants removed by vegetation KPI which is mentioned in IAc11.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	

Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

2.3.13 IAc13 Establishment of Fruit Walls

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0410; CH0411, CH0508	Establishment of Fruit Walls	IZM, Ege Landscape (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

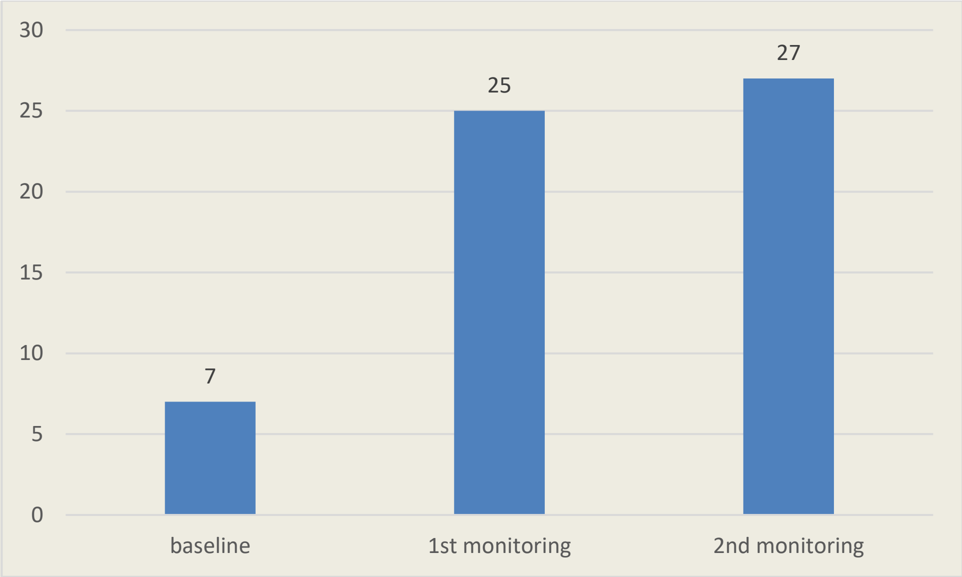
Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Fruit walls installed alongside the Peynircioğlu Stream to allow development of new green areas and hence rising bio-diversity since the existing river corridor is now mostly an open space with little or no vegetation except a linear green space on the western side of the Stream. Moreover, the fruit walls provide more attractive environment both for people and pollinating insects. The green area created by this NBS is 1600 sqm. Together with green fences and green pavements, fruit walls become a good example of re-naturing riversides in Izmir.

Pollinator Species Increase

In Peynircioğlu; pollinator species observed and recorded increased dramatically up to 357 % in the 1st monitoring period and 385 % in the 2nd monitoring period compared to baseline values.



The number of pollinator species observed in Peynircioğlu

Fruit Walls are assumed to have contribution to the Pollutants removed by vegetation and number of plant species KPIs which are mentioned in IAc11 and IAc12.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected	
Economical barriers	How they have been addressed
No barriers detected	
Social barriers	How they have been addressed
No barriers detected	
Environmental (including COVID)	How they have been addressed

No barriers detected	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
There was a short amount of time the maintenance works were not sufficient.	-
Economical barriers	How they have been addressed
No barriers detected	
Social barriers	How they have been addressed
No barriers detected	
Environmental (including COVID)	How they have been addressed
No barriers detected	

2.3.14 IAc14 Green Covering Shelter Around Car Parking Area

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0106; CH0108; CH0502; CH0503; CH0504; CH0505	Green Covering Shelter Around Car Parking Area	IZM, IYTE and BIT (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	November 2019	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

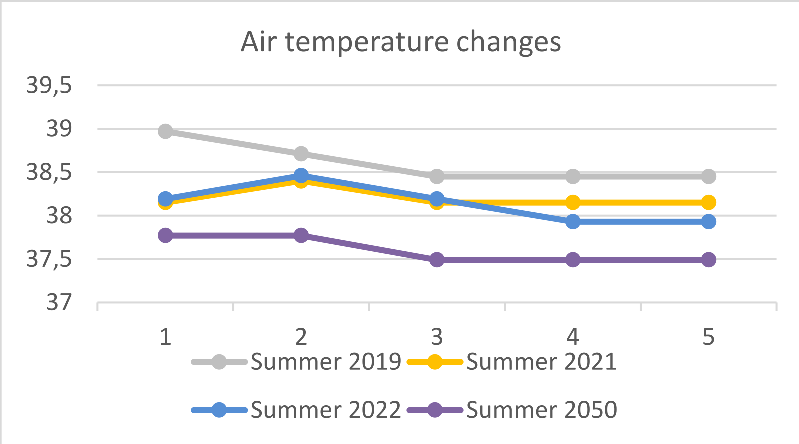
Green covering shelter installed to decrease temperatures and increase pollutant's removal with its planted cover. It is designed to integrate specific vegetation with a minimum maintenance, and their structural features allow providing water for plants, humidity for the ambient, shade for citizens. At the same time, it will capture CO2, reduce surface temperatures by preventing sunlight from reaching the surface. In the summer, green covering shelter will shade the parking lot and, through the process of evapotranspiration will provide cooling.

Green covering shelters installed as an extensive roof garden with low weight, low capital cost, low plant diversity, and minimal maintenance requirements.

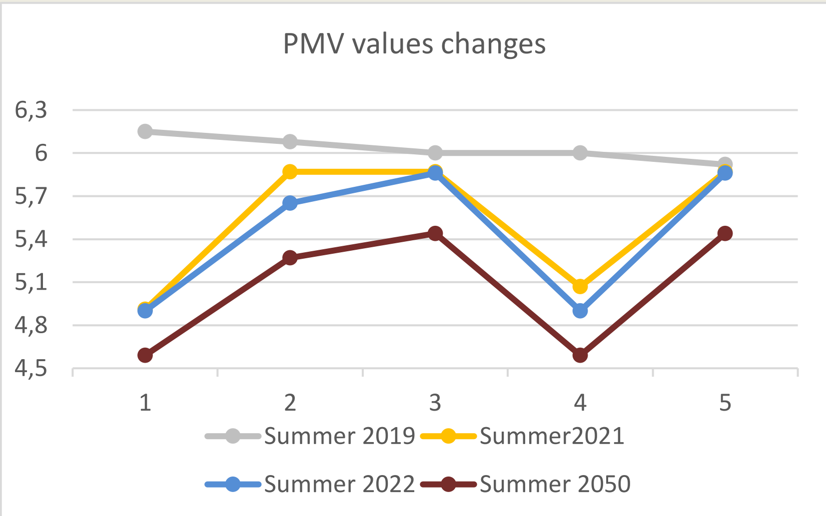
Green covering shelters built in parking lot of Vilayetler Evi and parking lot of Sasalı Natural Life Park. The former is in a very dense urban fabric and completely exposed to adverse effect of sun. The latter is situated adjacent to Sasalı Natural Life Park in a suburban landscape.

Temperature Decrease

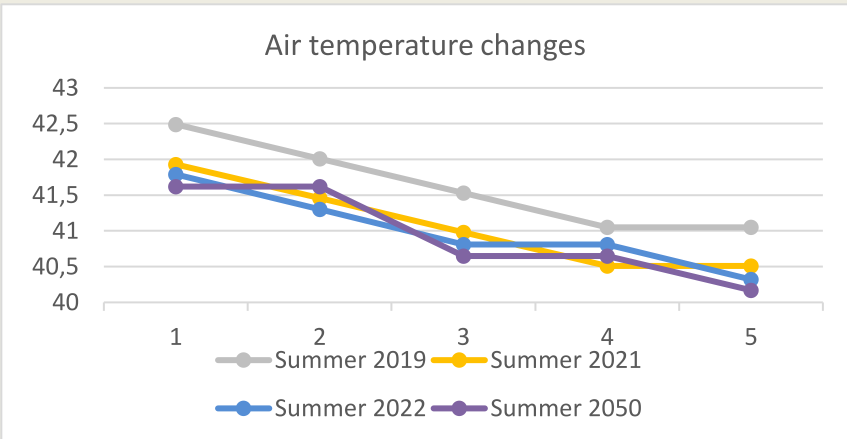
Temperature decrease and PMV values for Sasalı and Vilayetlerevi are shown in the figures below. Thermal comfort values of the demo areas were calculated with the Envi-met software. Although the results for monitoring period for temperature change is not very high the predictions for 2050 is higher especially for Sasalı.



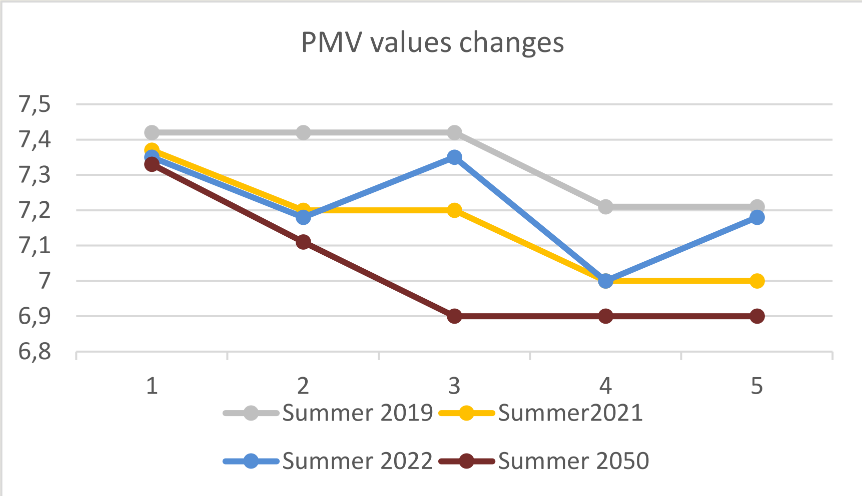
Air temperature changes and expectations for Sasalı



PMV values changes and expectations for Sasalı



Air temperature changes and expectations for Vilayetlerevi



PMV values changes and expectations for Vilayetlerevi

Total number of days with heatwave risk is combined from Table 1 and 2, and listed in Table 3 for both demo sites. Decrease in heatwave risk for Vilayetler Evi (urban area) compared with 2019 (ex-ante) is 20.3%, 30.5% and 33.9% for 2020,2021 and 2022, respectively. In Sasalı Natural Life Park (rural area), while decrease in heatwave risk is 8.6% and 11.4% for 2020 and 2022, an 11.4% increase is encountered in 2021. As can be seen from the Table 2, temperatures are quite high in 2021 summer compared with other years.

Comparison of demo sites for heatwave risk

Year	Vilayetler Evi		Sasalı	
	No. of days	No. of days change based on 2019 (%)	No. of days	No. of days change based on 2019 (%)
Ex-ante (2019)	59	-	35	-
Ex-post (2020)	47	-20.3	32	-8.6
Ex-post (2021)	41	-30.5	39	+11.4
Ex-post (2022)	39	-33.9	31	-11.4

Decrease in heatwave occurrences at Vilayetler Evi (dense urban area) is 3 times higher than Sasalı Natural Life Park (rural area) for 2019 (ex-ante) and 2022 (ex-post). This result emphasizes the powerful impact of NBS implementations on decreasing temperatures in urban areas over the rural areas.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
There are not much contractors experienced in NBS. Also the personnel of local government who forms the inspections team	The academic partners were an important help to IZM team.
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the operation process

Barriers encountered during the NBS operation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
The maintenance of the ivies were not carried out properly during the beginning of	Parks and Gardens department took over the maintenance of the areas.

the pandemic and after the İzmir earthquake at the end of 2020.	

2.3.15 IAc15 Green Permeable Pavement Around Car Parking Area

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0106; CH0108	Green Permeable Pavement Around Car Parking Area	IZM, IYTE and BIT (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	November 2019	

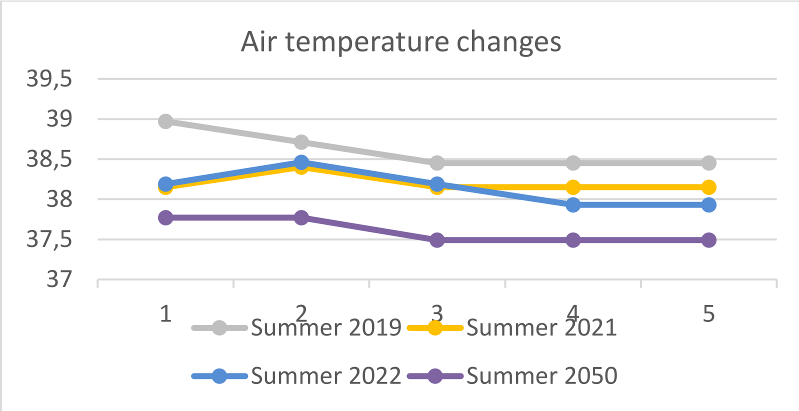
Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

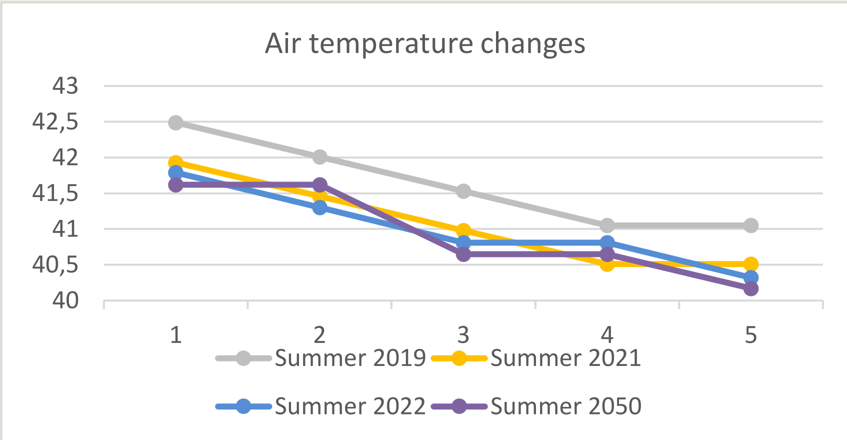
In the case of Izmir demo, conventional pavements replaced with vegetated permeable pavements in two parking lots that are recognized as thermal "hot-spots" in cities. One of them is the parking lot of Vilayetler Evi. It is located in a very dense urban fabric and completely exposed to adverse effect of sun. Other parking lot is situated adjacent to Sasalı Natural Life Park in a suburban landscape.

<u>Temperature Decrease</u>

Temperature decrease for Sasalı and Vilayetlerevi are shown in the figures below.



Air temperature changes and expectations for Sasalı



Air temperature changes and expectations for Vilayetlerevi

Decrease in heatwave occurrences at Vilayetler Evi (dense urban area) is 3 times higher than Sasalı Natural Life Park (rural area) for 2019 (ex-ante) and 2022 (ex-post). This result emphasizes the powerful impact of NBS implementations on decreasing temperatures in urban areas over the rural areas.

Comparison of heatwave risk of demo sites.

Year	**Vilayetler Evi**		**Sasalı**	
	No. of days	**No. of days change based on 2019 (%)**	**No. of days**	**No. of days change based on 2019 (%)**
Ex-ante (2019)	59	-	35	-
Ex-post (2020)	47	-20.3	32	-8.6

Ex-post (2021)	41	-30.5	39	+11.4
Ex-post (2022)	39	-33.9	31	-11.4

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed

No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

2.3.16 IAc16 Green Shady Structures for Car Parking Area

*This template aims to collect significant, relevant and accurate modifications on the NBS implemented during the project.

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0105; CH0106; CH0108; CH0502; CH0503; CH0504; CH0505; CH1002	Green Shady Structures for Car Parking Area	IZM, IYTE + BIT (Monitoring)
CITY	*DATE OF IMPLEMENTATION*	
IZM	November 2019	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Green Shady Structure designed as part of the urban heat island reduction strategies in the selected parking lots as a part of Sub-demo A. It covers the 2 sides of green car park areas by using fast-growing creepers and climbing plants (adapted to climate conditions) with the usage of perennial deciduous species, which allow pass the sunlight in wintertime. It will help to minimize of in-car temperature through shading.

Impacts: a) increasing shadow surfaces b) reducing ambient temperature and c) enhancing biodiversity.

PM2.5 Trends

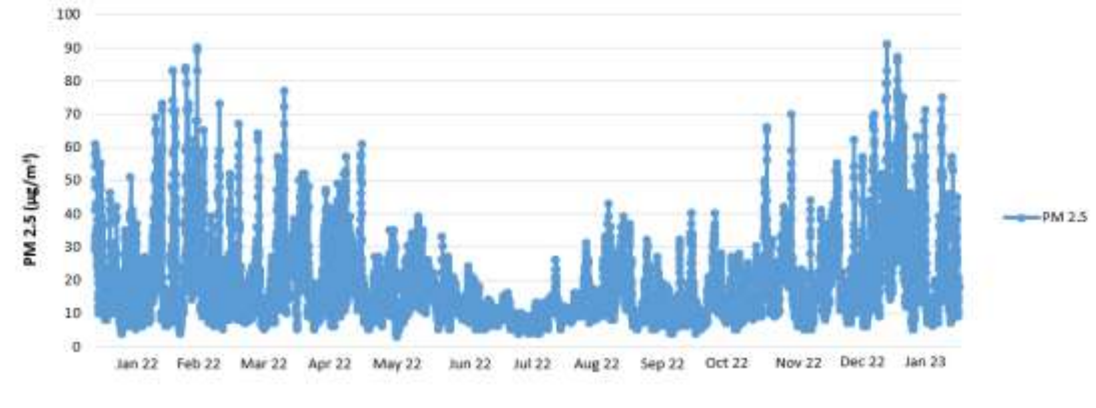
Fine particles ($PM_{2.5}$) are 2.5 micrometers in diameter or smaller, and can only be seen with an electron microscope. Fine particles are produced from all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

Air quality in Turkey is monitored by stationary Air Quality Monitoring (AQM) Stations, which were established in accordance with the Air Quality Control Regulation (AQCR), operated by the Ministry of Environment, Urbanization and Climate Change (MEUCC).

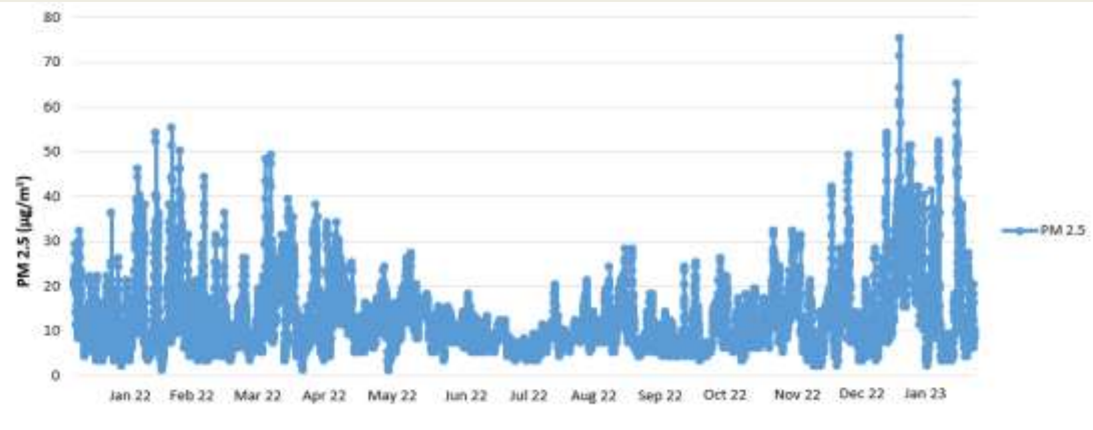
Background Data

PM2.5 values are collected by Cigli AQM station in 2019 and partially in 2020.

PM2.5 values



Vilayetler Evi Parking Lot (January 2022 - January 2023)



Sasali Natural Life Park Parking Lot (January 2022- January 2023)

In Cigli, PM2.5 values showed an increasing trend from 2019 to 2020 in summer, fall and winter seasons. Yearly average values are increased from 5.645 µg/m^3 to 15.697 µg/m^3. Fixed station measurements (av.) on the intervention sites are 13.21 µg/m^3 for Sasalı and 16.16 µg/m^3 for Vilayetler Evi. Trends indicate that in spring and fall, PM2.5 values are higher than other seasons. During the Covid-19 pandemic, all pollutants caused by traffic and industry were decreased. PM2.5 values of January-November 2022 indicate that the levels are already reached to pre-pandemic levels.

Subdemo A (Vilayetler Evi) is located in a heavily urbanized area with high population and traffic. It has been experiencing air pollution especially in winter months owing to fossil fuels. Although natural gas has been used for the heating, there are still neighborhoods in Karşıyaka and Çiğli districts that use solid fuels.

In summer period, PM 2.5 values are decreased both for Subdemo A (Vilayetler Evi) and Subdemo B (Sasali). This is most likely because of wind speed during this season is lower than other periods. Other reason may be related the population of the city. During this period citizens go to vacation. However PM 2.5 values in most of the months are high with respect to the 'WHO' limit which is 5 µg/m^3 annualy mean.

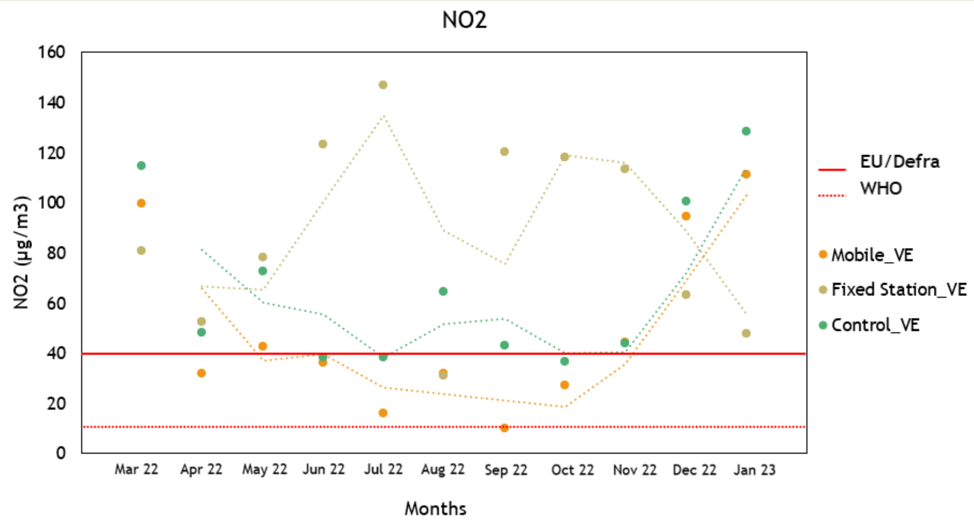
There are similar results for PM10 as explained in KPI0503.

<u>NOx Trends</u>

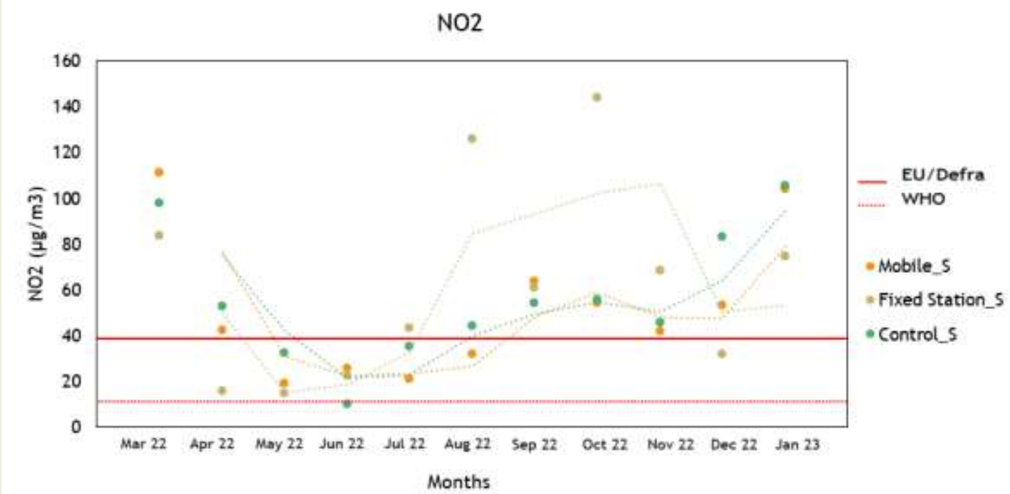
Measurement data and comparison of the mobile measurements for NO2 are shown in the table and figures below.

Fixed and mobile measurement data for 01.23.2023

January 23rd, 2023	Vilayetler Evi			Sasali		
	Intervention		Control	Intervention		Control
	Fixed	Mobile	Mobile	Fixed	Mobile	Mobile
T (°C)	16	20.84	20.43	20.5	23.41	24.76
RH (%)	64.25	49.98	50.04	49.73	47.16	44.84
NO_2(µg/m^3)	47.71	111.36	128.33	74.5	104.14	105.6



Comparison of the mobile measurement data at Vilayetler Evi (VE)(March 2022- January 2023).



Comparison of the mobile measurement data at Sasali Natural Life Park (S) (March 2022-January 2023).

<u>SO2 Trends</u>

SO_2 values are collected by Cigli and Karsiyaka AQM stations in 2021.

Figure 1: SO_2 measurement for 2021 for Karsiyaka and Cigli

Table 4: Fixed and mobile measurement data for 03.11.2022

March 11th, 2022	Vilayetler Evi			Sasali		
	Intervention		Control	Intervention		Control
	Fixed	Mobile	Mobile	Fixed	Mobile	Mobile
T (°C)	6.0	10.0	11.6	8.0	11.3	9.2
RH (%)	42.8	35.0	33.0	38.0	34.9	36.1
SO_2 (µg/m³)	65.5	0	0	79.9	13.1	13.1

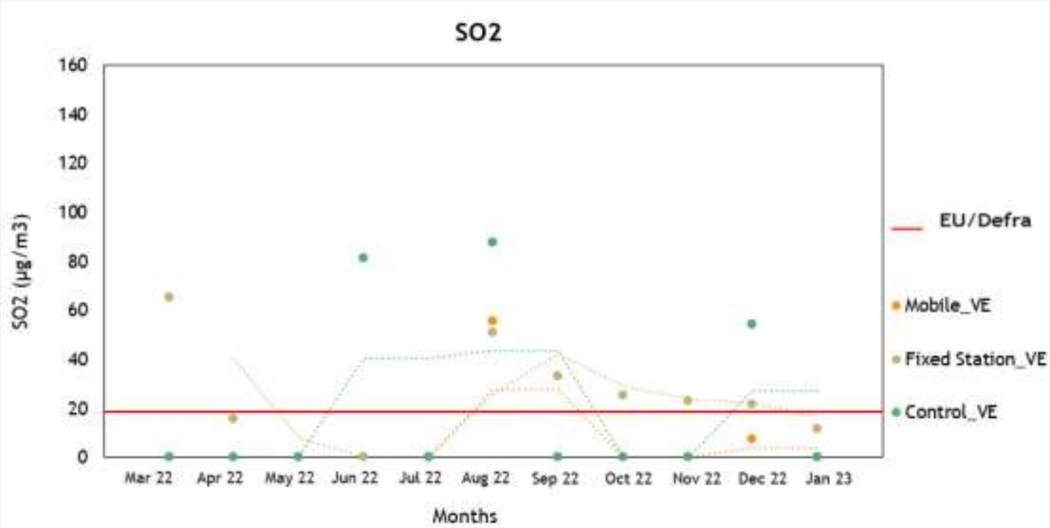


Figure 11: Comparison of the mobile measurement data at Vilayetler Evi (VE) (March 2022 - January 2023).

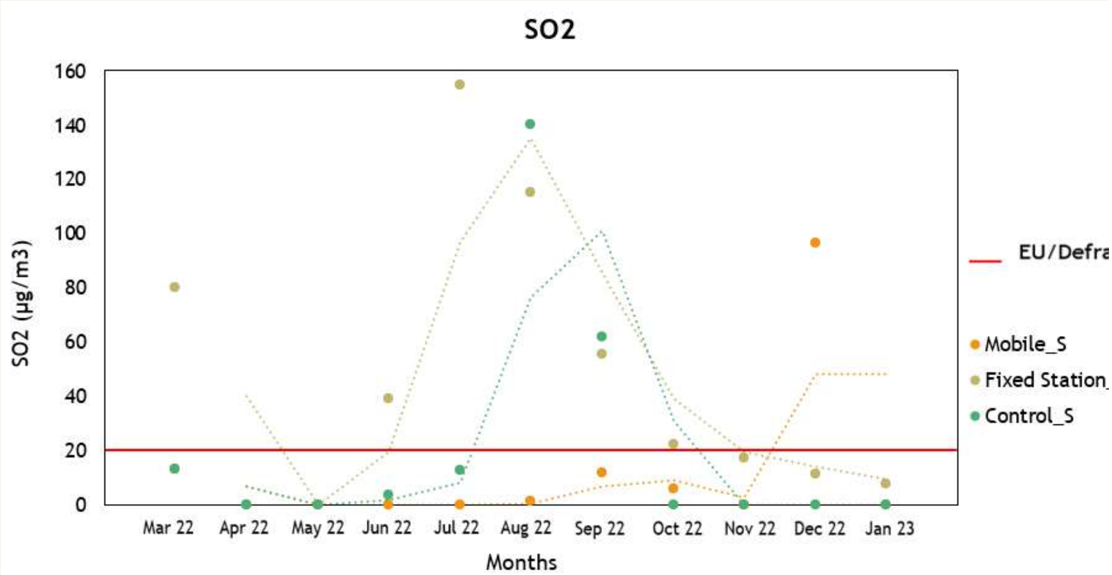


Figure 12: Comparison of the mobile measurement data at Sasali Natural Life Park (S) (March 2022 - January 2023).

The daily mean SO_2 graphs (2017-2021) reflects that SO_2 concentrations show fluctuations on a yearly basis. The highest decrease in SO_2 values is encountered in 2020. As a result of the measures taken within the scope of the pandemic in 2020, a serious decrease in SO_2 value recorded between March 16-May 31, 2020. In the following normalization period (June 1-30, 2020), decreasing trend was carried out.

Fixed station measurements (av.) on the intervention sites between January-March 2022 are 41.92 µg/m³ for Sasali and 36.68 µg/m³ for Vilayetler Evi. The data in this period is much higher than the pre-pandemic levels.

The KPIs related with kWh savings per year and t / C per year can be found within IAc3.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	After the pandemic the maintenance done regularly.
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
No barriers detected	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Maintenance was delayed during the pandemic.	After the pandemic the maintenance done regularly.
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed

No barriers detected	-
Environmental (including COVID)	How they have been addressed
The ivies did not grow as expected. The results could have been better.	-

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

Subdemo A (Vilayetler Evi) and Subdemo B (Sasali) are still highly affected by the Industrial zone nearby, and also, prevailing wind direction carries the air pollutants from the Heavy Industrial Area at the north. However, despite that during the mobile measurement process, it was observed that when the wind is less, the growing ivies have a momentary positive effect on reducing the PM 2.5 values.

2.3.17 IAc17 Climate Smart Greenhouses

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0409; CH0704; CH0706; CH0707; CH0802; CH1002	Climate Smart Greenhouses	IZM, EGE Soil
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

It is necessary to plan crop production in accordance with expected stress conditions in agricultural lands and to manage the drought. Climate-smart greenhouse can be defined as an approach for transforming and reorienting agricultural development under the new realities of climate change. Climate smart soil and agriculture will be practice in a greenhouse and on field together. This NBS employs greenhouse facilities to illustrate the effects of climate change on urban green vegetation used in urban green areas and farming (for both urban and peri-urban areas). This practice helps to select adequate vegetal species for urban farming and to establish community practices and new social forms of organization.

Climate smart greenhouse includes 3 production & demonstration parts and located in the eastern part of the Sasalı Natural Life Park. In addition, an open field agriculture demonstrated on salty soils and a seminar room will be design for educative propose.

The rotating agriculture unit enables the vegetation to have the same amount of sun for each unit and increase the production with vertical agriculture opportunity. There has been lettuce production of 1440 within a small amount of time on a limited area.

Vertical production unit.

Energy Saving

This section of the Greenhouse includes some applications aimed at reducing energy from the national electricity network. The heating of this part of the greenhouse is provided by parabolic solar energy. For this purpose, isolated water tanks that store heat during daytime hours are used for night heating purposes. As a result of the study, it has been understood that the use of parabolic solar panels in cities with long sunshine durations such as Izmir will be successful and can be used within nature-based solutions to reduce carbon emissions.

Electricity production

Reflective surface Area m^2	kW/h m^2	Total kW/daily	Months 2022	Total kW/month
24	12	84	July	2.520
24	12	84	August	2.520
24	12	84	September	2.520
24	12	84	October	2.520
	12	84	November	2.520
	---	---	December	Continue
Total	60	420		12.600


Water Saving

Harvested Water from monthly rain between November 2021- January 2022 can be seen in table below.

Water harvested

Roof area m^2	Monthly rain (mm)	Months 2021-2022
596,7	92	November 2021

596,7	146.8	December 2021
596,7	136.9	January 2022
596,7	102.9	February 2022
596,7	80.3	March 2022
596,7	60.4	April 2022
596,7	56.5	May 2022
596,7	37.4	June 2022
596,7	----	July
596,7	----	August
596,7	11.6	September
596,7	34.3	October
596,7	76.5	November
Total	**835.4**	**Total Rain (mm)**

HW =Roof Area (m^2) x RLC x FSC x Total Rain (mm)

HW = 596.7 (m^2) x 0.8 x 0.9 x 0.8534 (m)

HW = 358.91 m^3



The education activities are given in detail in IAc20 and IAc22.

There are also at least 10 personnel employed in the area permanently.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected	-
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
No barriers detected	-
Environmental (including COVID)	How they have been addressed
No barriers detected	-

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Although it is not a major challenge, the cleaning and maintenance of parabolic systems and the lack of experts in parabolic systems can be a problem in solving specific problems.	The establishment that will ensure the continuity of the system must employ an expert for this job.
Economical barriers	How they have been addressed
No barriers detected	-
Social barriers	How they have been addressed
The system is built in a publicly owned greenhouse so social acceptance was not an issue. It also draws the attention of the people who visited the area for training activities.	
Environmental (including COVID)	How they have been addressed
No barriers detected	-

2.3.18 IAc18 Development of Smart Soil from Mud Plant

*This template aims to collect significant, relevant and accurate modifications on the NBS implemented during the project.

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0112	Development of Smart Soil from Mud Plant, to use in urban farming	
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

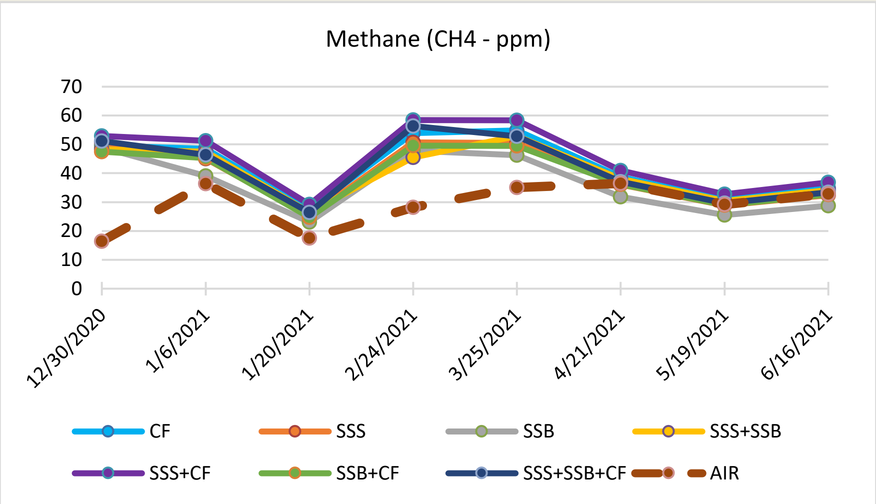
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

In order to sustain soil fertility in the Mediterranean biodegradable conditions where the soil organic matter content is below 1%, the applicability of sewage sludge at appropriate rates is a highly valuable waste management strategy. In this study, microbiological parameters of the soil used to demonstrate quickly and clearly both the appropriate application rates and the ecological effects of the treated sewage sludge.

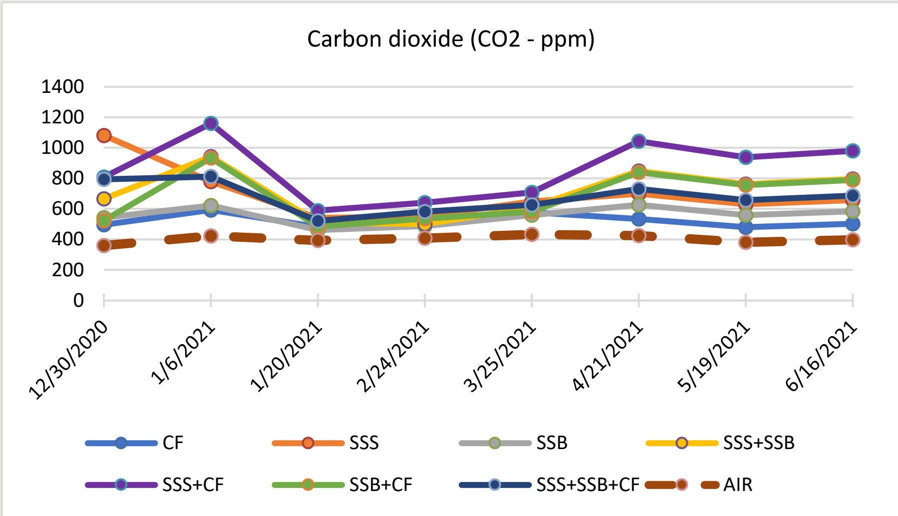
The application of sewage sludge improved the physical and chemical characteristics of the soil, and generally support microbial growth and activity. Depending on the application doses of the treated sewage sludge; a) 1% of the organic carbon content of the experimental soil; b) 10-50% of microbial activity and c) 5% of energy yield, were increased.

Global Warming Potential

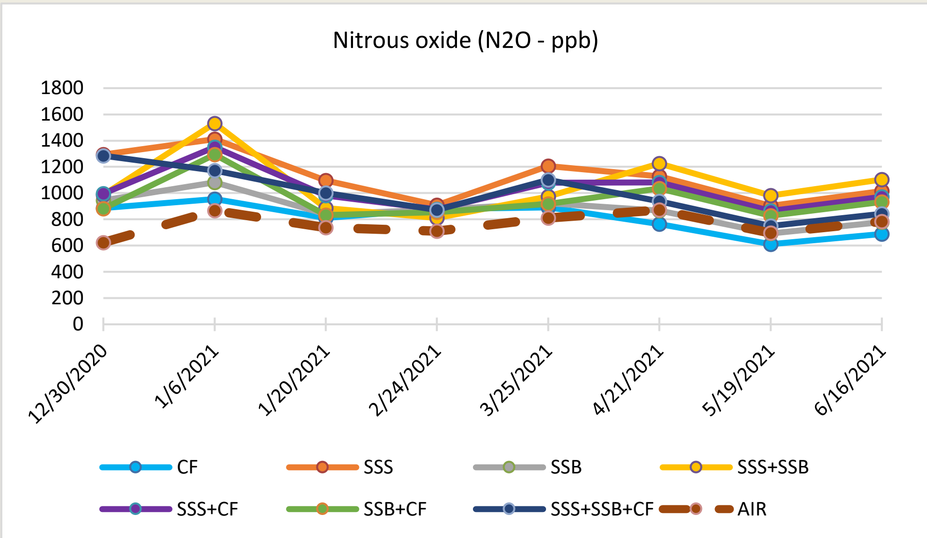
Biochar (SSB) applications caused a 9% reduction in methane emissions from soil to the atmosphere, 21% in CO2 and 22% in N2O compared to sewage sludge (SSS) applications. It is thought that biochar had this effect because it has stable carbon and improves the physical and chemical properties of soils.



Methane Change (CH_4-ppm)



Carbon dioxide Change (CO_2-ppm)



Nitrous Oxide (N_2O – ppb)

In general, the use of organic wastes in agriculture by a consideration of certain conditions provides the opportunity to simultaneously increase soil productivity and potentially offer a more sustainable way of dealing with organic wastes. When organic wastes are thrown randomly, they cause a large amount of greenhouse gas emissions. In addition, our agricultural soils especially under the Mediterranean climatic condition need organic matter additions in terms of sustainable soil fertility.

Biochar (SSB) applications caused a 9% reduction in methane emissions from soil to the atmosphere, 21% in CO2 and 22% in N2O compared to sewage sludge (SSS) applications. It is thought that biochar had this effect because it has stable carbon and improves the physical and chemical properties of soils.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
There is a need to obtain permission for the use of wastewater mud. The process took longer than expected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

2.3.19 IAc19 Industrial Heritage Route

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH…; CH…; CH…	Industrial Heritage Route Along the Izmir Urban	IZM

	Green	
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Çamaltı Saltworks with its 'Salt City' and its ongoing manufacturing activity, harmonious relationship with nearby Bird's Paradise area, especially a feeding area for Flamingo Birds, it should be protected as cultural heritage area as a symbol of nature-based industrial production. It is urgent because whether old nature-based production technology is changed the whole ecosystem will be affected in a destructive way.

Among the lots of small and medium sized sea-sourced salt beds, Çamaltı Saltworks is the oldest and the biggest one reaching today. Therefore, when searching the historical traces of salt manufacturing coastal areas between Sub-Demo C and Sub-Demo B can be considered as parts of cultural landscape representing the awareness of sea salt production in the region. This route can also be integrated with existing cycling ways till Çamaltı Saltworks and created an identity of nature-based manufacturing with İzmir's oldest industrial heritage of white gold.

There are no KPIs related with this action.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers	-
Economical barriers	How they have been addressed
No technical barriers	-
Social barriers	How they have been addressed
No technical barriers	-
Environmental (including COVID)	How they have been addressed
No technical barriers	-

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No technical barriers	-
Economical barriers	How they have been addressed

No technical barriers	-
Social barriers	How they have been addressed
The planned dissemination activities could not be realized starting from the pandemic period. The frequent change of management also hindered the planned engagement actions.	-
Environmental (including COVID)	How they have been addressed
No technical barriers	-

2.3.20 IAc20 Educational Path_Bio-boulevard

*This template aims to collect significant, relevant and accurate modifications on the NBS implemented during the project.

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0802	Educational Path/ Bio-boulevard	IZM
CITY	*DATE OF IMPLEMENTATION*	
IZM		

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

As a part of Sub Demo B and part of Izmir's new urban green corridor, Bio-Boulevard is an educational path to exemplify less reliance on conventional grey infrastructure systems, thereby reducing cumulative urban heat island effects, and increasing bio diversity and filtration of ground/air pollutants.

Bio-boulevard is located at the climate-smart urban farming area, a special precinct within Sasalı Natural Life Park. Therefore, it represents an interface among different types of nature-culture areas, a perfect setting for educative purposes.

Bio-boulevard, as an integral part of climate-smart urban farming precinct, helped to increase awareness amongst the wider urban community about the value of green infrastructure in urban areas.

Impacts are: a) Increase in impacted citizens, b) Increase in awareness impact rising, c) Increased number of pollinator species, d) Increased run-off detention and infiltration, e) Habitat for biodiversity, f) Green intelligence awareness.

Promotional material like leaflets and brochures prepared and distributed in the entrance of Sasalı Natural Life Park to increase the awareness of the new precinct. Together with supporting activities for the food-smart future of Izmir, Bio-boulevard promoted ecological concepts and implementations among urban residents.

Many activities with primary schools, universities other stakeholders took place in the climate-smart urban farming.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers *How they have been addressed*

No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
Most of the visitors were really interested in the area but due to mis management there are no specific surveys were conducted.	
Environmental (including COVID)	How they have been addressed
Less events organized because of the restrictions in especially 2021.	

2.3.21 IAc21 Supporting Activities for the Food-smart Future of Izmir (Non-technical)

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*

CH0704	Supporting Activities for the Food-smart Future of Izmir (Non-technical)	IZM, Ege Soil Dept.
CITY	*DATE OF IMPLEMENTATION*	
IZM		

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

In the Aegean Region, salinity is expected to increase in urban and agricultural lands due to climate change. Within the scope of the project, studies on urban agriculture and the sustainability of urban green cover were carried out in Sasalı bio-lab (Demo side B). One of them was about agricultural production on high-level salty soils at field conditions. For this purpose, a spatial planting technique has been developed. According to this technique, high ridge planting pads 70 cm high from the ground are prepared for planting seedlings (Figure below).

This method is exemplified in the open field in front of the greenhouse. A coarse sandy layer about 20 cm thick was laid at the bottom of the high soil ridges to stop saline groundwater transformation by capillarity to topsoil. Before the saplings, a subsurface drip irrigation system was installed on the ridges to protect from evaporation. Pomegranate and quince trees seedlings were planted on high ridges. This method can also be used in urban agriculture and urban green covering.

High ridge type soil pads on salty ground and fruits plantation

Baseline measurements are made in sections such as high ridge planting and data are obtained periodically.

Fruit trees are sensitive to salinity and cannot grow in salty soils. After these processes, soil samples were taken both from the top of the high ridges and the areas between this row (ground). Soil samples were taken from 9 points separately in July and October to see the effect of climate on soil salinity. It was observed that the salinity (EC) was minimally increased in the high ridge (HR) samples while rising in the soils taken from the ground (GR).

Healthy pomegranate and quince trees planted on the high ridge

With the implementation, the development of typical plants for a landscape planted in saline soils was also monitored. Direct planting was carried out on existing soils. This is also very important in terms of showing the impact of climate change on urban green spaces. Despite being irrigated with the drip irrigation system, the root development of some plants was very insufficient and they dried out in a short time due to the effect of salinity. As a result, many different landscaping plants could not adapt to these conditions and dried. Among these plants, only the Tamarix, which is resistant to salt by nature, survived. In order to protect both agricultural production and urban green spaces, we need to identify both planting techniques and plants types that are resistant to salinity and increasing drought.

Dired plants and well growth salt resist plants, *Tamarix sp*

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed
Monitoring activities were not affected by COVID since the place is not a densely populated area, it was easier to go and monitor.	

Other comments

Optional: Any other relevant comments that you consider essential to be included as part of the NBS implementation assessment

There were no obstacles during the implementation and operation of the system since academia who have been experts on the subject worked on it.

2.3.22 IAc22 Education for the Food-Smart Future of Izmir

*This template aims to collect significant, relevant and accurate modifications on the NBS implemented during the project.

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH…; CH…; CH…	Education for the Food-Smart Future of Izmir	IZM
CITY	*DATE OF IMPLEMENTATION*	
IZM		

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

This special educative and communication programs simulate the future climate condition of the Izmir city and demonstrated some of precautions against changing condition. The effects of climate change on green texture, fresh water and soils explained both the rural and urban populations for create awareness. Targeted population are farmer, citizens and particularly elementary school students. Effects of increased temperatures, decreased and rainfall irregularity and changes of soil chemistry demonstrated in the open-air "laboratory of the future" and climate smart greenhouse.

Especially farmers living in the urban and peri-urban informed about climate change and its increasing affects, periodically.

One part of the greenhouse is used for demonstrating future stress conditions due to climate changes and soil degradation including dried plants, dried soil with cracks and salt crust on the surface etc. Aims of this part of the greenhouse is used for educative purposes trough students and citizens.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*

Economical barriers	How they have been addressed

Social barriers	How they have been addressed

Environmental (including COVID)	How they have been addressed

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
Economical barriers	How they have been addressed
Social barriers	How they have been addressed
Environmental (including COVID)	How they have been addressed

2.3.23 IAc23 Engagement Portal

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0802	Engagement Portal	IZM
CITY	*DATE OF IMPLEMENTATION*	
IZM		

Results and Discussion

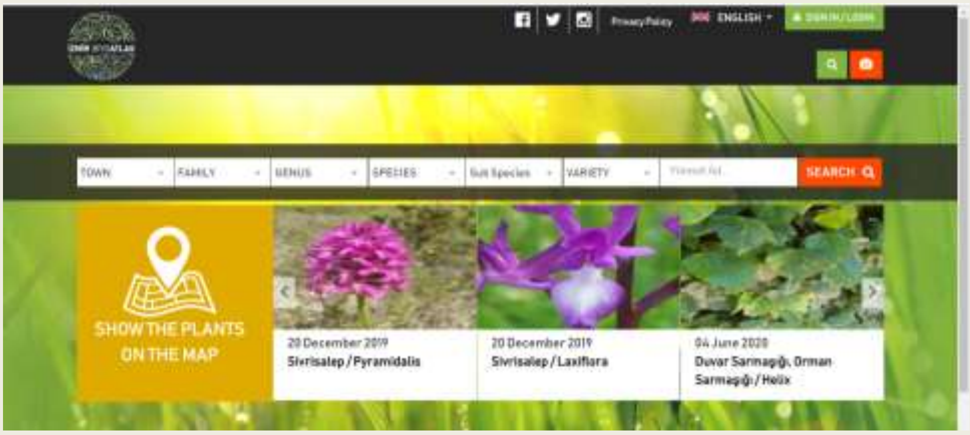
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

Engagement Portal for citizens prepared integral to İzmir Green Infrastructure Strategy Website is directly be linked to real-time information like İZUM Dashboard illustrating the real time urban transportation data of Izmir.

By development of a user-friendly interface, engagement portal informs people of Izmir about existing and new GI interventions by illustrating the impacts on the urban environment. This portal is also allows monitoring results of complete and ongoing implementations.

Supporting activities for the food-smart future of Izmir, educational path Bio-Boulevard, Engagement Portal and its associated supporting ICT platforms are all help to promote ecological reasoning and awareness about nature-based solutions throughout the city.

İzmir Bio-atlas project is web portal like French online platform of Tela Botanica. Additionally, like Rescaper in cultural heritage mapping, it can be supported by mobile app too. In this category iNaturalist, a joint initiative by the California Academy of Sciences and the National Geographic Society, is one of the best-known mobile application with a community of over 400,000 scientists and naturalists. With this regard, it is aimed to reach 5.000 Izmir residents with a means of mobile app in later stages.



Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
Dissemination efforts are not adequate.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

2.3.24 IAc25 Support to Citizen Project of NBS

RELATED KPI CODE	NBS NAME	PARTNER(S)
CH0702; CH0802	Support to Citizen Project of NBS	IZM
CITY	*DATE OF IMPLEMENTATION*	
IZM		

Results and Discussion

Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

This action supporst green job creation which is open to third party developers and citizens as makers. The objective here is that İzmir Metropolitan Municipality-led support to citizen project of NBS to facilitate the development of novel nature-based solutions and possibly the increase in nature-based entrepreneurship.

To increase number of project suggestions from local communities İzmir Metropolitan Municipality held regular green-collared job training programs under the 'Department of Meslek Fabrikası'. This renovated building includes training rooms, ateliers and municipality-operated FabLab that was launched with a grant program of Izmir Development Agency.

This non-technical intervention promote the use of maker space operated by İzmir Metropolitan Municipality as a special program within the frame of UrbangreenUP Project. This FabLab called as 'FabrikaLab İzmir', as novel and innovative infrastructure, allow citizens to make specific products or design where they may wish to see some new green infrastructure developed to meet a specific local need.

As a teaching city Izmir MM has decided to support 10.000 citizens to build up a rain garden with an incentive to distribute native plants and flowers. Rain gardens are storm water management applications that collect water from impermeable surfaces such as roofs and roads. It has many purposes such as ensuring the effective use of rain water, cleaning the water by acting as a natural filter in the cleaning of the flowing rain water and feeding the underground waters, providing economical and sustainable solutions for drainage solutions, creating a suitable environment for the flora and fauna specific to the area where it is applied, and increasing biological diversity.

This is an emerging need since the heavy rains and flash floods are increasing in the area of Izmir. The website applications are collected is https://yagmurbahcesi.izmir.bel.tr/.

Another incentive is the rainwater harvesting system. It is aimed by IMM to include 5000 buildings in the incentive system with 5000 polyethylene harvesting tanks. Applications must be made by the apartment managers. In detached houses, applications must be made by the property owners. The website applications are collected is https://yagmursuyu.izmir.bel.tr/.

Conclusions and recommendations.

Please, answer to the questions.

Regarding the implementation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	
Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
No barriers detected.	
Environmental (including COVID)	How they have been addressed
No barriers detected.	

Regarding the operation process

Barriers encountered during the NBS implementation process and how they have been addressed.

Technical barriers	*How they have been addressed*
No barriers detected.	

Economical barriers	How they have been addressed
No barriers detected.	
Social barriers	How they have been addressed
The projects about water management have just started.	The applications are collected as of March of 2023.
Environmental (including COVID)	How they have been addressed
No barriers detected.	