URBAN GreenUP

Final NBS catalogue

D5.4: NBS implementation conclusions and recommendations. Annex

WP 5 , T 5.5

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URBAN GreenUP

SCC-02-2016-2017

Innovation Action – GRANT AGREEMENT No. 730426

1 Valladolid

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	

1.1.1 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.

<u>Urban regeneration challenge:</u>

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.

1.1.2 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

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 CH0504CH0507 CH0514 CH0602 CH0702 CH0801	Arboreal interventions VAc2 Planting 1,000 trees, VAc3 Tree shady places (500 trees), VAc4 Shade and cooling trees (600 trees), VAc5 Re-naturing parking trees (250)	VAL

CITY	*DATE OF IMPLEMENTATION*	
VAL	2020 (25%), 2021 (>60%), 2022 (15%)	

1.2.1 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).

1.2.2 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.	

1.2.3 Other comments

Trees are essential in cities. The benefits outweigh the drawbacks (citizen complaints, raised sidewalks, need for maintenance, etc.)

1.3 Vac06 Green resting areas

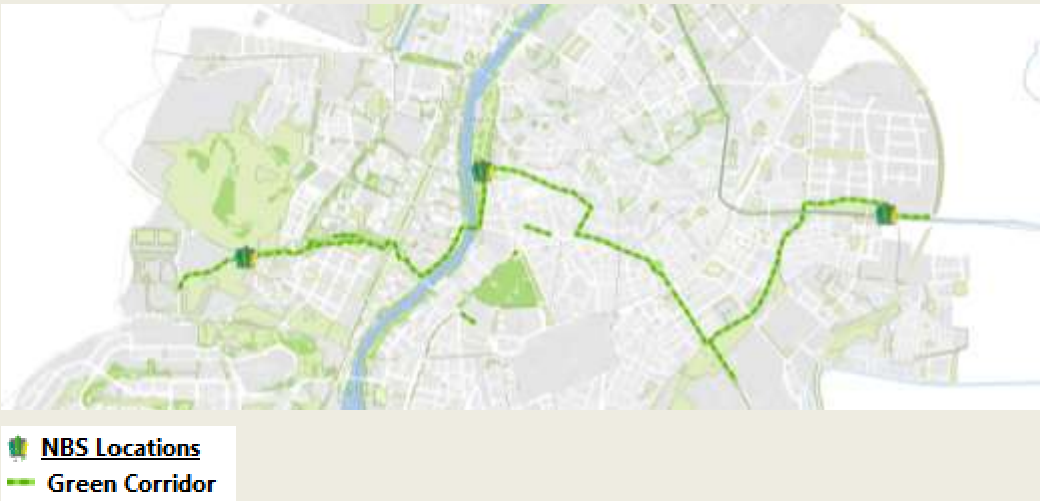
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0203 CH0206 CH0401 CH0403 CH0404 CH0405 CH0407 CH0408 CH0602 CH0702 CH0801 CH0902 CH0903	Vac6 Green resting areas	VAL/CAR
CITY	*DATE OF IMPLEMENTATION*	
VAL	April 2022	

1.3.1 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.



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.

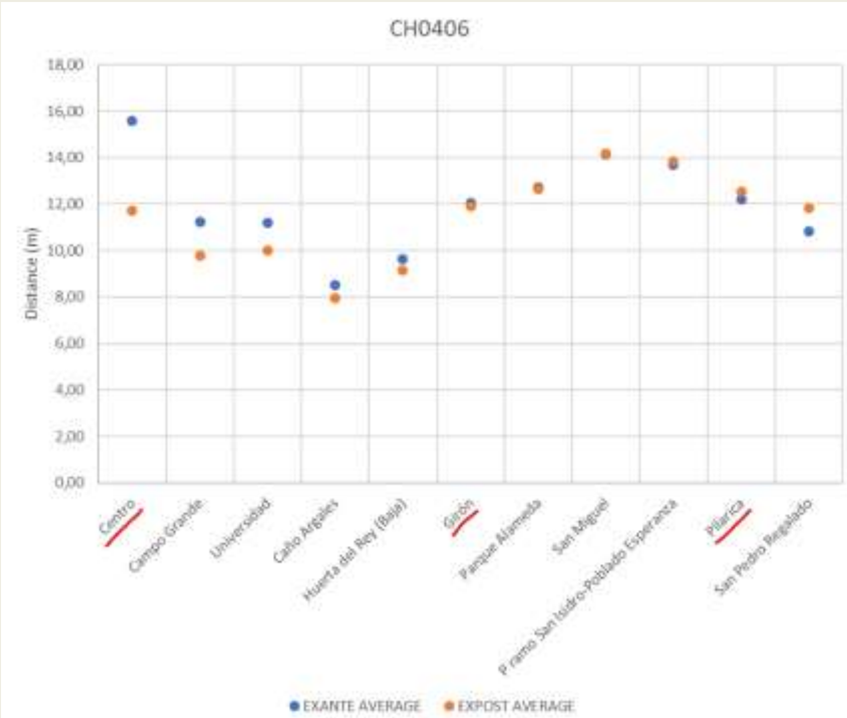
CH0401 Green Space Distribution (m2/capita)			
DISTRICTS	BASELINE	POST-INTERVENTION	INC (%)
Girón	124.96	125.38	<1%
Centro	19.75	19.86	<1%
Pilarica	13.09	21.56	64%

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.

1.3.2 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

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	

1.4.1 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, Quercus faginea, Quercus 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.

1.4.2 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.

1.4.3 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).

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	

1.5.1 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.

<u>Water management challenge:</u>

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.

<u>Green space management challenge</u>

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.

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.

1.5.2 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.

1.5.3 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.

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	

1.6.1 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.


<u>Water management challenge:</u>

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.

<u>Green space management challenge</u>

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.

1.6.2 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.

1.6.3 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.

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	

1.7.1 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.

1.7.2 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.

1.7.3 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.

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	

1.8.1 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.

1.8.2 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

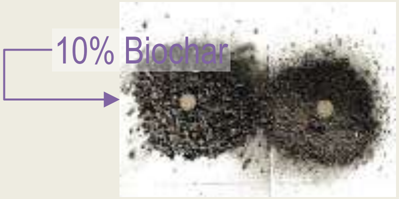
The European project does not finance maintenance.	The Valladolid City Council finances all maintenance actions.
Social barriers	How they have been addressed
Some citizens: Non-acceptance of uneven surfaces to reduce the speed	Educational activities
Environmental (including COVID)	How they have been addressed
Due to the COVID the implementation was delayed.	

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	

1.9.1 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

1.9.2 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. ▪ Large volumes of soil require a large storage area. ▪ 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)	▪ Schedule the supply with time in advance, so that the biochar can be bought and brought to Valladolid. ▪ 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) ▪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*

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

1.10.1 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.

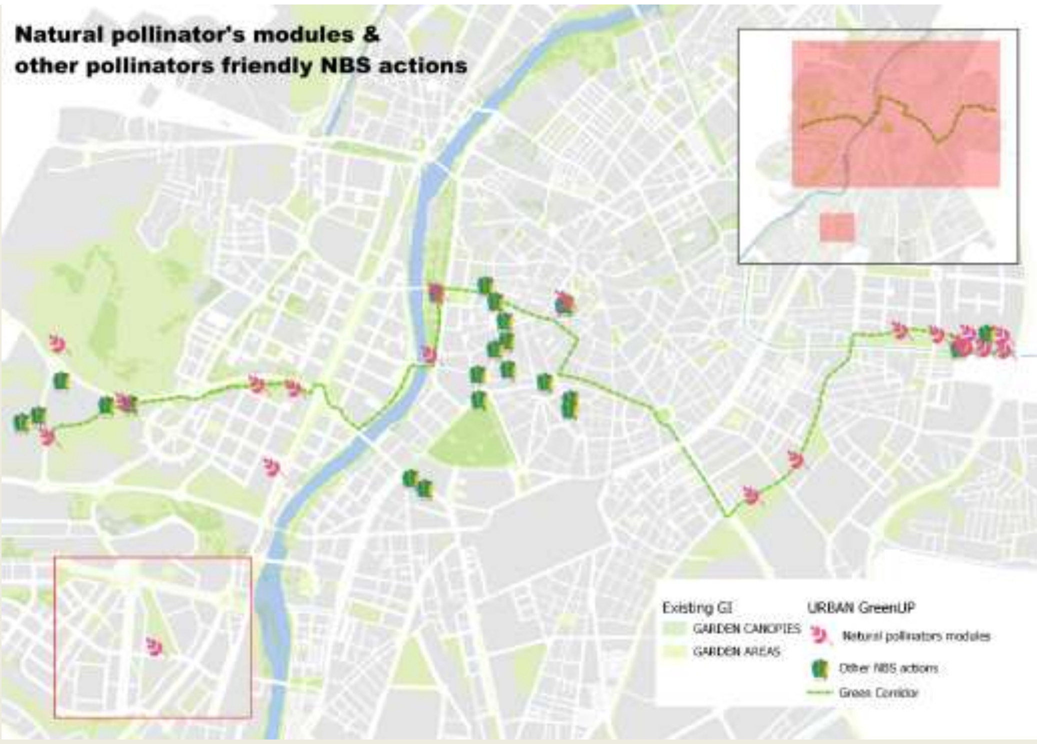


Figure 1.1. NPM location in the existing green urban areas, in relation to the Green Corridor line and other NBS actions.

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

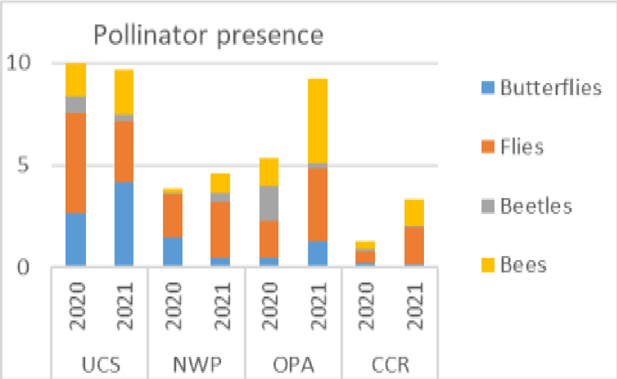


Figure 1.4. Pollinator presence average per year

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).

1.10.2 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	**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.

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.	**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 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.
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.

1.10.3 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.

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

1.11.1 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.

Compact Pollinator's Modules (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.

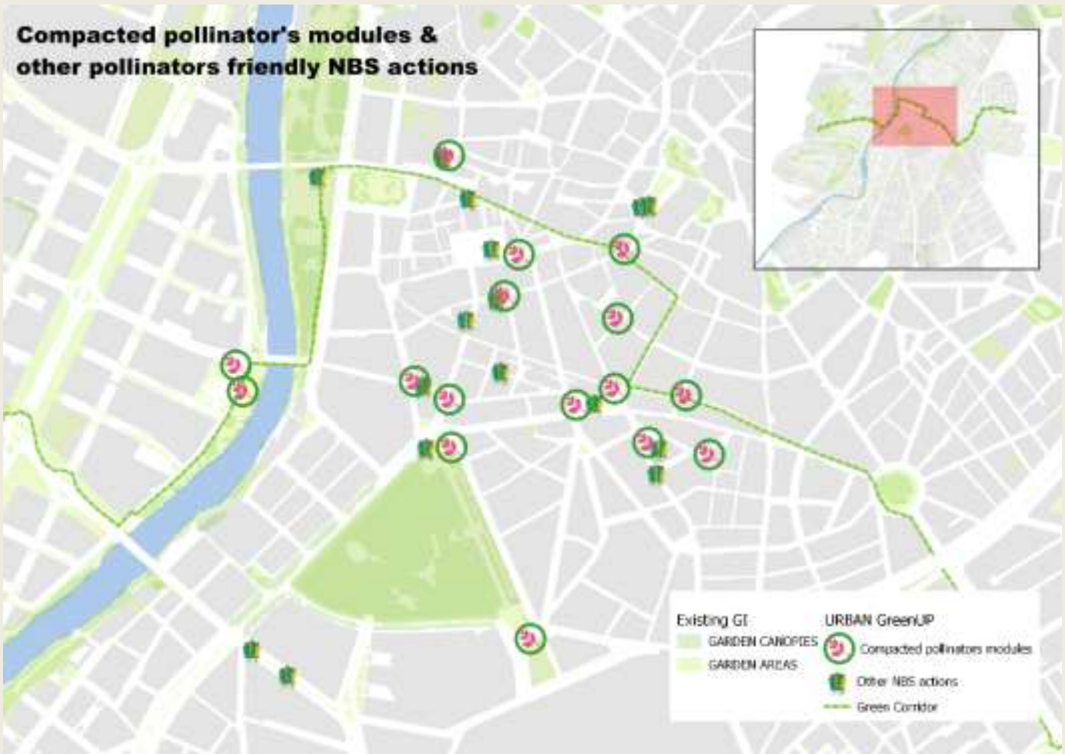


Figure 1.5. CPM location in the city centre in relation to the Green Corridor line and other NBS actions

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 1.7. 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).

1.11.2 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	**1. 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 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.	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 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

1.11.3 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.

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)	

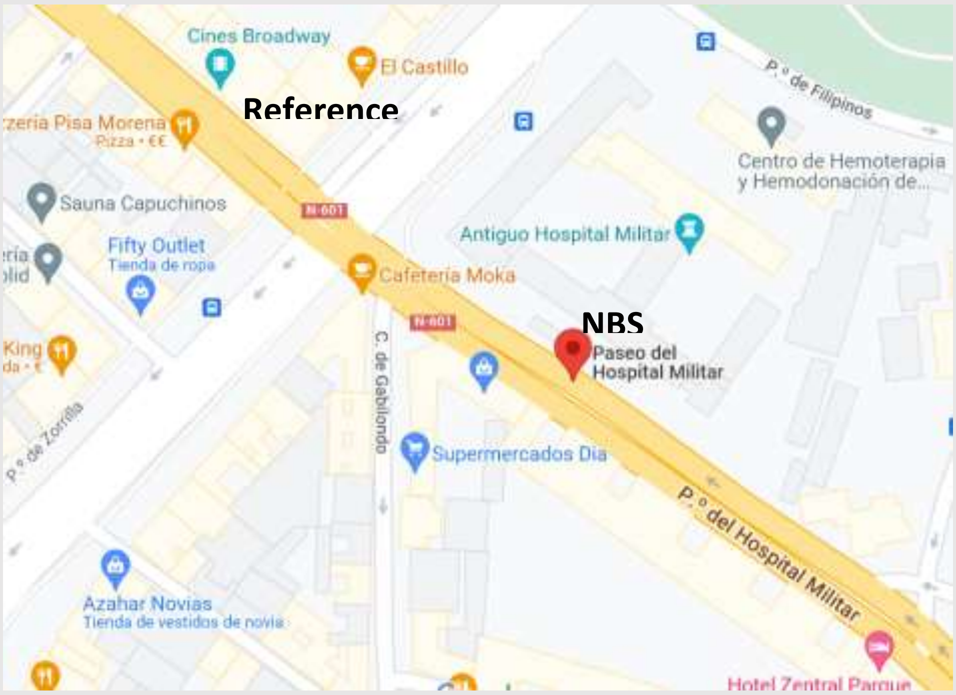
1.12.1 Results and Discussion

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.

1.12.2 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.

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)	

1.13.1 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.

1.13.2 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.

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)	

1.14.1 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, PM2,5 and PM10 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.

1.14.2 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.

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	

1.15.1 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 Total
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

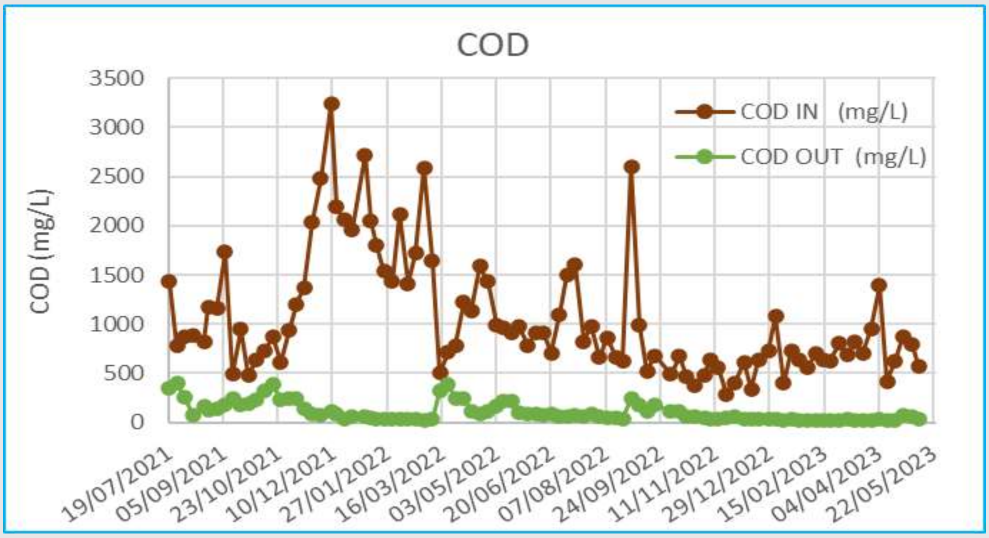
Results are expressed in kg NUTRIENT/year

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

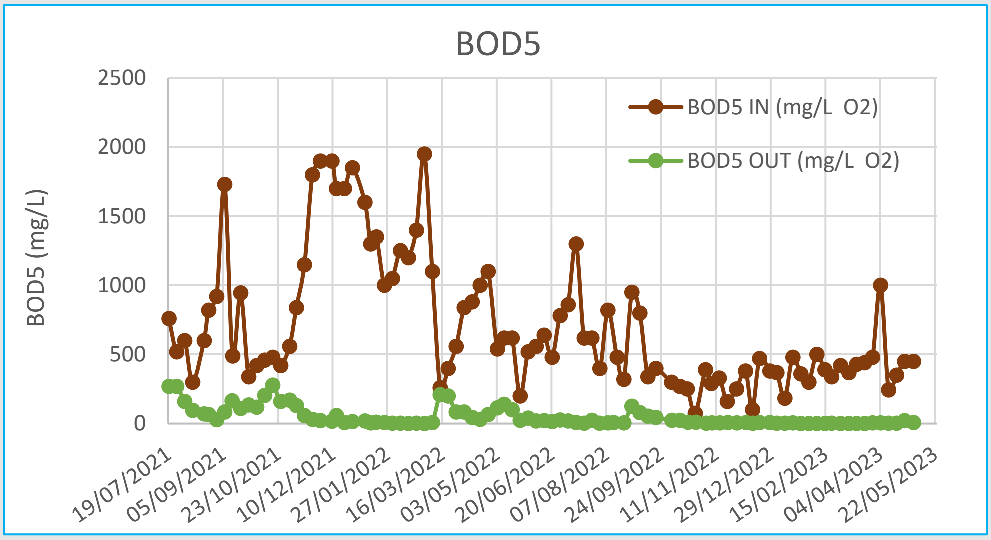
*Negative result due to a removal efficiency. To calculate result, the absolute value has been taken.

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.

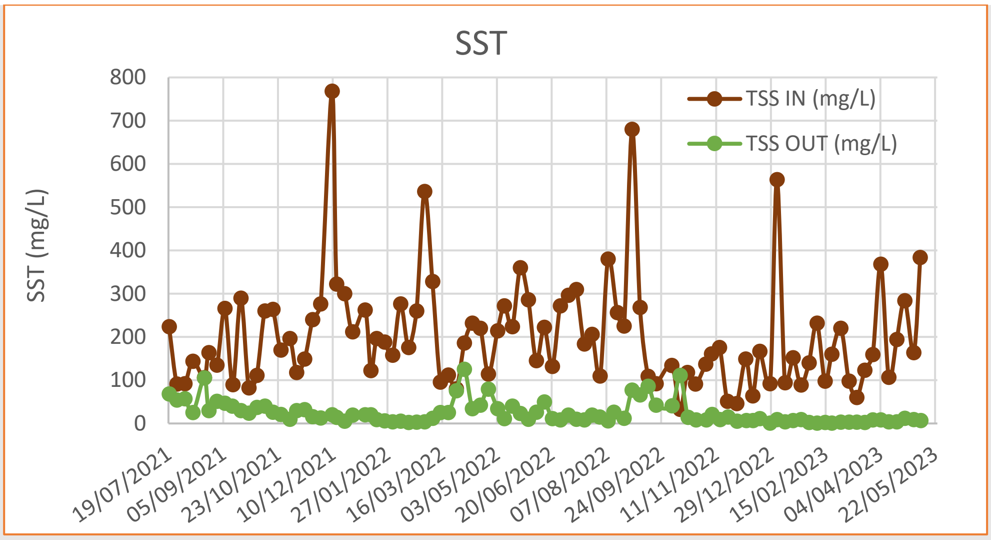
Evolution of COD degradation is being shown on the right, from the beginning of the implementation of electrowetland until now. We can see that COD was reduced by an average of 89%.



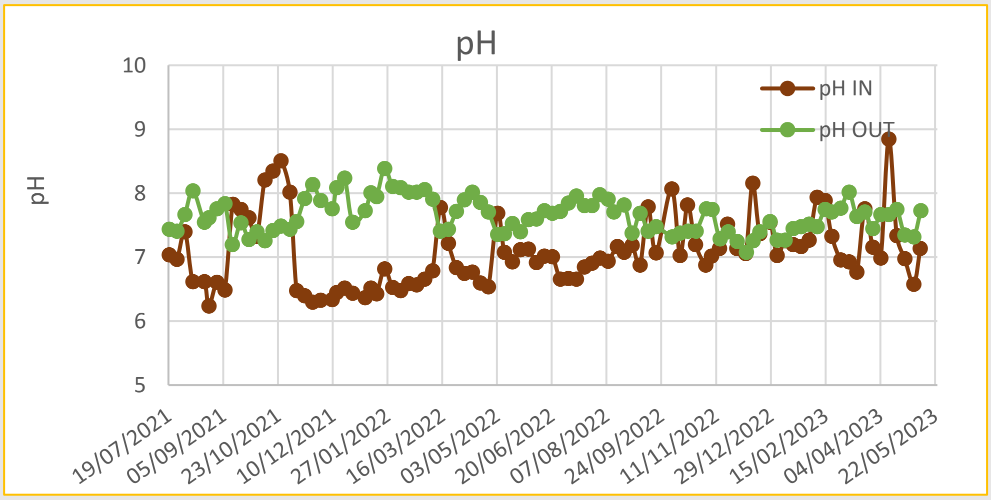
Evolution of BOD degradation is being shown on the left, from the beginning of the installation of electrowetland until now. BOD was reduced by 90.4%.

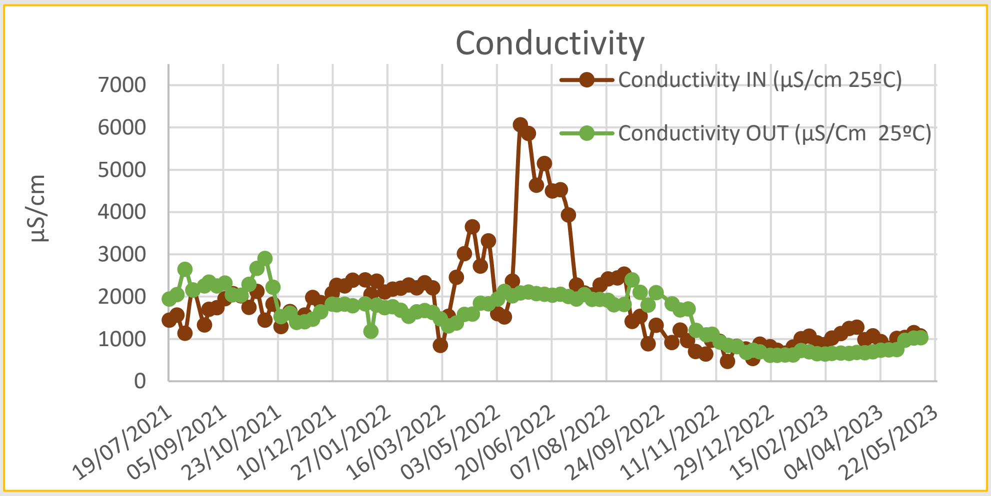


Evolution of SST reduction is being shown on the left, from the beginning of the installation of electrowetland until now. Total suspended Solids were reduced by 81%.

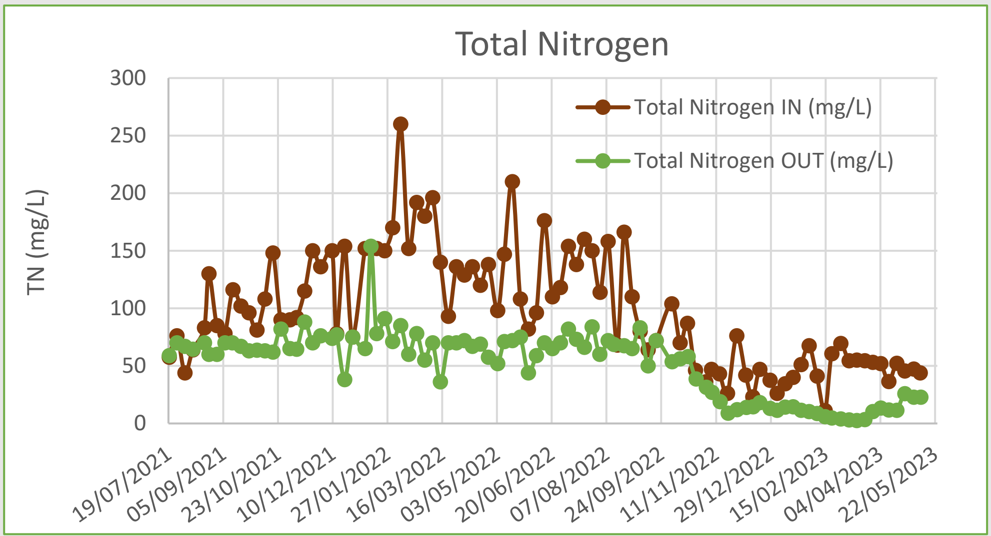


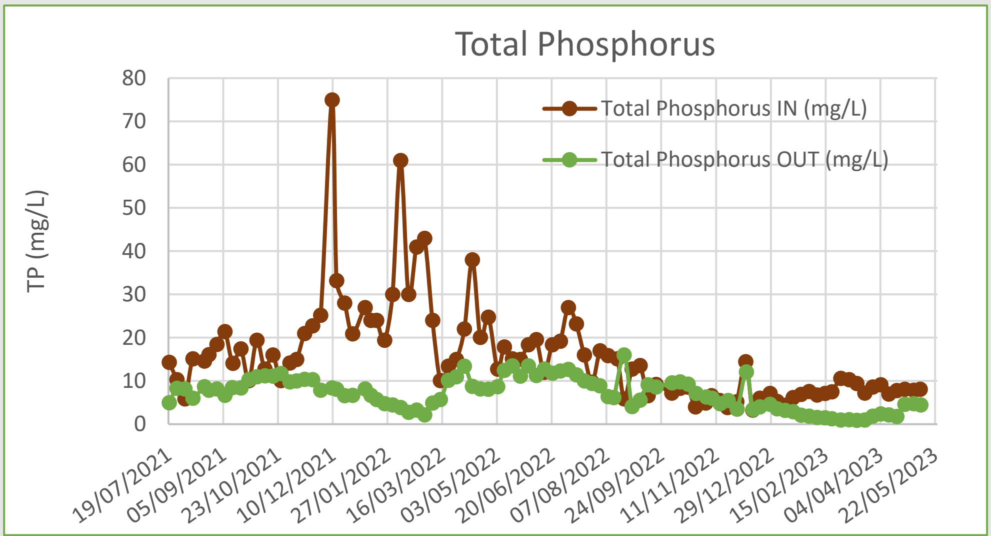
A part from the KPI, other parameters were monitorized (nutrients, pH and conductivity). Evolution of pH and Conductivity is being shown above. There is a tendency to stabilize pH and conductivity in the electrowetland effluent over time.





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.





1.15.2 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	Construction company fixed the problem.

band leaks	
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.

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)

1.16.1 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.

1.16.2 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.

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	15^{th} August 2020 (M39)	

1.17.1 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.

1.17.2 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.

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;	VAc29 Green Shady Structures	SGR

CH1003		
CITY	*DATE OF IMPLEMENTATION*	
VAL	26th February 2021 (M45)	

1.18.1 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, $PM_{2,5}$ and PM_{10} 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 $PM_{2,5}$ and PM_{10} 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.

1.18.2 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

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	

1.19.1 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 [1].

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[2] but with a limited impact at district or city

[1] 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.

[2] Grote et al., 2016. Functional traits of urban trees: air pollution mitigation potential. Front Ecol Environ 2016; doi:10.1002/fee.1426.

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 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.

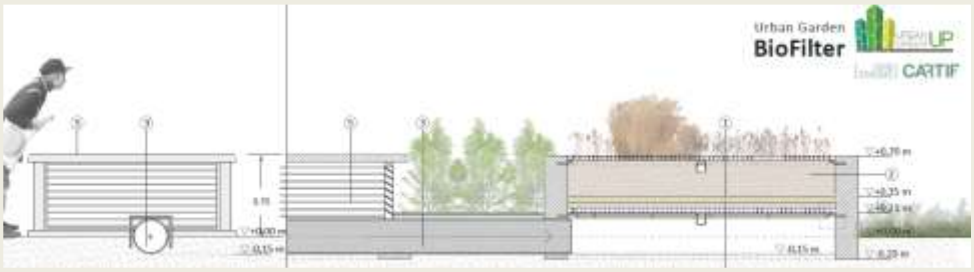
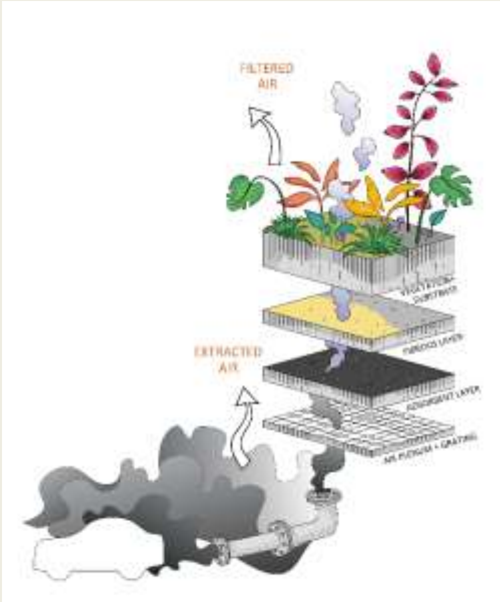


Figure 8. CARTIF. URBAN GreenUP Project. Biofilter cross section

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 **¡Error! No se encuentra el origen de la referencia.**) 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 1 for NO_X (NO and NO_2) and PM. Then, the annual amounts of PM, NO and NO_2 are calculated.

Table 1. Biofilter summary results.

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

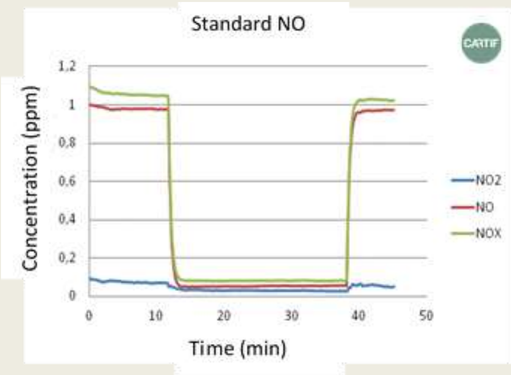


Figure 10. Standard lab test to removal evaluation of the NO by the biofilter.

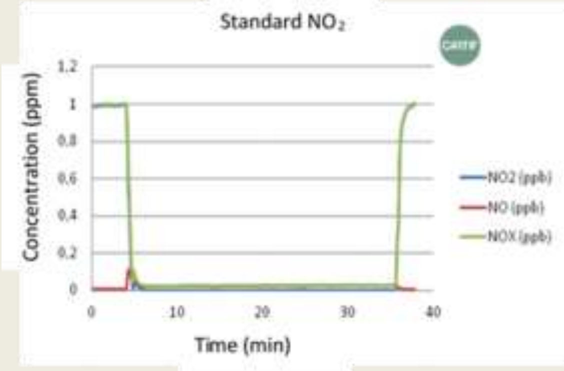


Figure 11. Standard lab test to removal evaluation of the NO by the biofilter.

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).

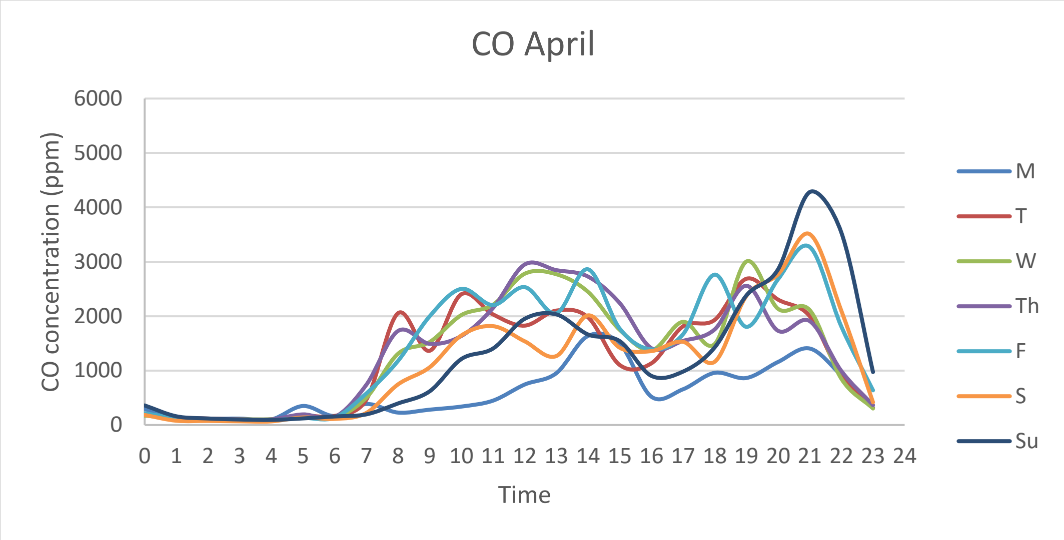


Figure 12. Evolution of the CO concentration through the days of the week in April 2021

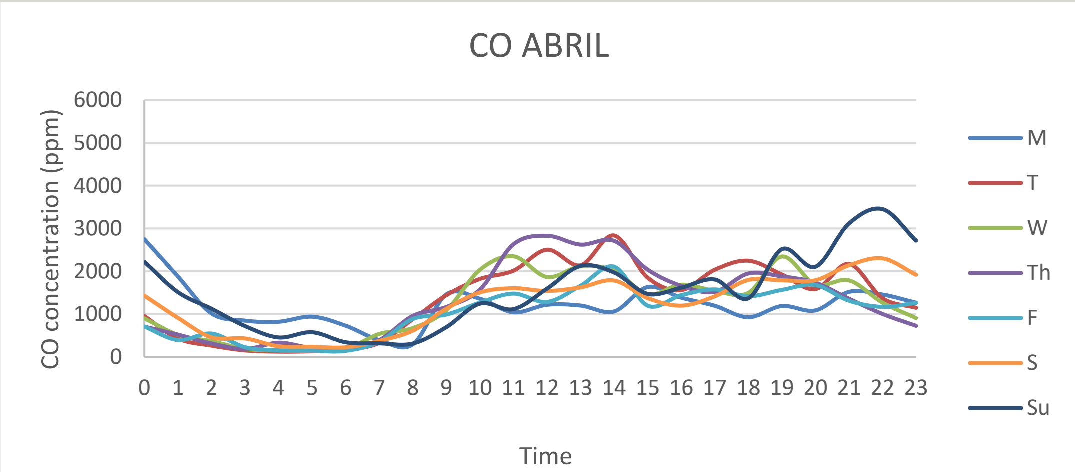


Figure 13. Evolution of the CO concentration through the days of the week in April 2022

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.

1.19.2 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. It is hard to measure and determine the impact of the biofilters filtering the air expelled by extraction systems of the indoor car parks. 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.	Increasing the efforts to carry out frequent visits to the car park and also, finally, changing the selected car park. 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.
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. Civil works to construct the biofilter implies a reduction in the income of the underground car park.	Results will be used to promote the installation of biofilter in the new underground car parks. 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.

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	

1.20.1 Results and Discussion

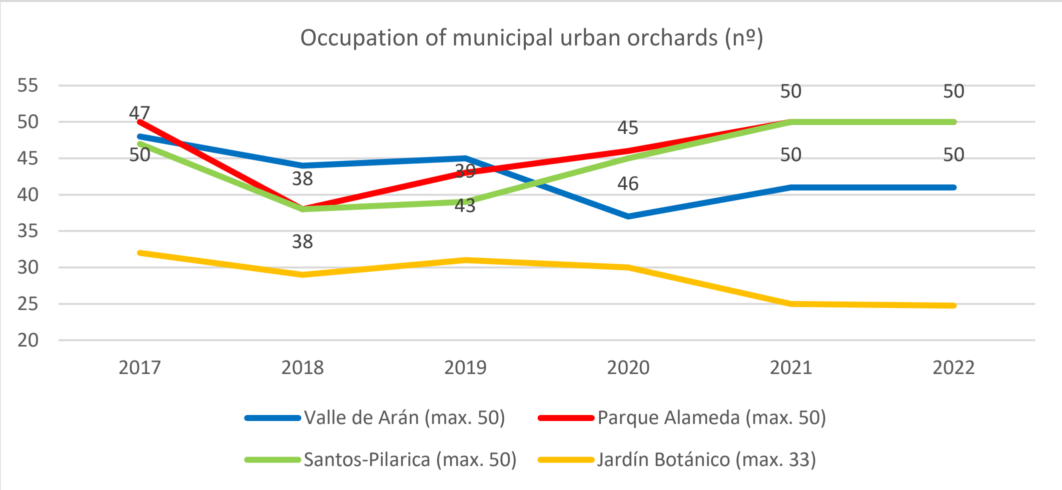
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

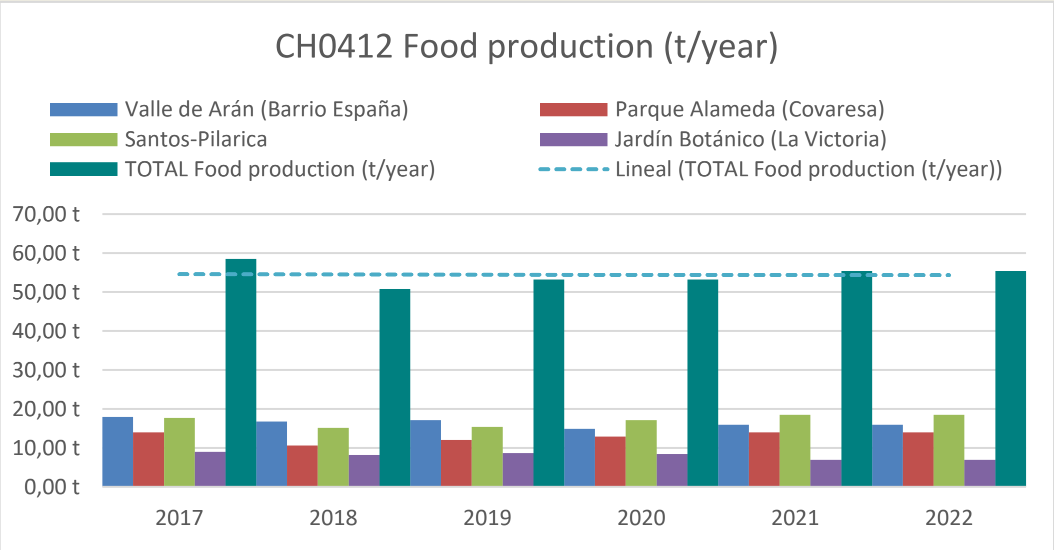
In Valladolid a network of urban orchards already exists in four different locations. These orchards are intended to produce organic fruits and vegetables that are primarily cultivated and consumed by vulnerable populations (such as the unemployed, retired, disabled, and people with special needs). The 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.

1.20.2 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*

1.21 VAc35 – Vac 42 Non-technical actions

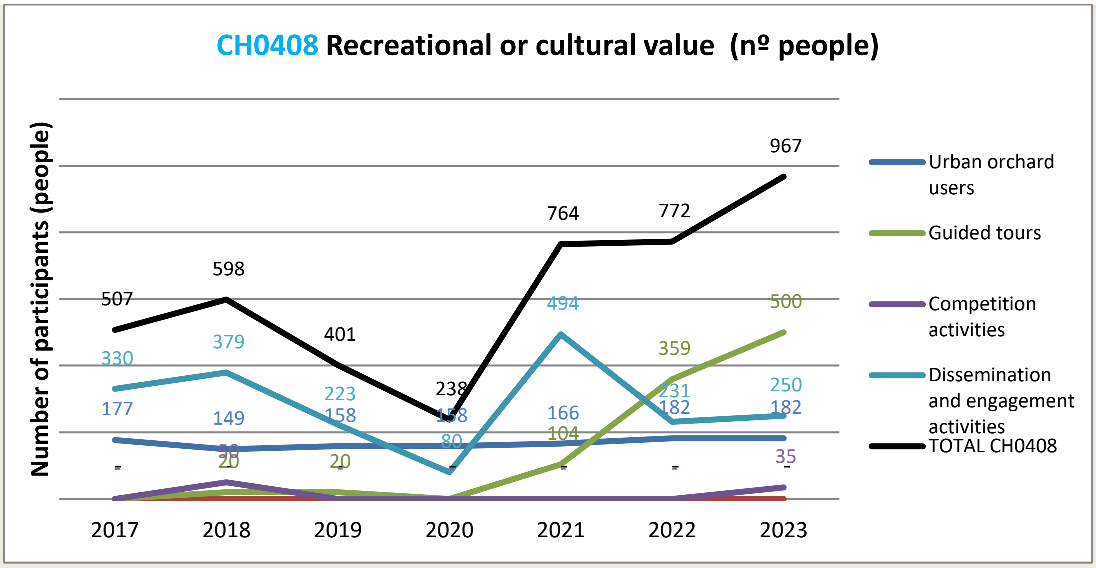
RELATED KPI CODE	*NBS NAMEs*	*PARTNER*
CH0406; CH0408; CH0602; CH0701; CH0702; CH0703; CH0802; CH0803;	VAc35 Educational path in floodable park area; VAc36 Urban Farming Educational activities; VAc37 Engagement Portal for citizen; VAc38 Sponsoring activities; VAc39 Promotion of ecological reasoning and 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	

1.21.1 Results and Discussion

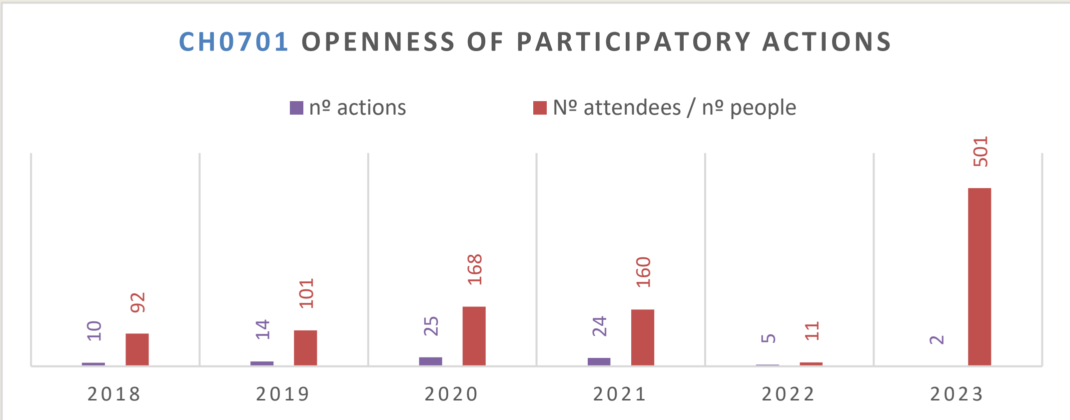
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

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.

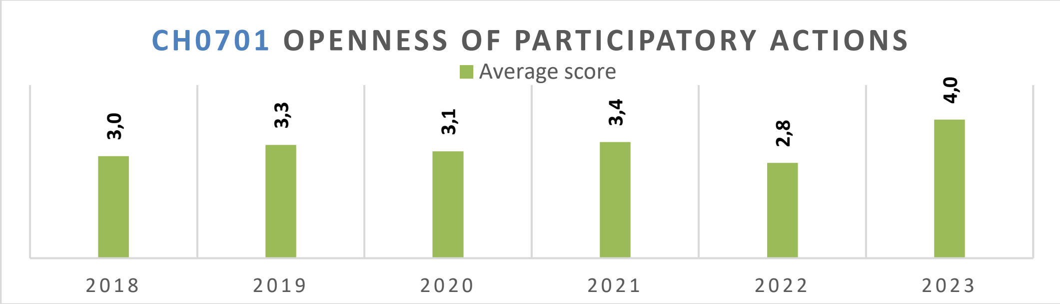


CH0701Openness of participatory processes: It is based on the participation actions delivered in the city of Valladolid. There are defined two steps, data collection and data evaluation: Step 1. Data collection and characterization: we complete a database completing the Participation techniques, Degrees 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)

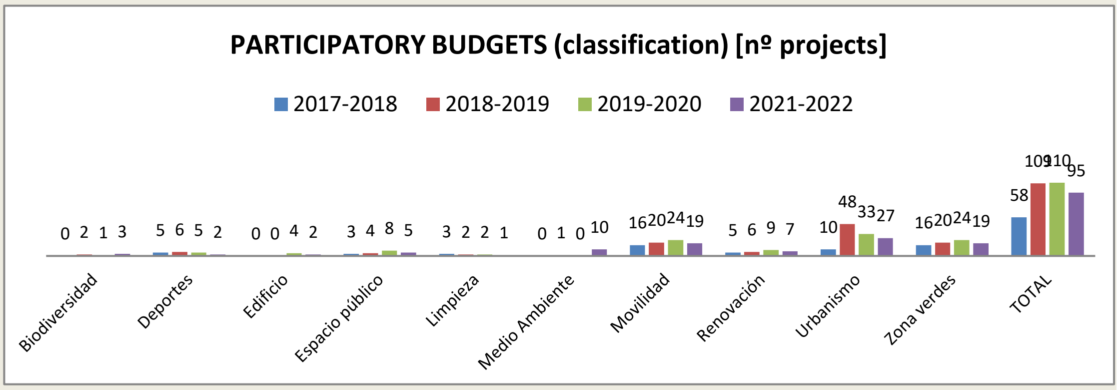


The number of attendees increased a lot in 2023 due to the organization of the “Walks for Innovation”, focused on scholars and senior people.

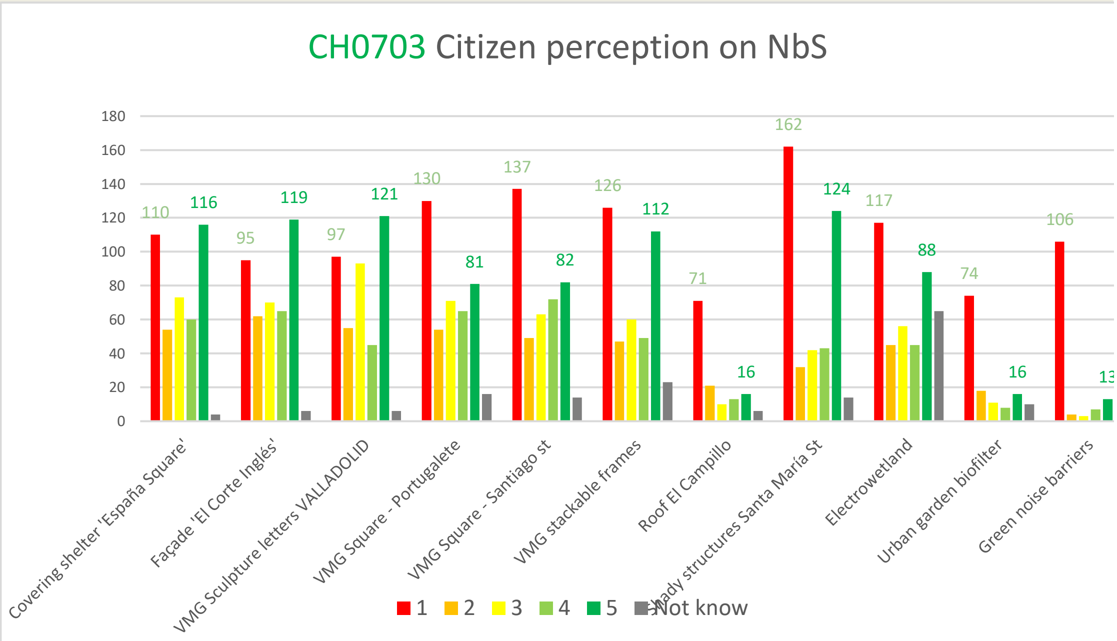
The following table shows that the average score of the openness of the participatory actions has increased to an average of 4 points in 2023.



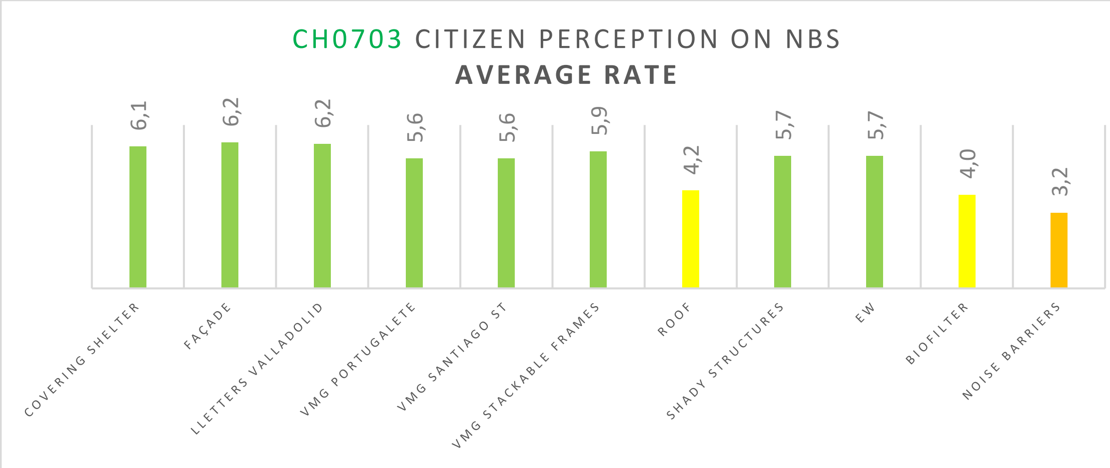
According to the participative budgets, the following chart shows that the most common areas that the citizens are asking for investment are Urban planning (*urbanismo*) and Green areas (*zonas verdes*).



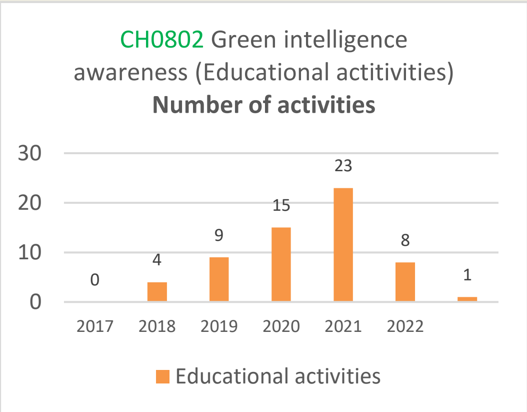
CH0703 Citizen perception: There were launched a survey about the perception and opinion of the citizens on the NbS implemented with the URBAN GreenUP project (2021-2022) [online survey fulfilled by almost 300 inhabitantes]. A likert scale (0-5) shows that the NbS are scored with 1 point or 5 points mostly. Innovative NbS solutions are either loved or disliked.

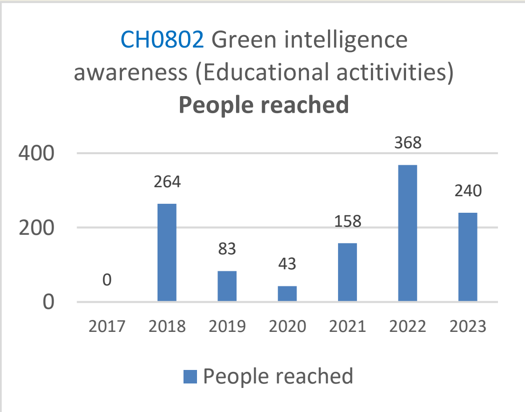


On average rate, citizen perception is 5,30 / 10 (Good perception). We have verified that recently implemented solutions are less liked than when the solutions take longer: that is, citizens reject the new but later they get used to it and like it.

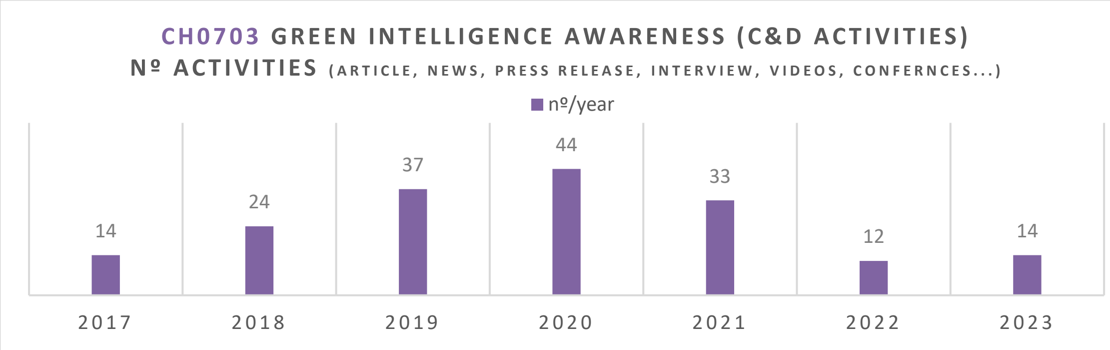


CH0802Green intelligence awareness (Educational activities): Altough the number of in situ activities has been lower due to the Covid 2019 pandemic, the people reached has been increasing, specially before pandemic. However, in 2022 and 2023 a consistent number of people were reached again.

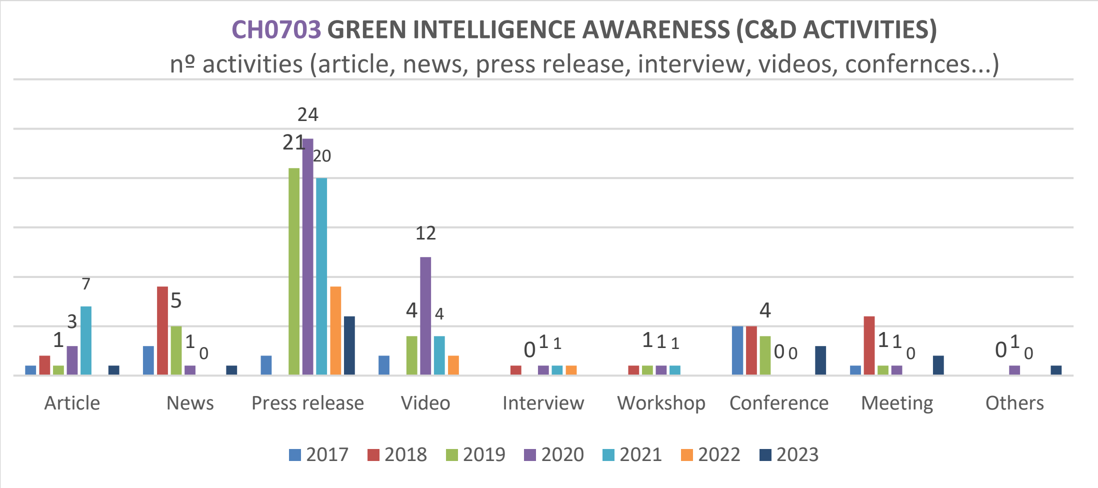




CH0803Green intelligence awareness (Communication and Dissemination activities): Communication actions have been constant throughout the project, with an increase in 2020-2021 of the number of activities (press release, articles, news, interviews, videos, etc) due to the years of full implementation of the solutions.



The following chart illustrates the type of communication and dissemination activities.



1.21.2 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

1.21.3 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 Liverpool

2.1 Lac1 Cycle and pedestrian route

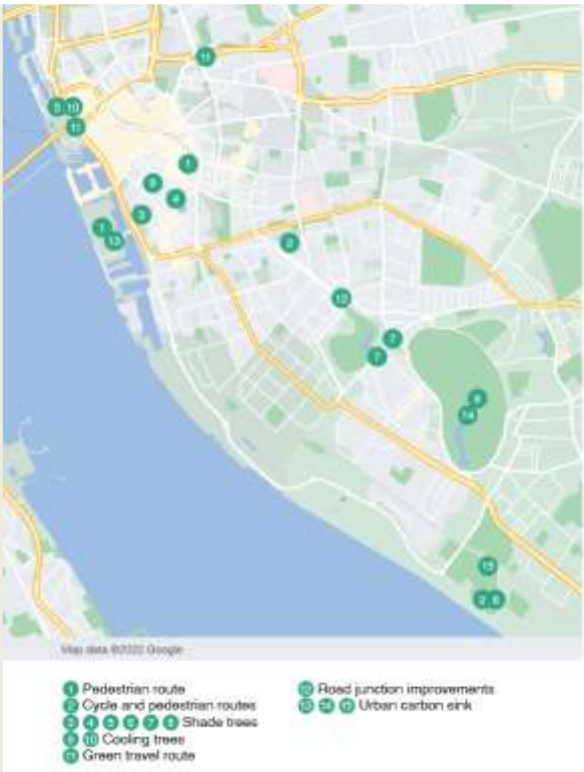
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0106; CH0108; CH0111; CH0403; CH0404; CH0501; CH0502; CH0503:CH0504; CH0505; CH0508; CH0509; CH0511; CH0512; CH0508; CH0602; CH0702; CH0705; CH0801; CH0902; CH0903; CH0904; CH1002; CH1004; CH1005;	Cycle and pedestrian route LAc1	LIV/UoL/CFT

CITY	*DATE OF IMPLEMENTATION*
LIV	Completion of all works July 2020

2.1.1 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



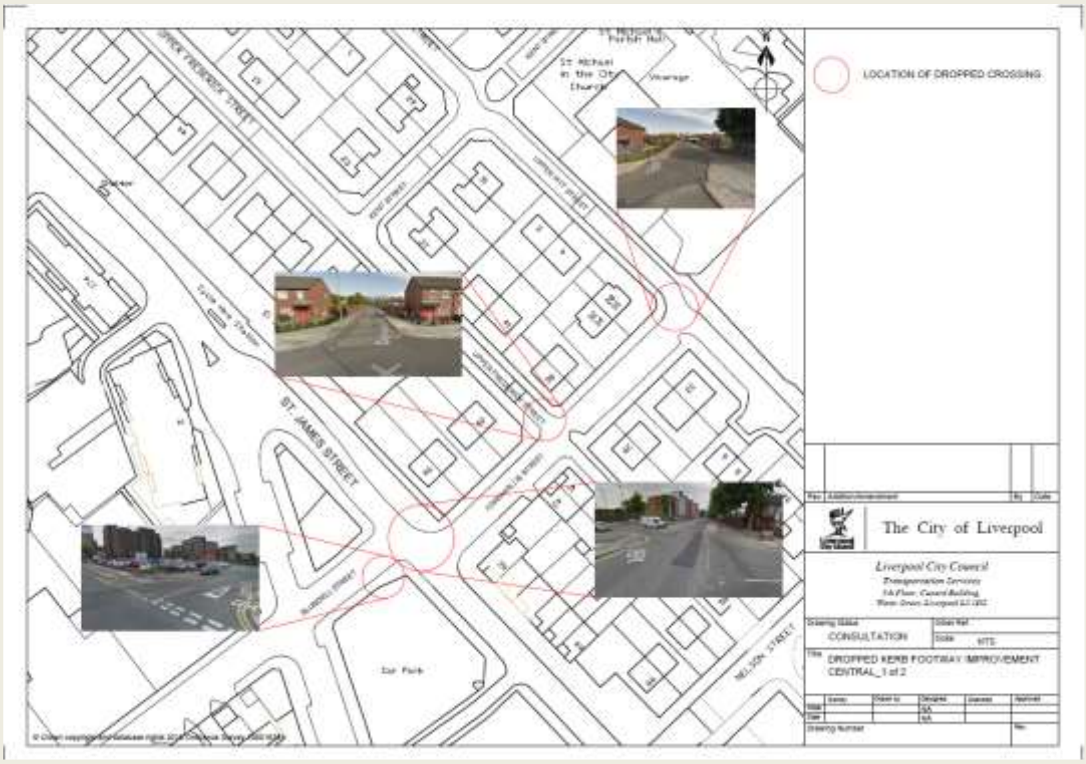
Traffic count methodology equipment:

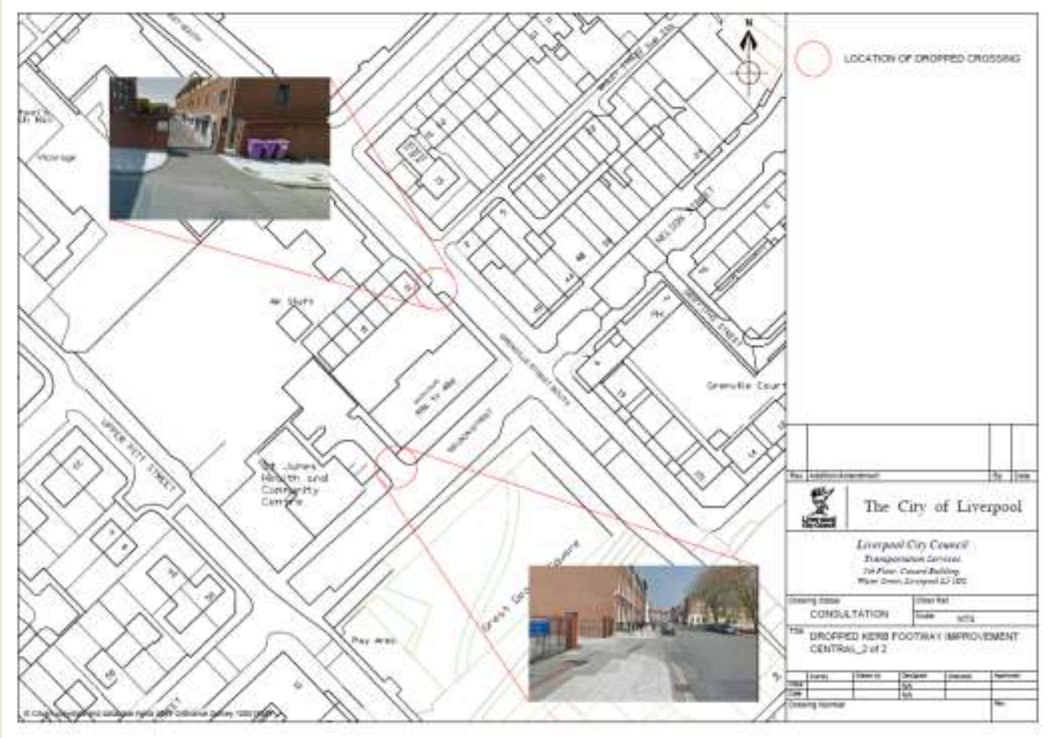
Demo A – Pedestrian routes

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.





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

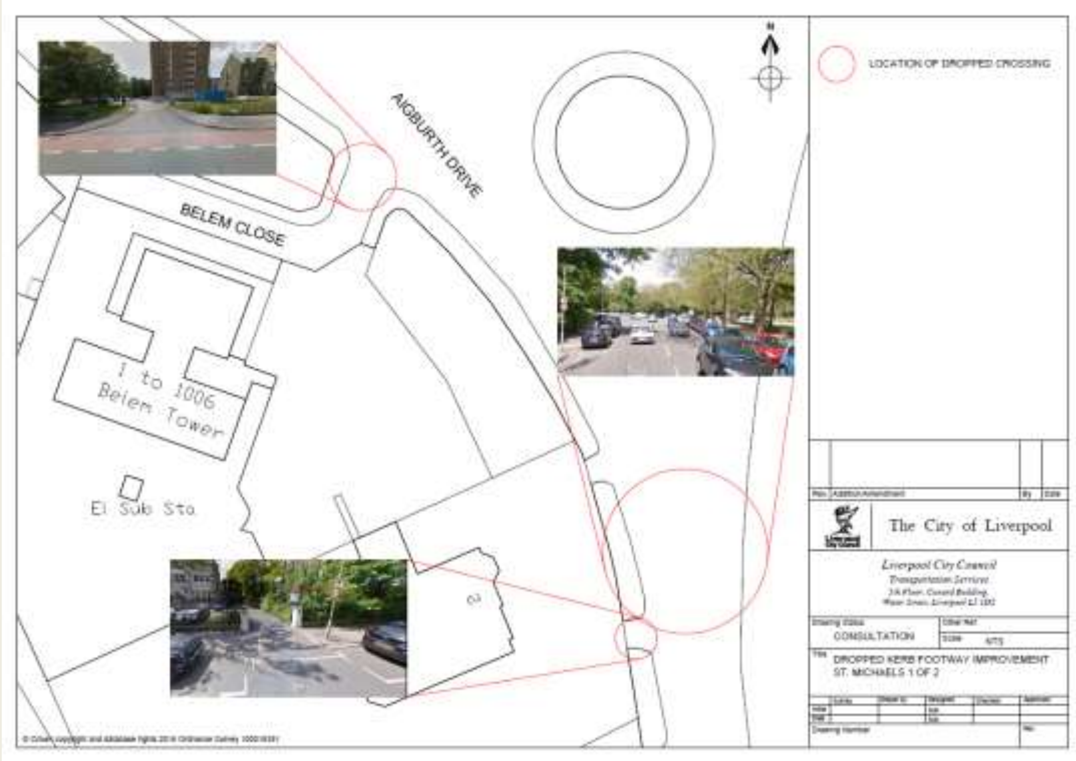







Above and left: Variety of dropped kerbs and road resurfacing works to create the cycle and pedestrian route from Princes Avenue to Otterspool promenade.

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

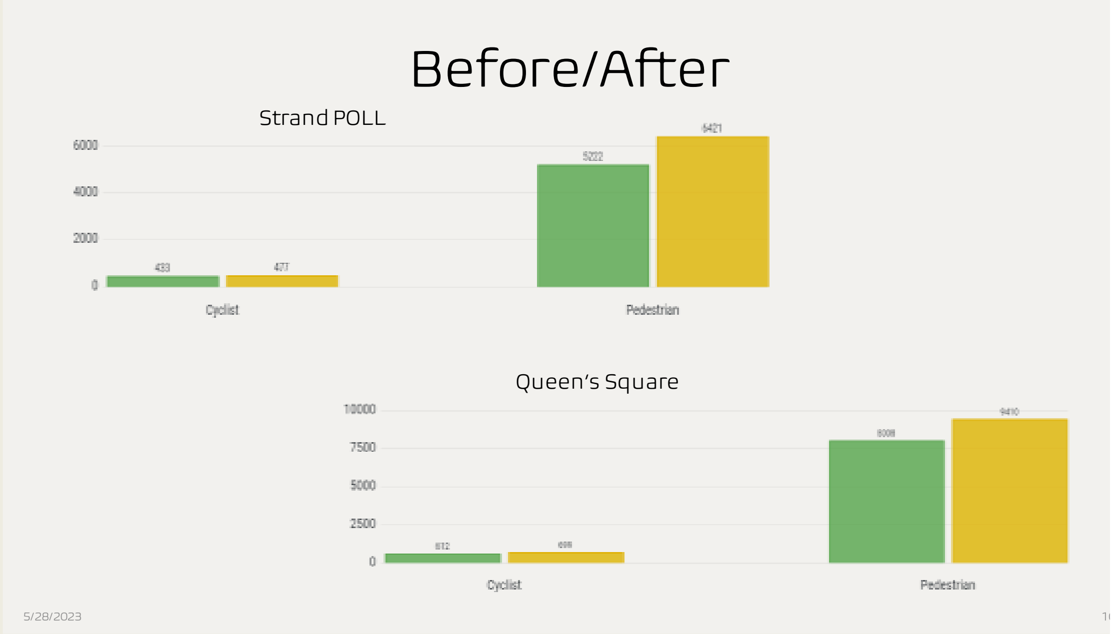
LAc12	Strand POLL	620	1	778.1	457.1	159	1	737.7	360.6	-5.2	4
LAc12	Ullet Rd POLL	411	1	1536.0	483.0	368	1	1433.0	441.8	-6.7	5
LAc1	Green_Route_ 1	2337	3	683.1	408.4						

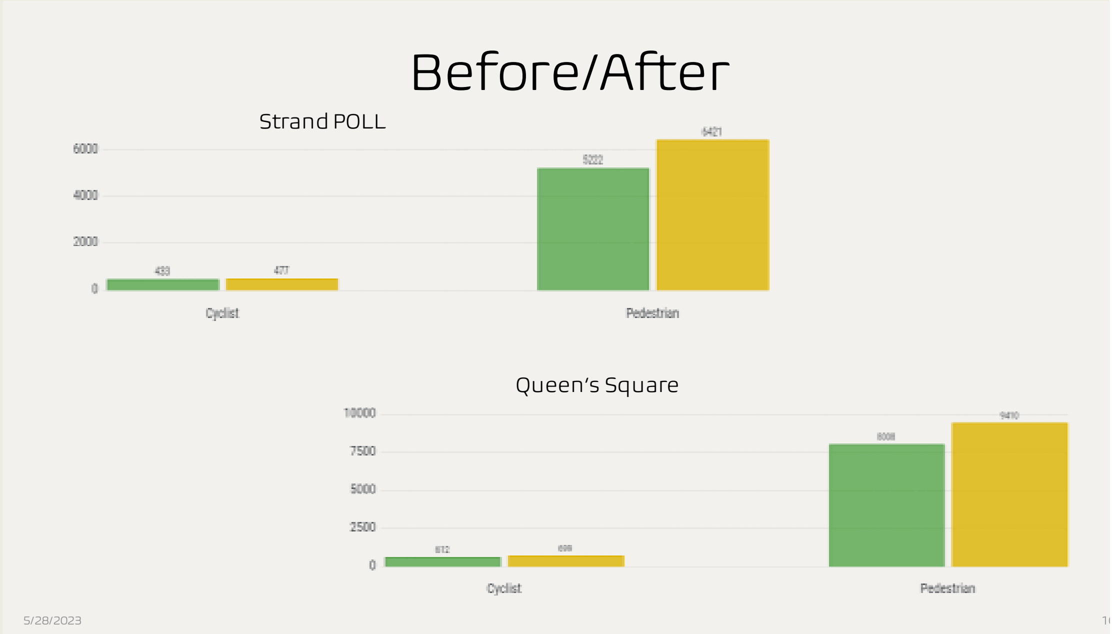
QUANTITATIVE DATA SUMMARY			
CH0903: Cycling			
NBS	**NBS Name**	**% Change**	**Rank**
LAc5	shade trees	86.1	1
LAc6	cooling trees	86.1	1
LAc12	Pollinator verges and spaces	-5.7	2
LAc1	Green Travel Route		

QUANTITATIVE DATA SUMMARY											
CH0903: Cycling		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_site s**	**estimate**	**sd**	**n_obs**	**n_site s**	**estimate**	**sd**	**% Change**	**Rank**
LAc5	Shade_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	1
LAc6	Cooling_TREE S	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.

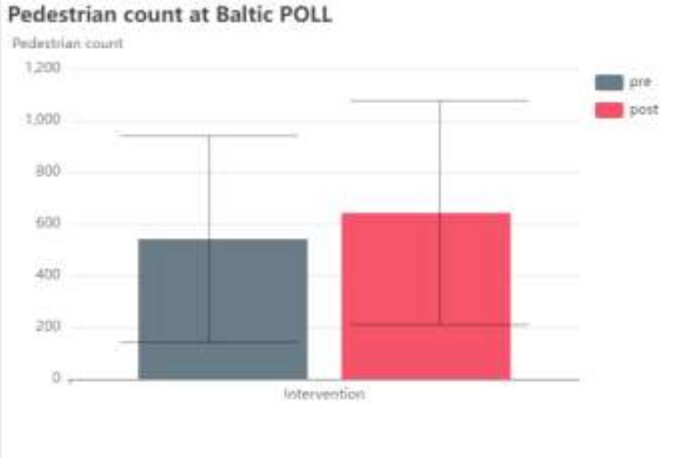
The plots below show the differences pre- and post- interventions for pedestrians and cyclists at different sites. As can be observed, the levels of pedestrians, in particular, seem to increase after the interventions are introduced.

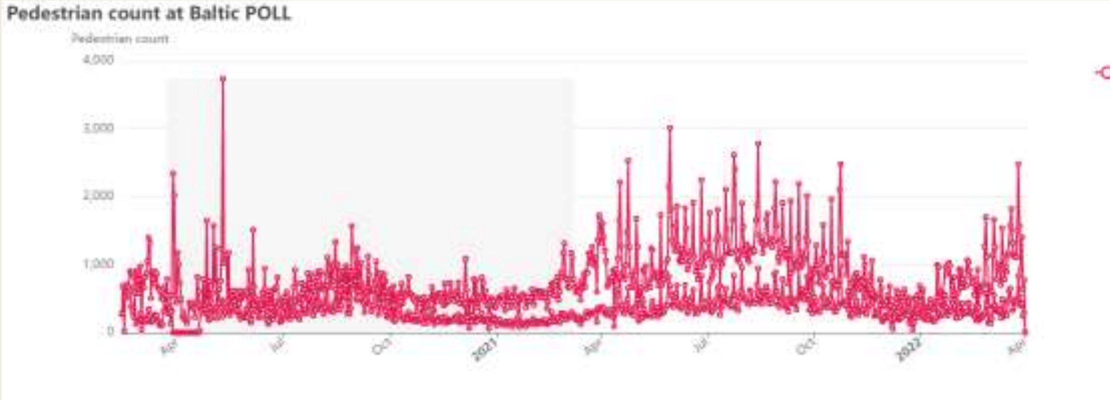




Further plots can be found for different interventions on the Liverpool portal.

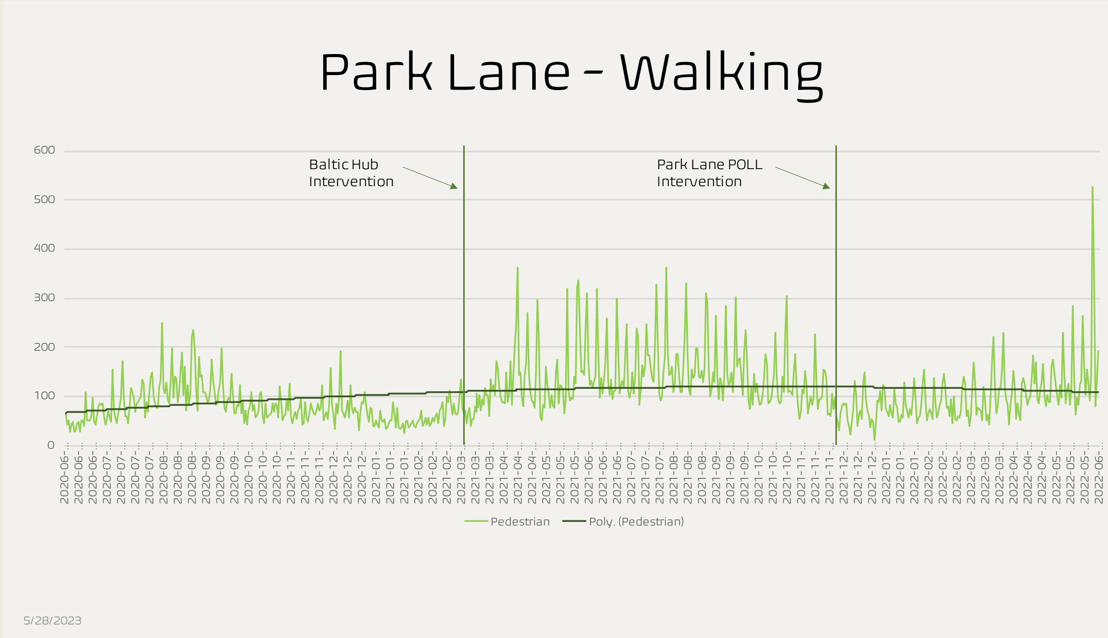
Example plot for pedestrians in Sub Demo A: Baltic green route: Box plot of pre- and post-data; Time line of data (shaded area showing Covid Lockdown):

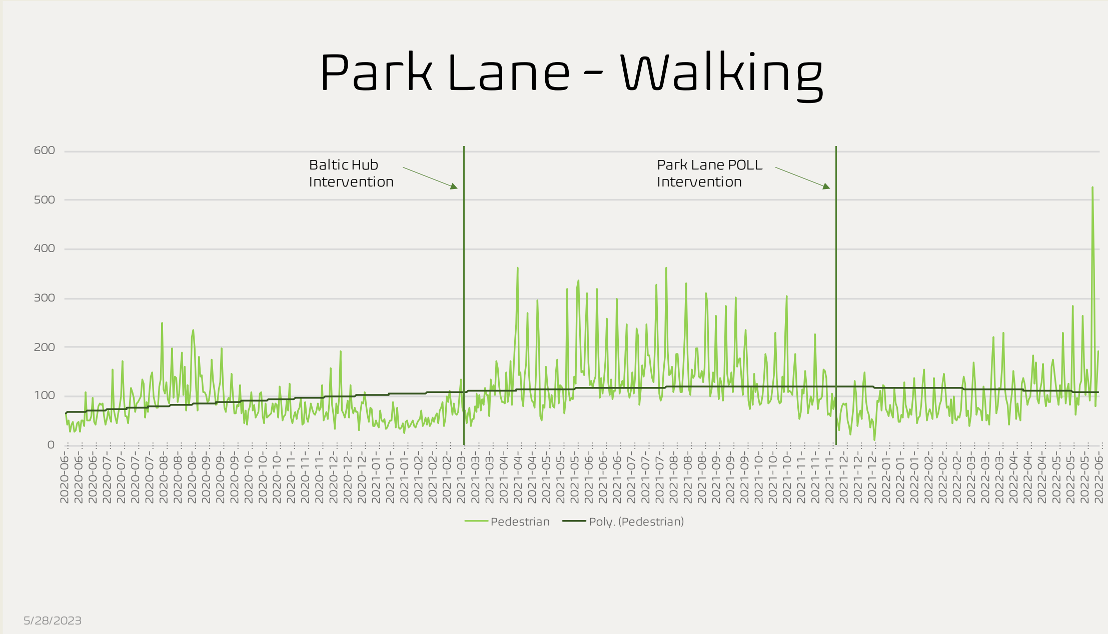




The timeline for the Vivacity data (example plot from the Baltic sub demo A Green Route) shows the depression in numbers with lockdown (grey background) and seasonal effects. The box plot demonstrates a slight increase after the interventions were added for pedestrians. Further analyses may help to determine if any particular interventions made a difference to the walking levels.

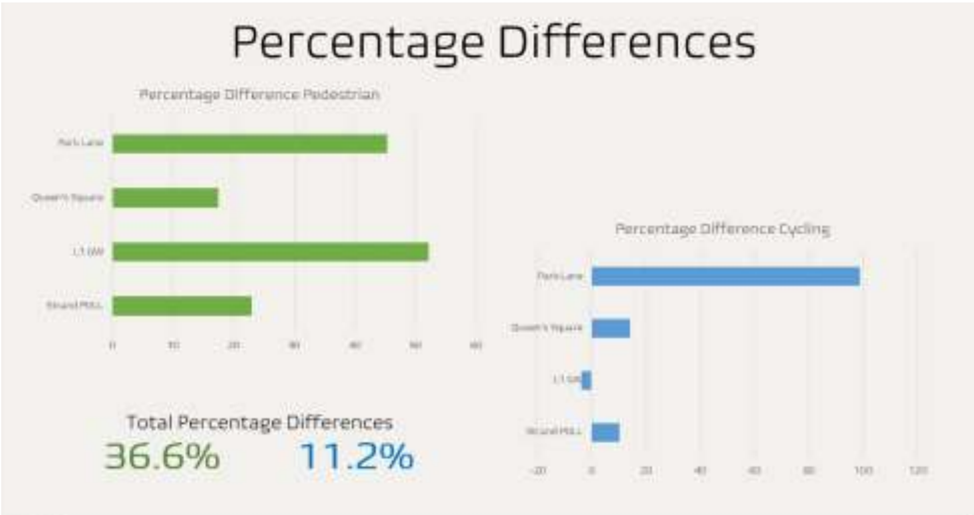
Further example plots for sites with the Baltic sub demo area showing the time line when interventions were introduced for walking and cycling levels:





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.

2.1.2 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

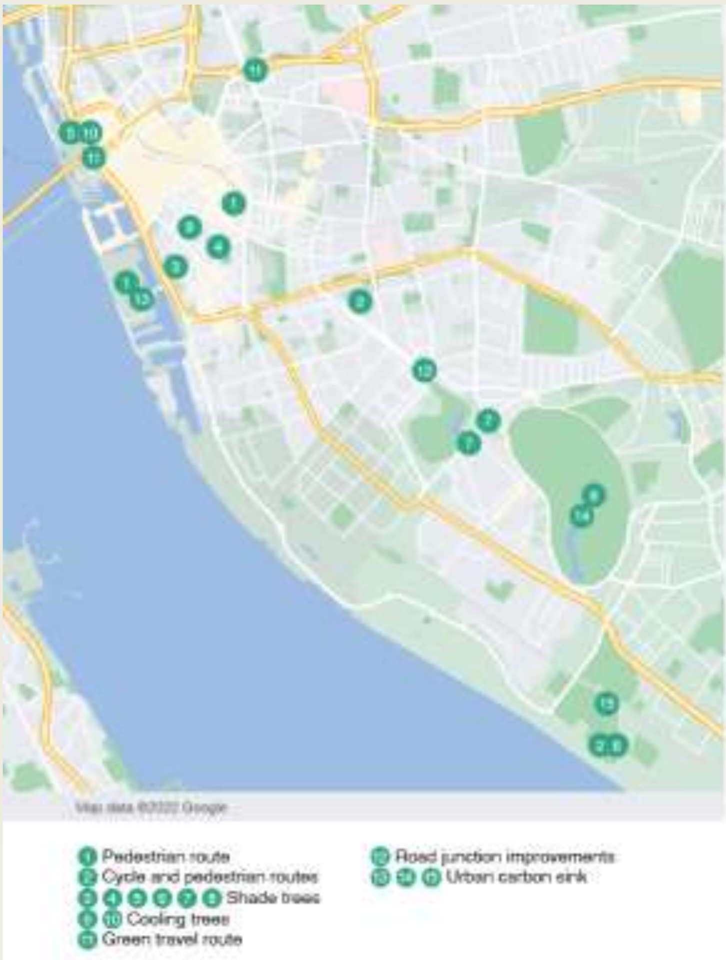
2.2 Lac2 Green Travel route

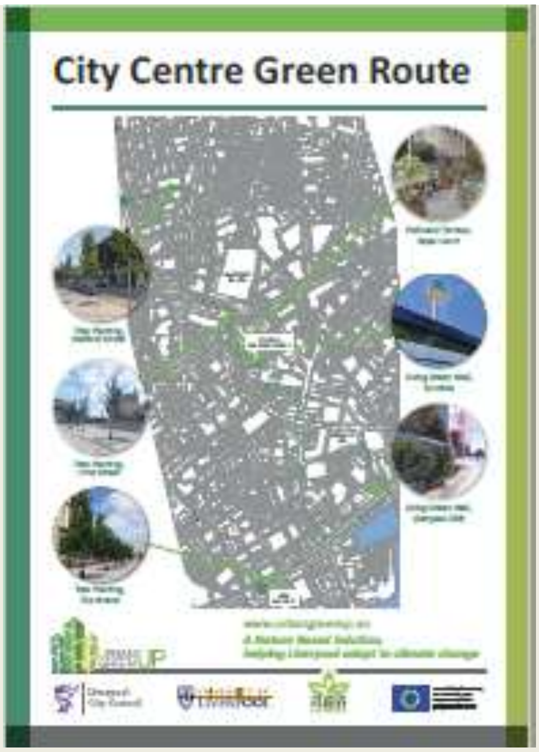
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0111; CH0403; CH0404; CH0501; CH0502; CH0503:CH0504; CH0505; CH0508; CH0509; CH0511; CH0512; CH0508; CH0602; CH0702; CH0705; CH0801; CH0902; CH0903; CH0904; CH1002; CH1004; CH1005;	Green Travel route LAc2	LIV/ UoL/ CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	All works completed July 2020 Final signage completed March 2023	

2.2.1 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.

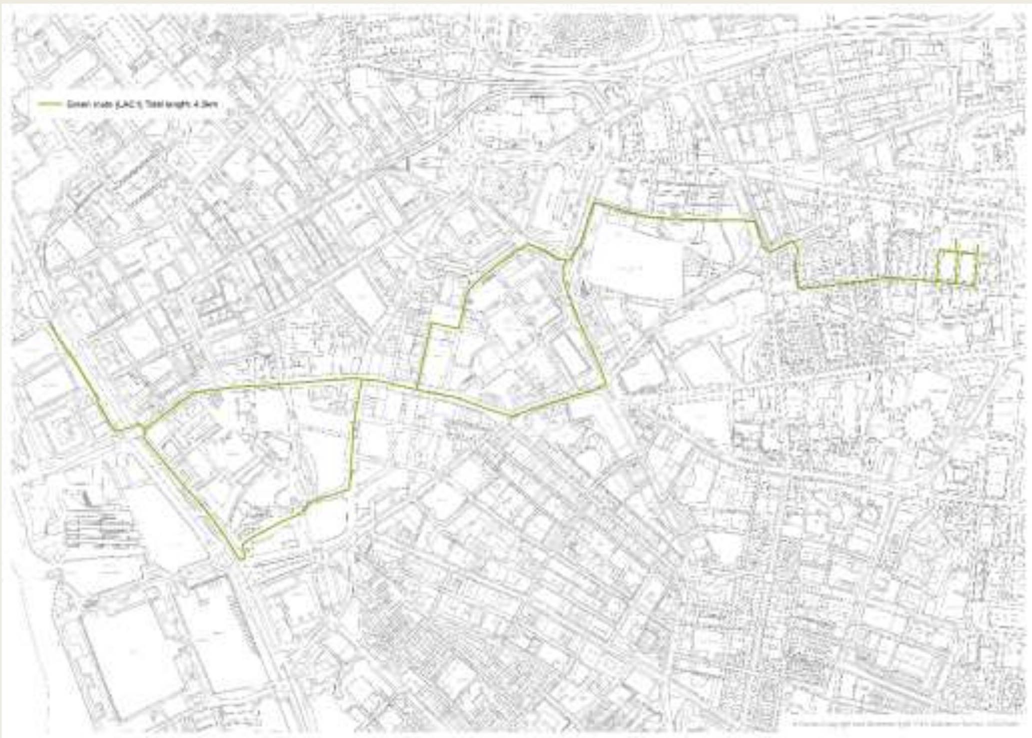
Demo B Green Travel Route – Location



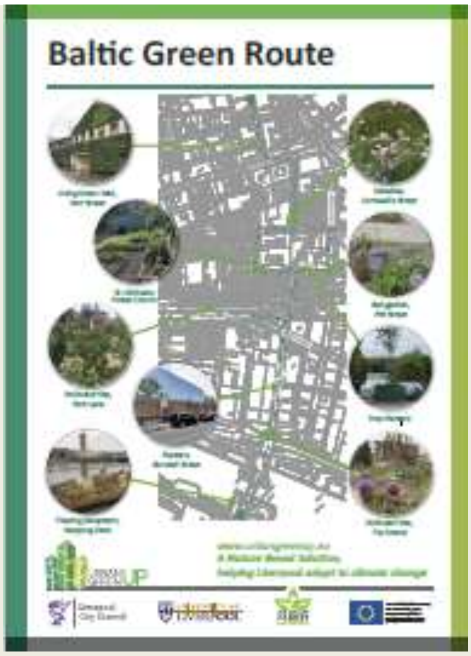


The green travel route is located between numbers 11 to 11 on the above map but is not a linear route. The route links areas of new development to the Business Improvement District area and uses existing green infrastructure and the URBAN GreenUP interventions. It is being promoted through UoL to students. 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						

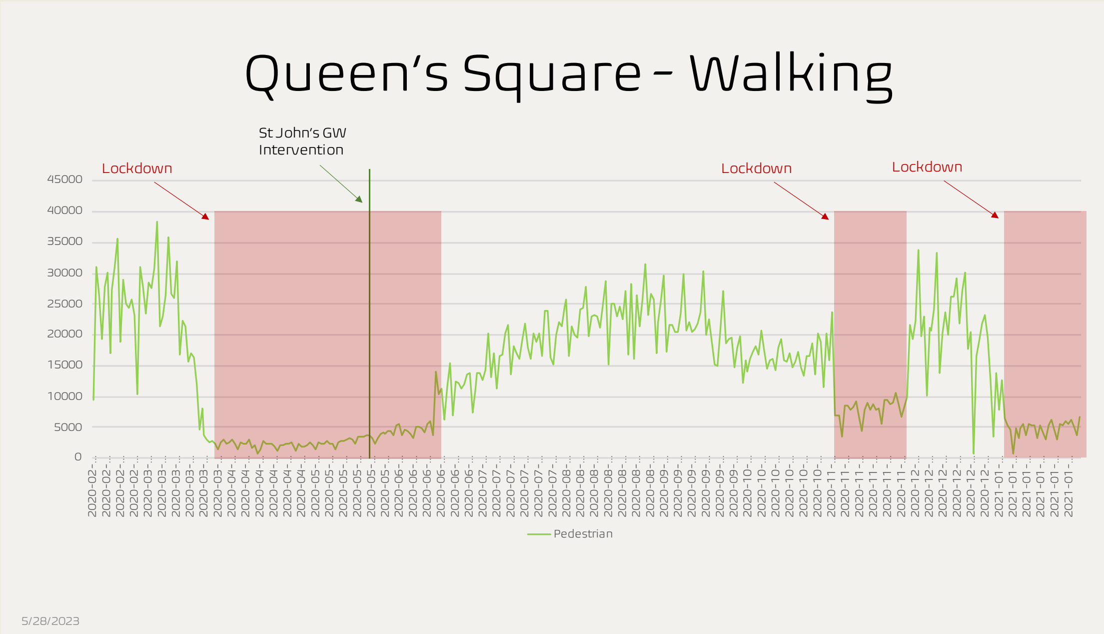
QUANTITATIVE DATA SUMMARY			
CH0903: Cycling			
NBS	**NBS Name**	**% Change**	**Rank**
LAc5	shade trees	86.1	1
LAc6	cooling trees	86.1	1
LAc12	Pollinator verges and spaces	-5.7	2
LAc1	Green Travel Route		

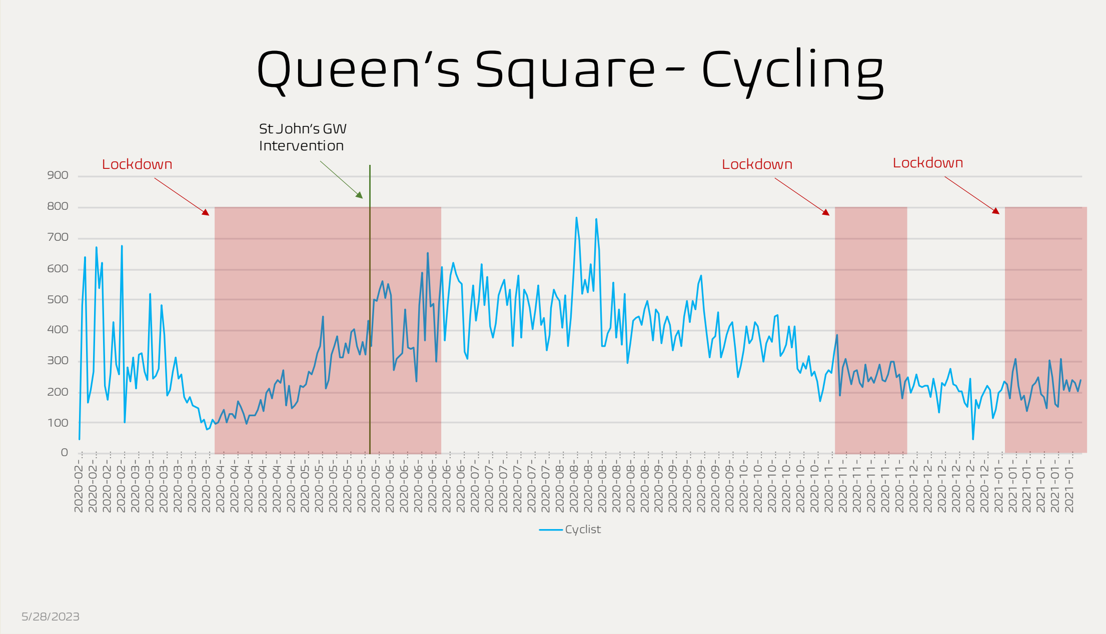
QUANTITATIVE DATA SUMMARY											
CH0903: Cycling		**Pre-Intervention**				**Post-Intervention**				**% Change**	
NBS	**inter_code**	**n_obs**	**n_sites**	**estimate**	**sd**	**n_obs**	**n_sites**	**estimate**	**sd**	**% Change**	**Rank**
LAc5	Shade_TREES	17	1	39.1	14.2	762	1	72.8	41.4	86.1	1
LAc6	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.

2.2.2 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	Temporary signage in place (but is frequently removed) Delayed works.

as it cannot be produced until all the NBS are in situ. 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.

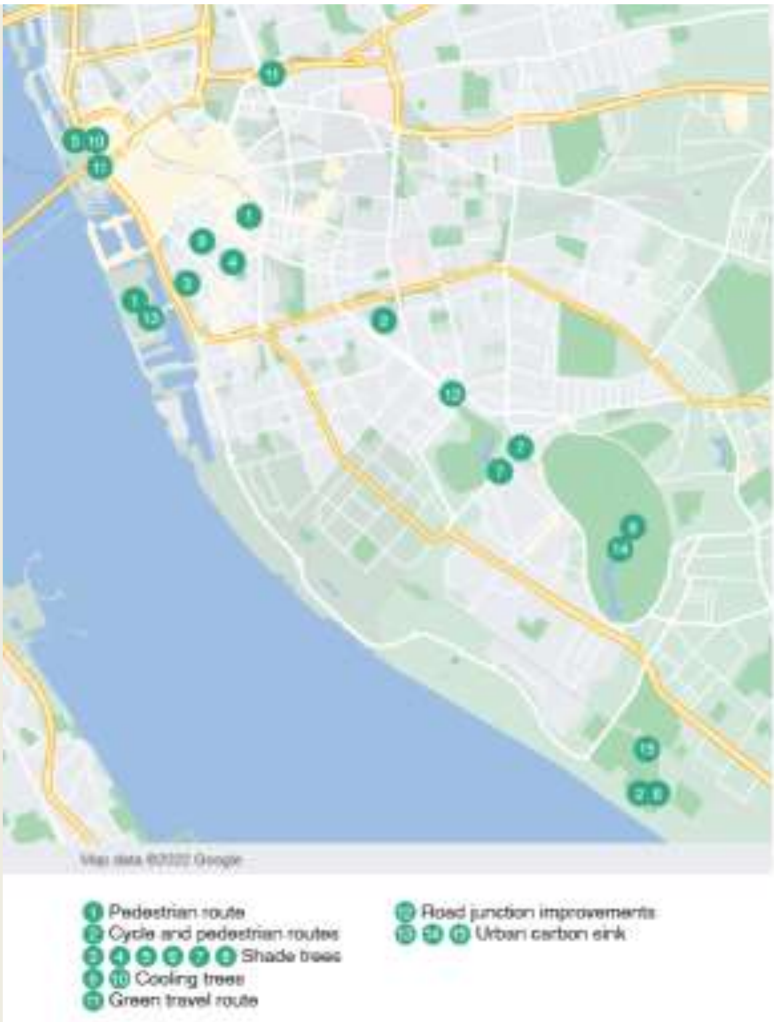
2.3 Lac3 Road junction pedestrian improvement

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	

2.3.1 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.

2.3.2 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.

2.4 Lac4 Urban catchment forestry

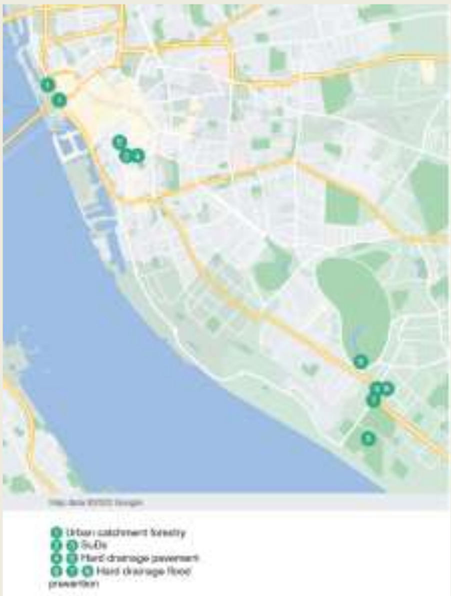
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0105; CH0111; CH0201; CH0207; CHO213; CH0217; CH0212; CH0501; CH0502; CH0503; CH0504, CH0505; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Urban catchment forestry Lac4	LIV/UoL/CFT

CITY	*DATE OF IMPLEMENTATION*	
LIV	Trees in March 2020 and May 2021 Surrounding landscape August 2020	

2.4.1 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

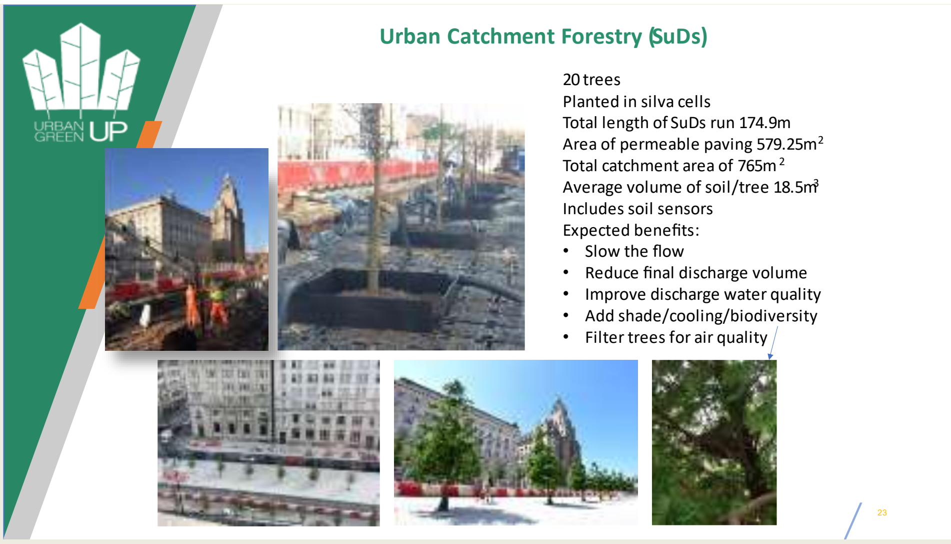
April 2020

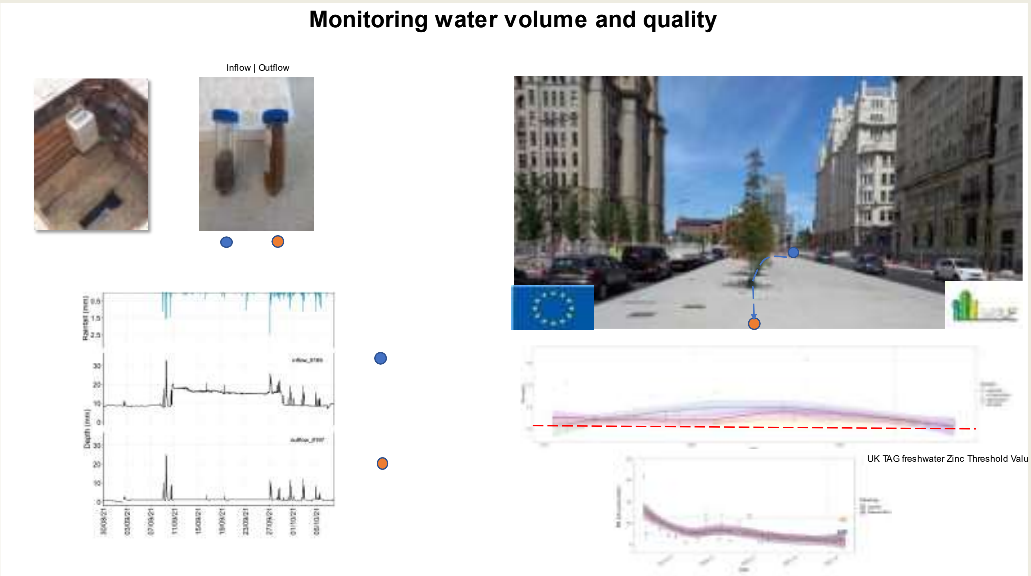
June 2020

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)

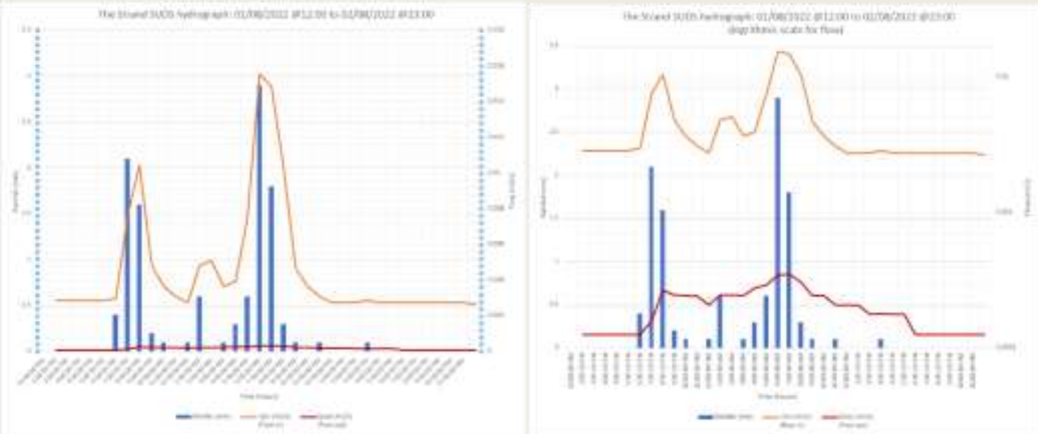
Lower ranking levels were observed for:

- 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.

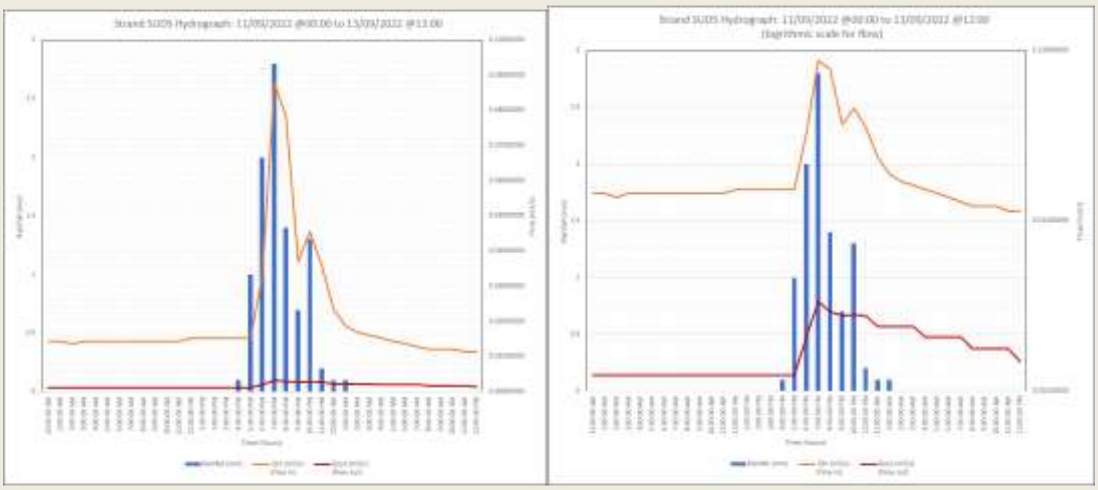
Rainfall events were analysed in more detail to observe how the tree SuDs or urban catchment forestry reacted. Two examples were chosen, as below. These plots were created using the Mannings roughness equation to calculate flows. The plot on the right is with a logarithmic scale to be able to observe 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.

2.4.2 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	

2.5 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	

2.5.1 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

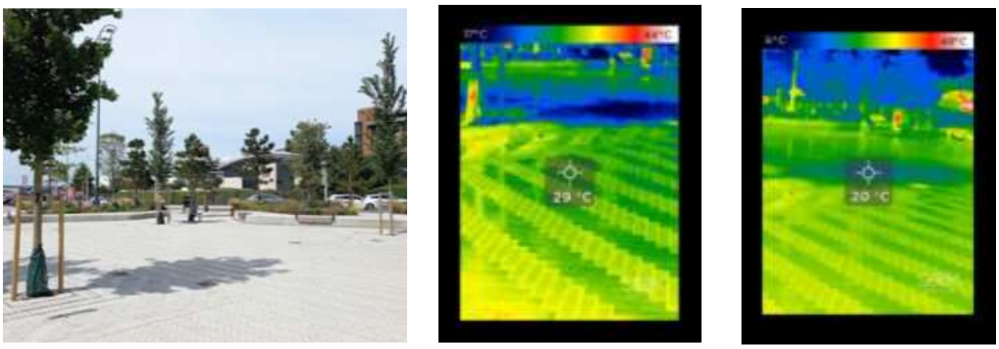
Lower rankings were found for:

- 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.

2.5.2 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

2.6 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	

2.6.1 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.

2.6.2 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 Container trees installed directly onto pavement and not bearers so could not be easily moved without dis-assembly	Forklift used (some minor damage to containers which will be rectified) 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.

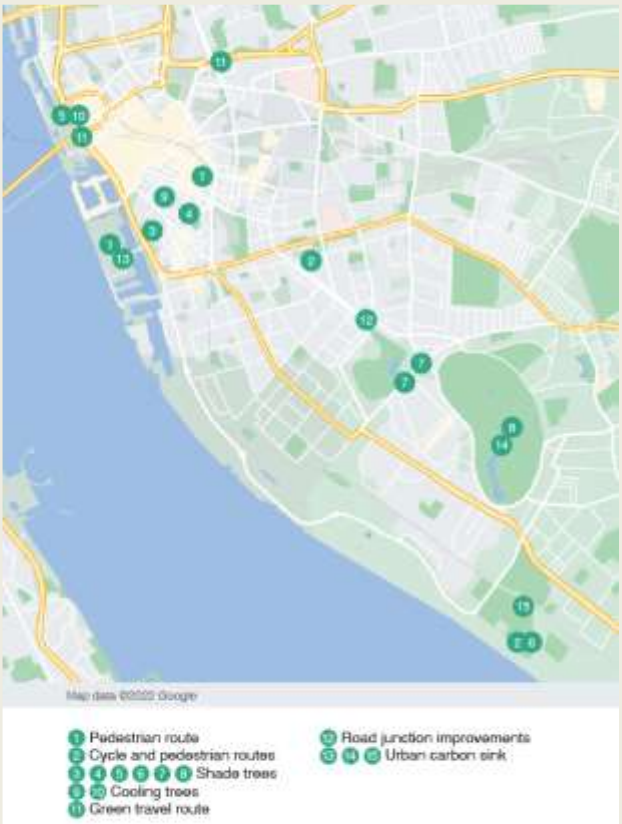
2.7 Lac7 Urban carbon sink

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	

2.7.1 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.

2.7.2 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

2.8 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

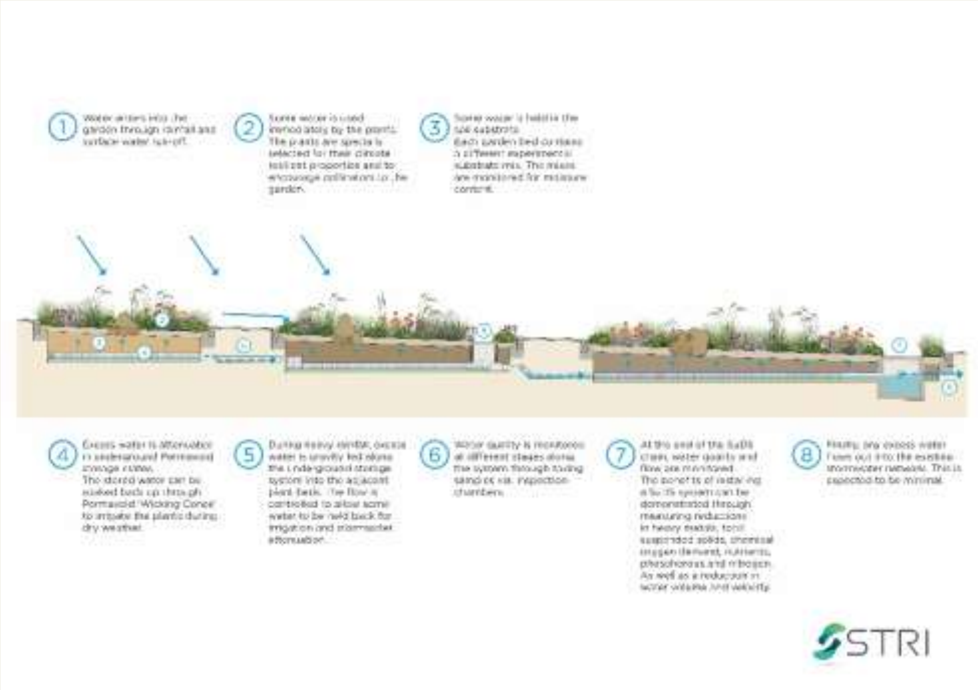
CH0602; CH0703; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;		
CITY	*DATE OF IMPLEMENTATION*	
LIV	June 2022	

2.8.1 Results and Discussion

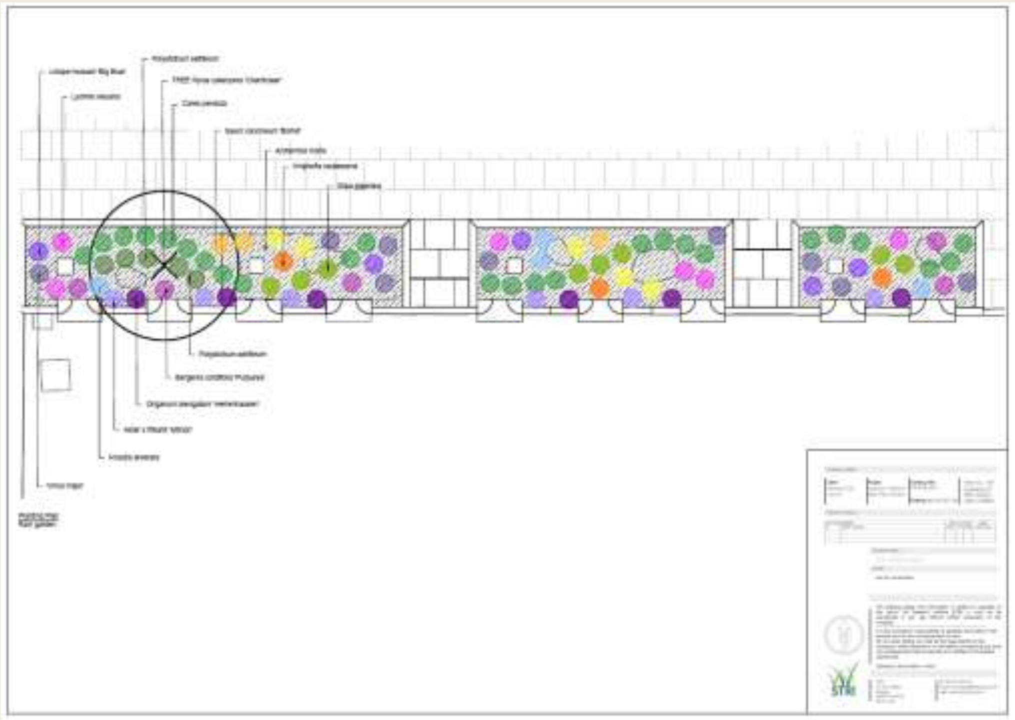
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

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.

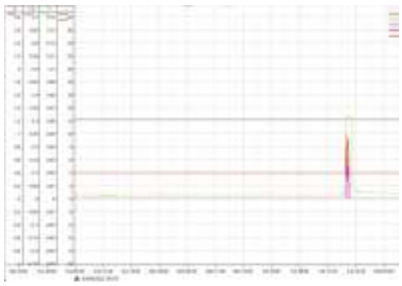
An example of a snapshot of data from from the water flow meters is as below:

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.

2.8.2 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

2.9 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	

2.9.1 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.

2.9.2 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 Lower pond- site had previously been an old glass tip and ash rubbish dump	Culvert was used to drain excess water from new pond and new pond shape was adapted to accommodate the culvert 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

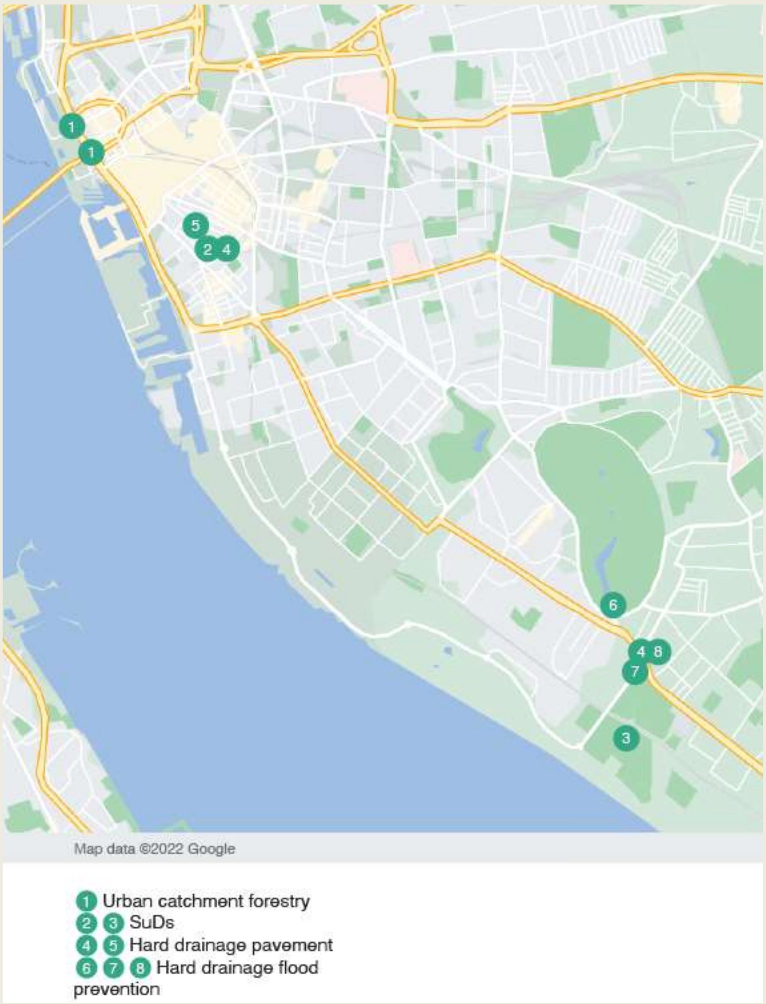
2.10 Lac9 Hard drainage flood prevention

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	

2.10.1 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.

2.10.2 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

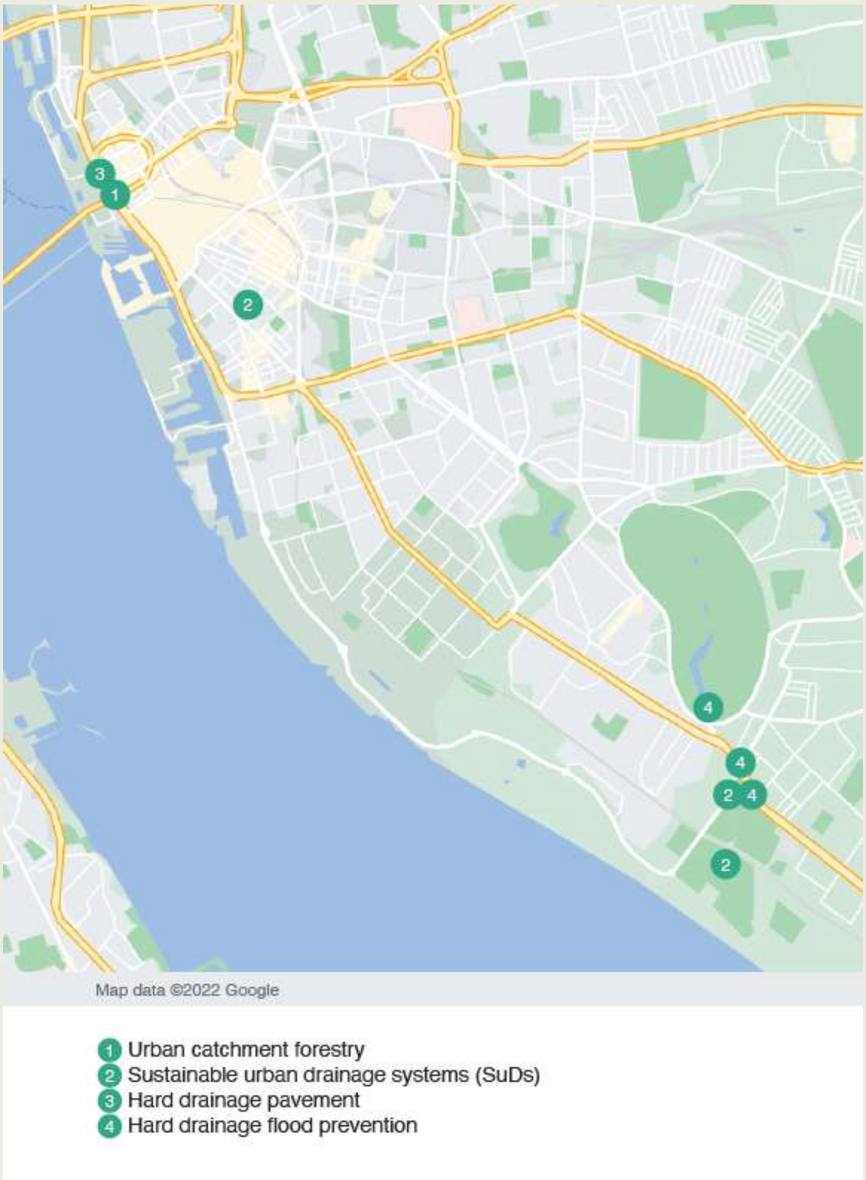
2.11 Lac10 Hard drainage pavements

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	

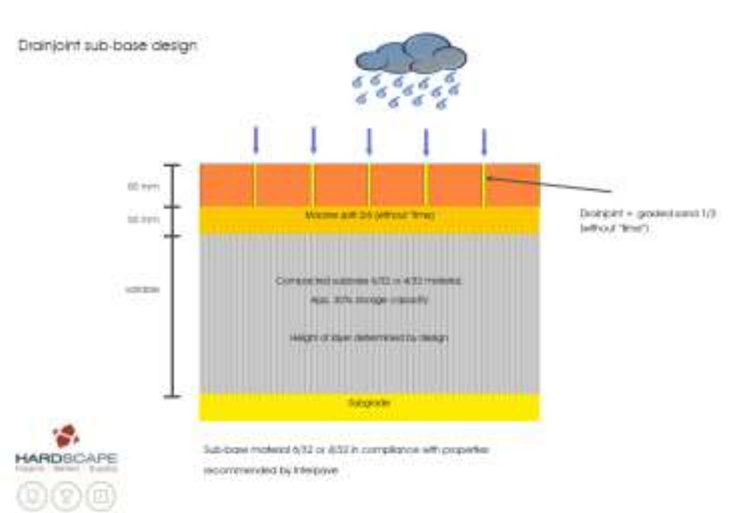
2.11.1 Results and Discussion

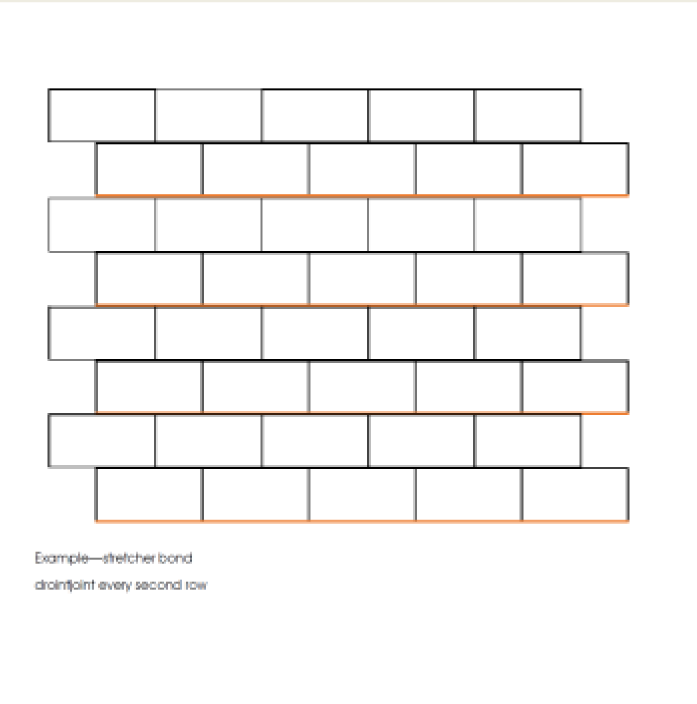
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

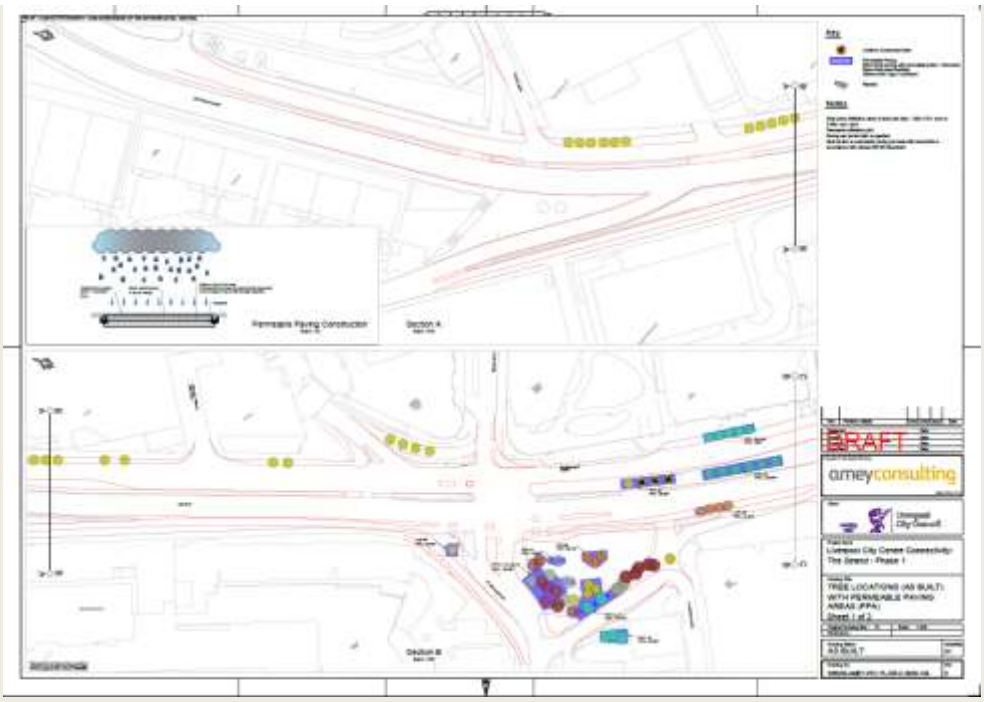
Hard drainage pavements at Location 3

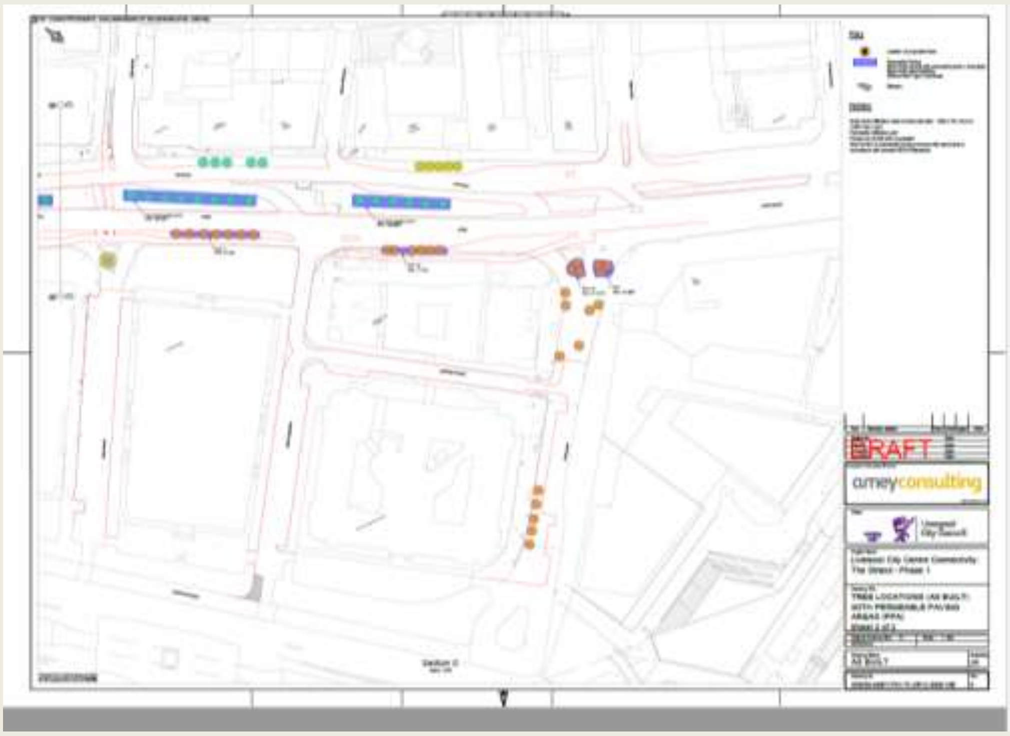


Location 1 – Strand tree planting with urban catchment forestry and permeable paved areas.









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	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	3.0	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.

2.11.2 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

2.12 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	

2.12.1 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 700^{o}C.

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

2.12.2 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	

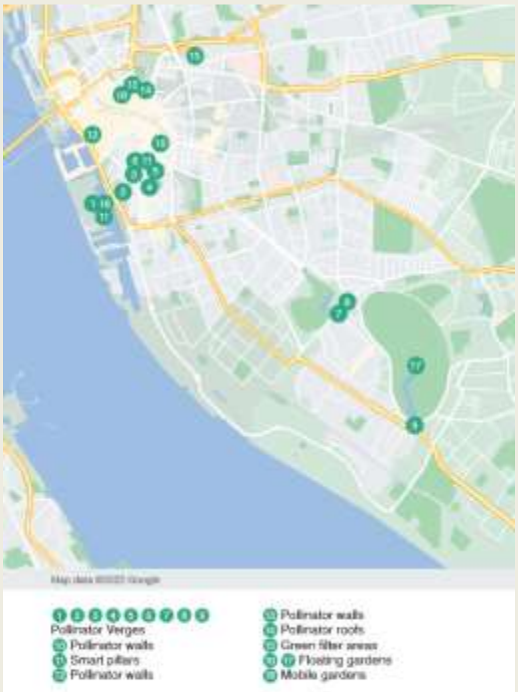
2.13 Lac 12 pollinator verges

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	

2.13.1 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.

2.13.2 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.

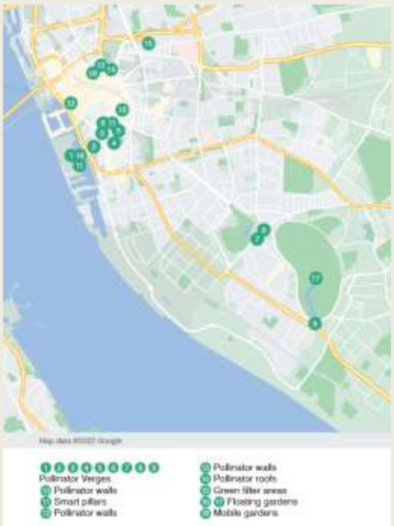
2.14 Lac13 Pollinator walls vertical

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	

2.14.1 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.

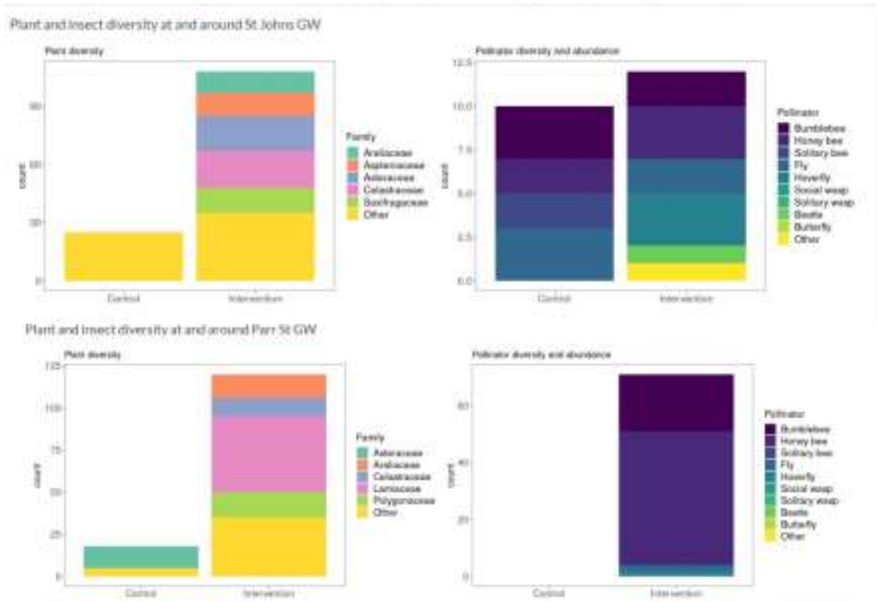
Lower rankings were found for:

- 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.

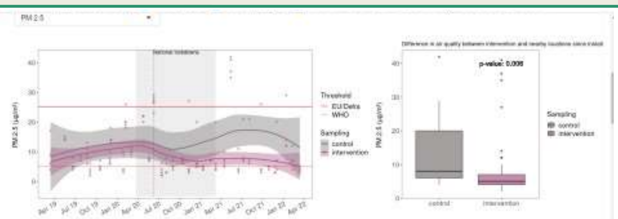
The highest percentage changes creating a positive effect were for the Baltic area Parr Street green wall plant counts and diversity, although all green walls did well for these biodiversity measures.

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

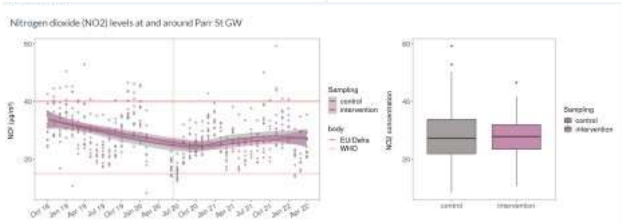


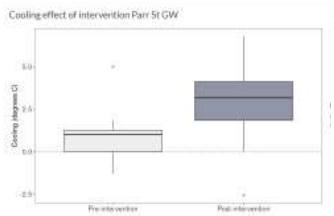
St Johns Green Wall is close to other pollinator sources(pollinator roof, park, planted containers)

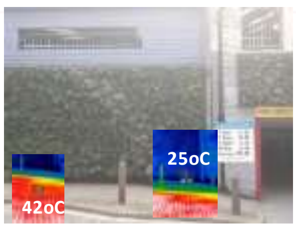


Data Grab Green Walls

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.

2.14.2 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	Additional steel supports
Fire calculations needed at Parr Street following procurement challenge and change in the law	Specialist appointed
Solar panel and materials issues with smart pillars	Delayed works on site
Economical barriers	How they have been addressed
Additional costs for st Johns extra support	Project contingency budget
Additional costs for Parr st during covid and additional fire calculations	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

2.15 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	

2.15.1 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

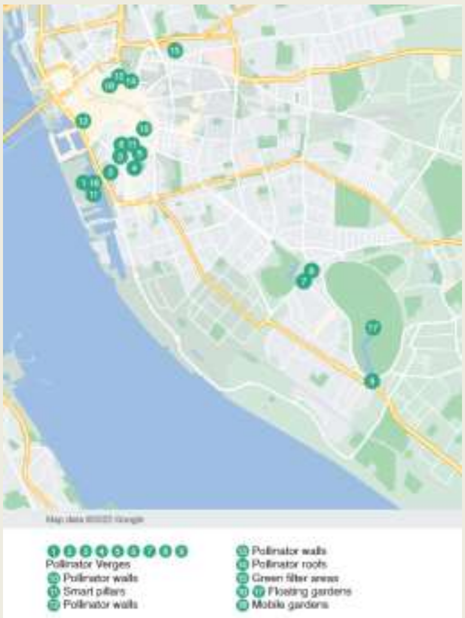


Image pollinator roof

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:

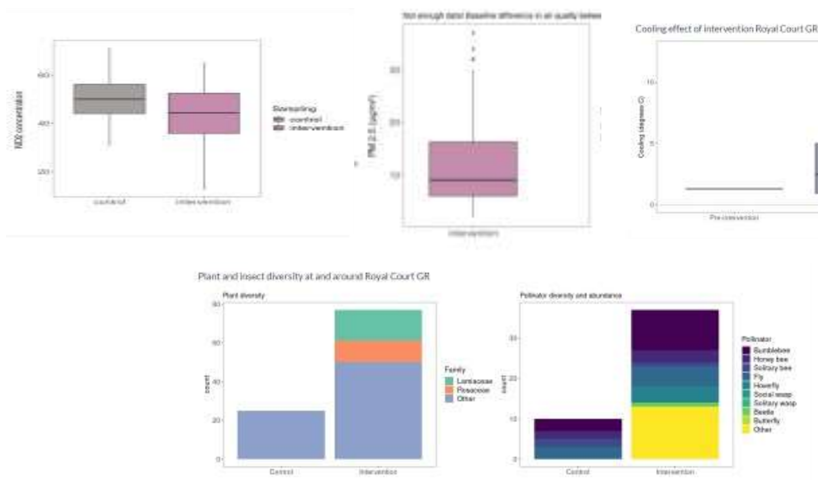
- Air quality (PM2.5, PM10 and NO2)
- Air quality (modelled)

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.

2.15.2 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

2.16 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	

2.16.1 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	

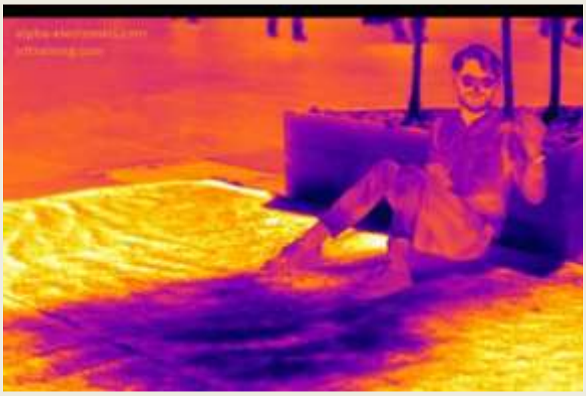
We have used the mobile forest to stimulate conversation about greening the city to tackle projected climate change and raise aspirations about "what could be", greener more sustainable cities.

<u>Overview</u>

- 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.

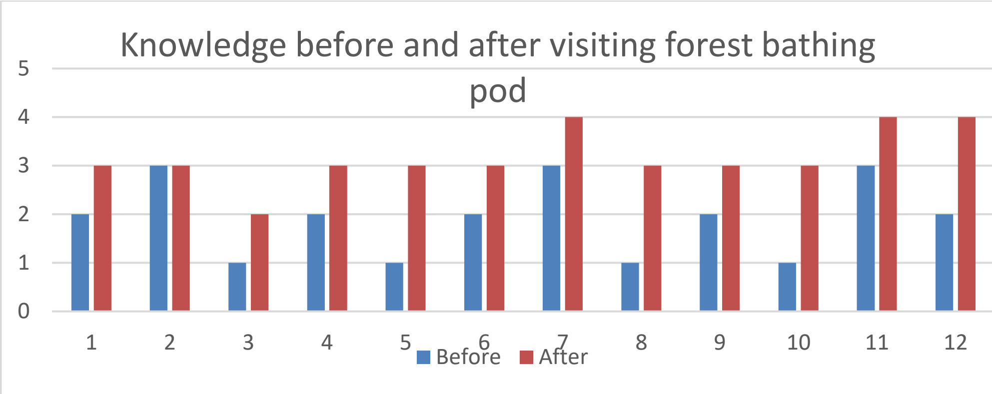
Earlier trial of a pop-up forest

Cooling impact of pop-up trees



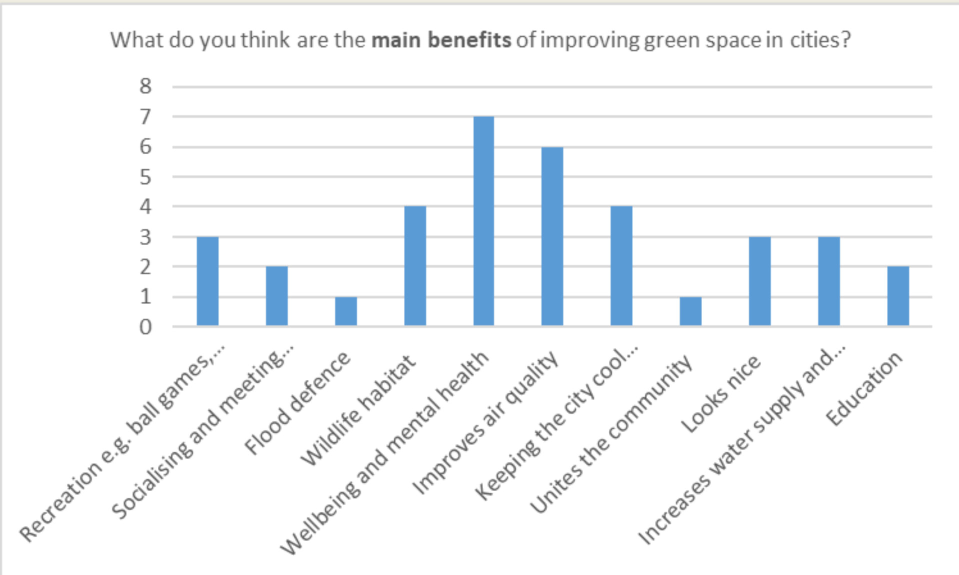
Selected comments from people attending trial pop-up forest:

- "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.

2.16.2 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	Design
Storage location	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	Hired from nursery
Miscellaneous items such as sand/cones /collection times etc	Liaised with city council
Permanent home required	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

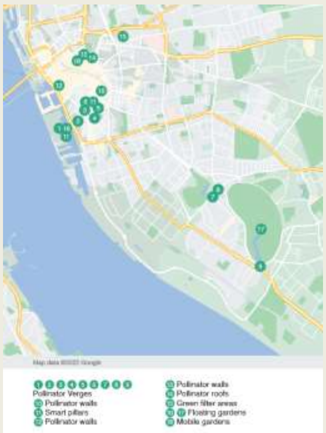
2.17 Lac16 Floating Gardens/Ecosystems

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	

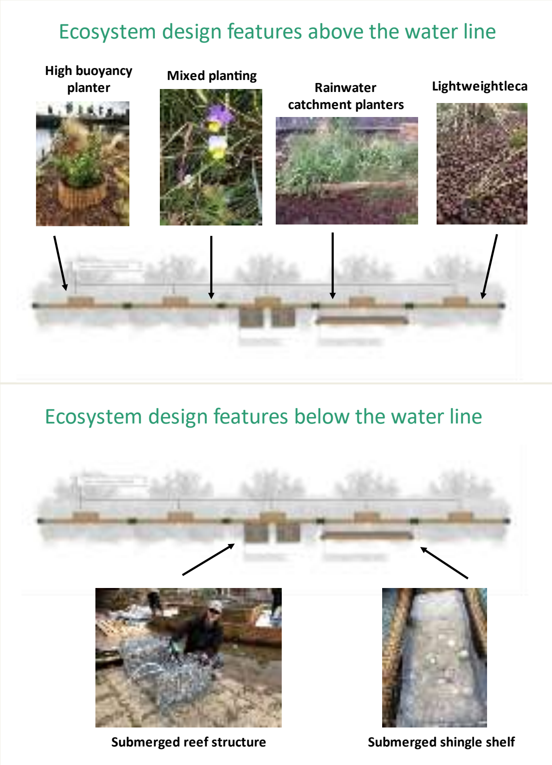
2.17.1 Results and Discussion

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 Fl	0.15	1
SPL Fl	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 FI	100	22.0	1
SPL FI	20	0.0	2
SPL FI	100	0.0	2
Wapping FI	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 Fl	20	15.35	1
Wapping Fl	100	12.98	2
SPL Fl	20	0.00	3
SPL Fl	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.

2.17.2 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.

2.18 Lac17 Green Filter

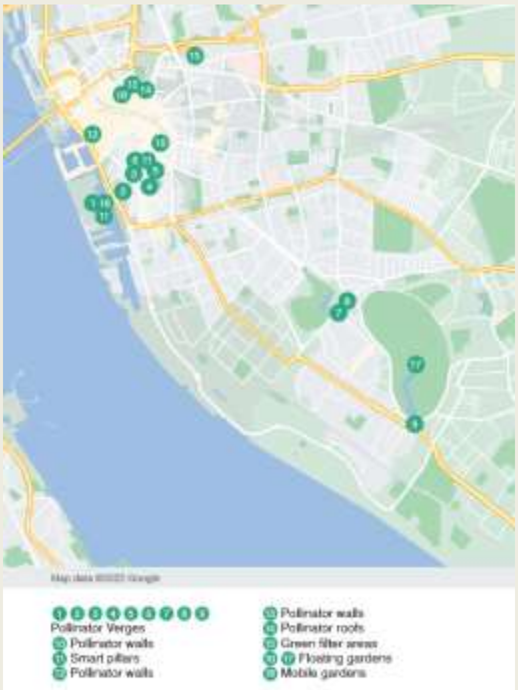
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0103; CH0104; CH0105; CH0111; CH0501; CH0502; CH0503; CH0504; CH0505; CH0508; CH0509; CH0510; CH0511; CH0512; CH0513; CH0602; CH0702; CH0705; CH0801; CH0904; CH1002; CH1004; CH1005;	Lac17 Green Filter	LIV/UoL/CFT
CITY	*DATE OF IMPLEMENTATION*	
LIV	Strand- June 2021 Stafford Street – June 2021	

	Lime Street – summer 2022	

2.18.1 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:

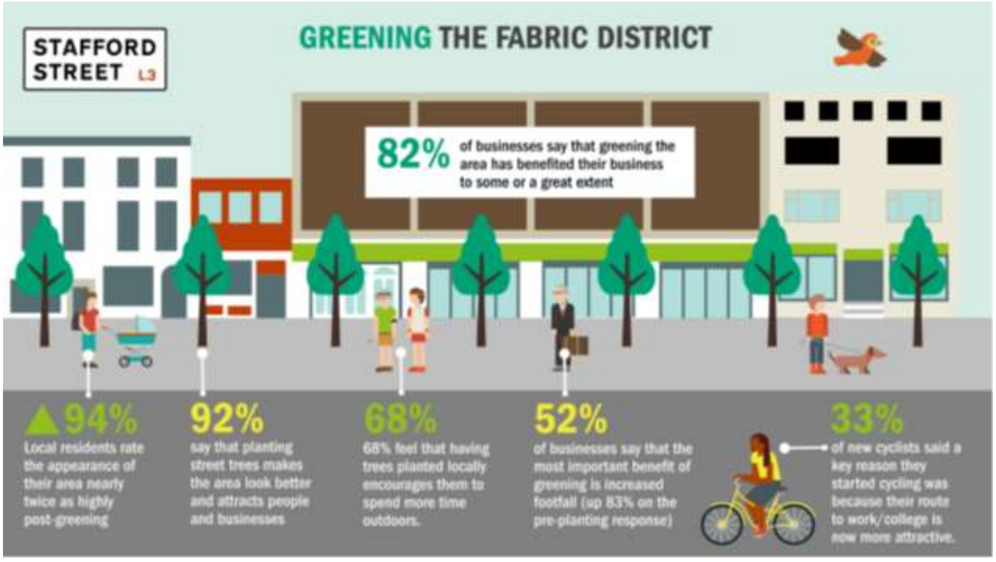
- Carbon storage
- Carbon sequestration, together with other tree-based interventions
- Thermal cooling
- Temperature decrease (modelled), particularly at greater radii distances
- Water slowed, particularly at close radii distances
- Green space accessibility
- PM2.5 particulate matter particles, particularly 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.

2.18.2 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 Contractor at Lime Street went into administration	Accommodated from external partner budgets 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

2.19 Lac18 - Lac 27 Non-technical interventions

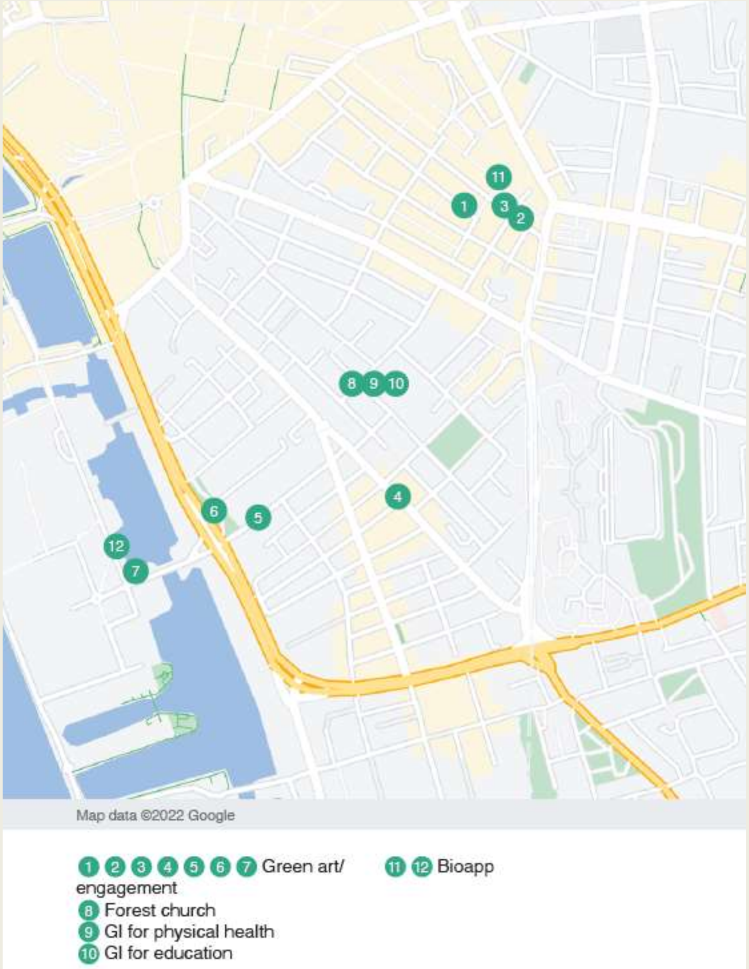
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*

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	

2.19.1 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

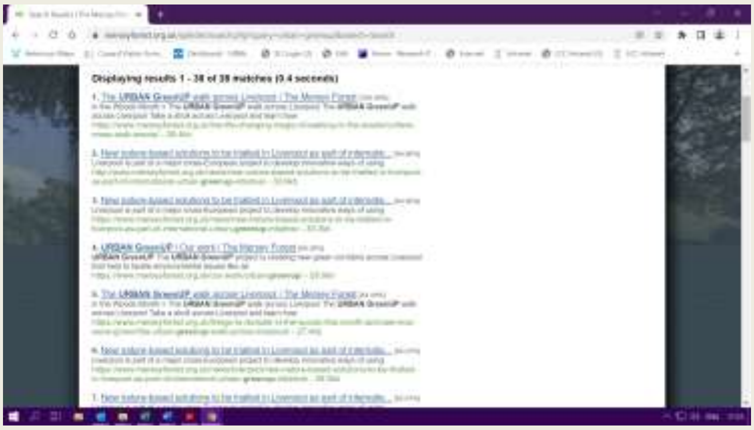


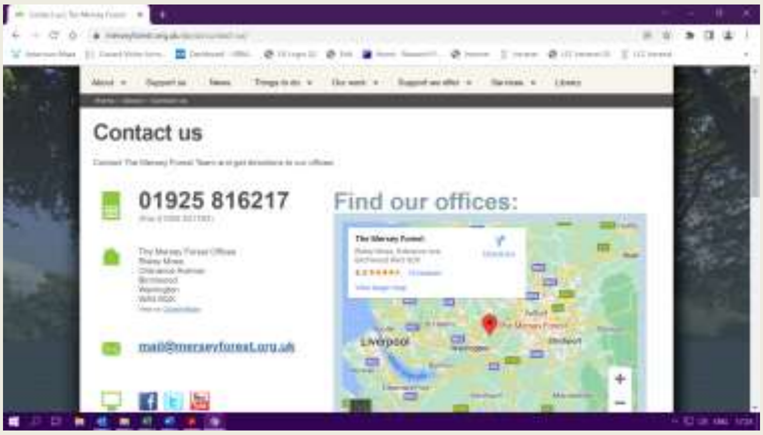
Lab 18 – Wood Allotments – Cancelled

Lac 19 –GI for Education

Lac 20 – Forest School

Lac 21 – Engagement portal



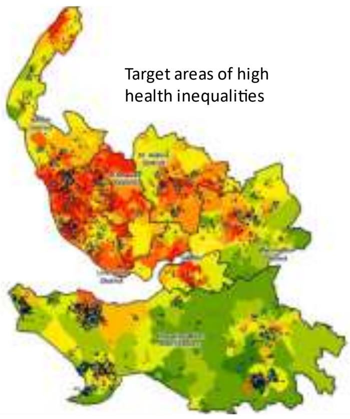


Lac 23 – Forest Church



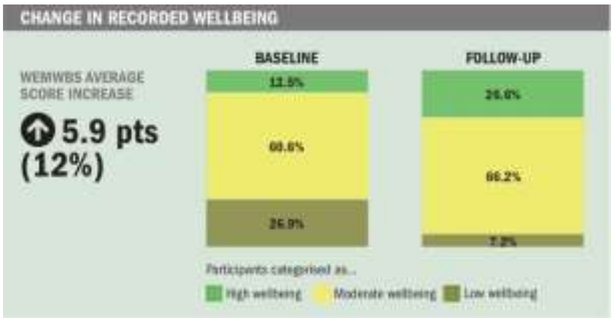

Lac 25 GI physical health - Lac 26 GI mental health

The Natural Health Service

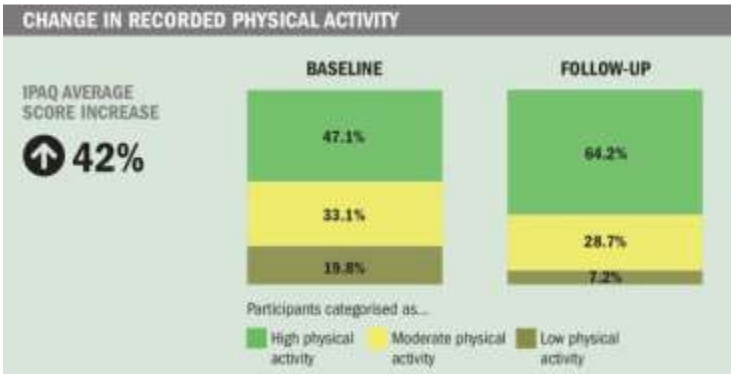


- Use the **natural environment** as a health asset
- **Reducing inequalities – big issue**
- **8-12 week programmes – a "dose" of nature**
- **Evidence-based products** and interventions
- **Targeted at areas of need**
- **Long term partnership** with universities to develop evidence and improve practice.

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.

2.19.2 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

2.20 Lac 22 Green Arts Engagement

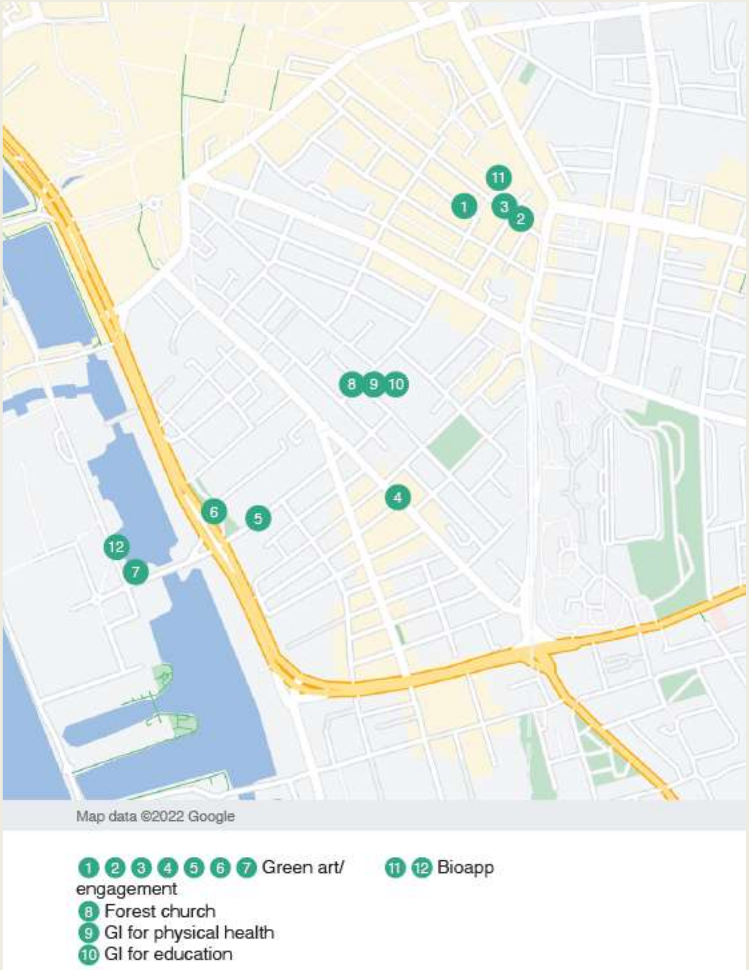
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0111; CH0501; CH0513; CH0514; CH0515; CH0516; CH0517; CH0518; CH0602;	Lac 22 Green Arts Engagement	LIV/UoL/CFT

CH0703; CH0704; CH0707; CH0801; CH0904; CH1003; CH1004; CH1005; CH1007		
CITY	*DATE OF IMPLEMENTATION*	
LIV	May 2021	

2.20.1 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.

2.20.2 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 Bee sculpture moved due to vandalism and eventually damaged	Assessed and records kept quarterly 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.

2.20.3 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.

2.21 Lac 24 Bioapp

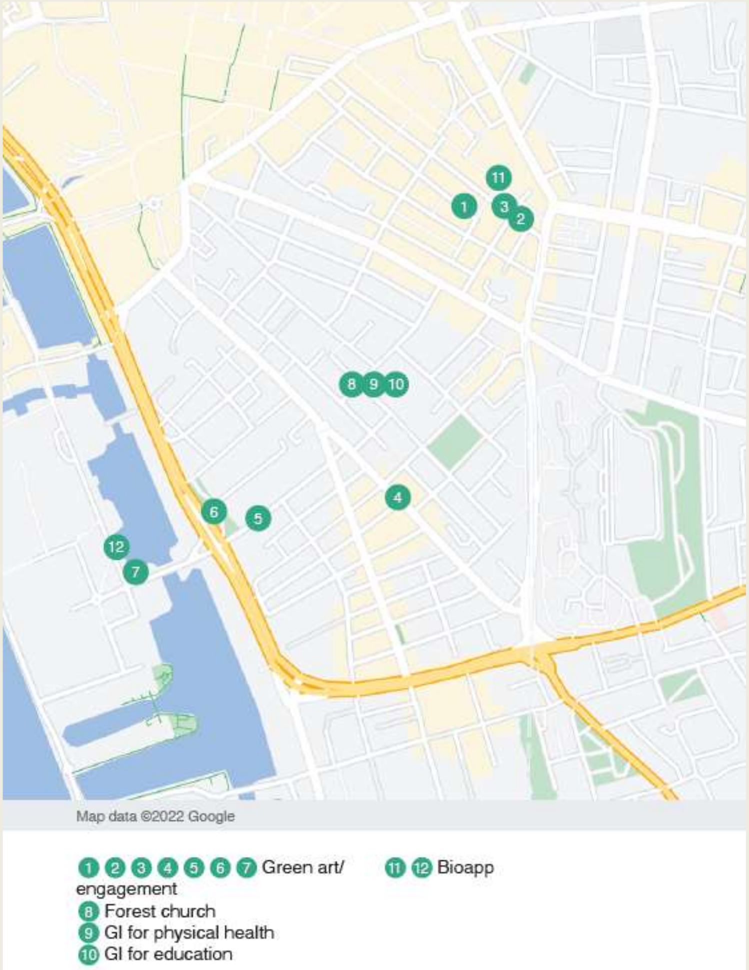
RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0104; CH0111; CH0501; CH0513; CH0514; CH0515; CH0516; CH0517; CH0518; CH0602; CH0703; CH0704; CH0707; CH0801; CH0904; CH1003; CH1004; CH1005; CH1007	Lac 24 Bioapp	LIV/UoL/CFT

CITY	DATE OF IMPLEMENTATION	
LIV	March 2021	

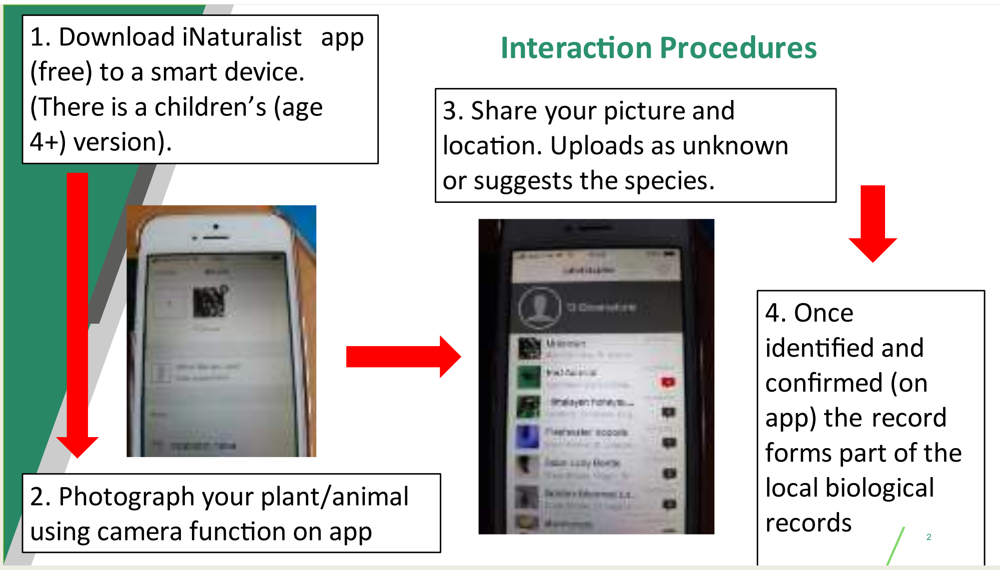
2.21.1 Results and Discussion

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.

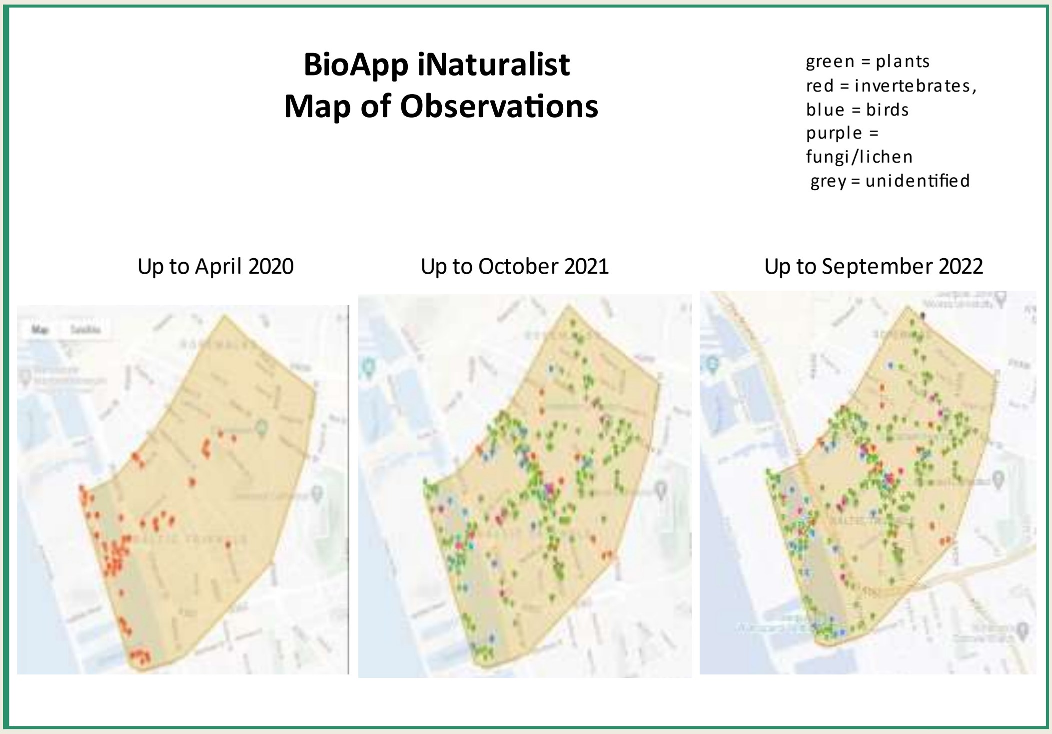
Location of non technical interventions bioapp



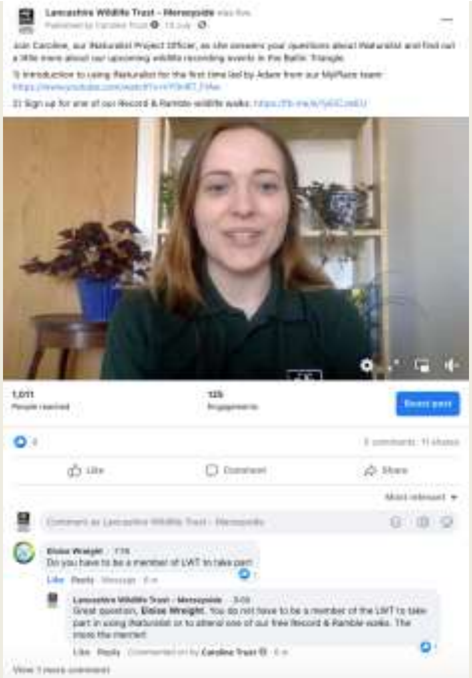
Images – use of bioapp



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	
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	

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.

2.21.2 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

2.21.3 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.

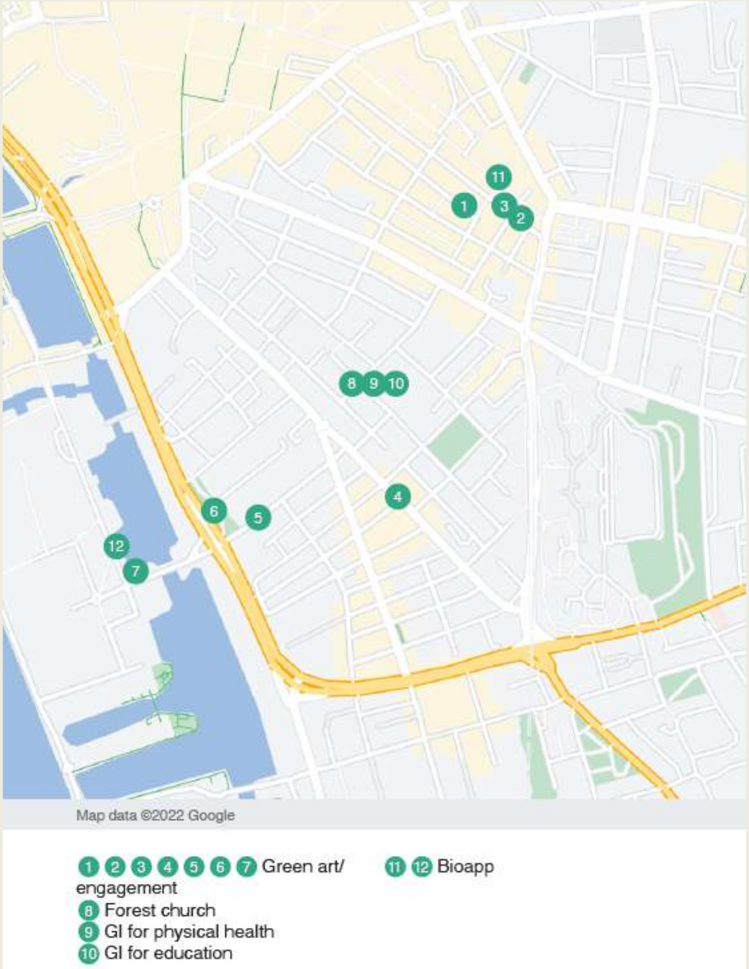
2.22 Lac 28 – Lac 30 Non-technical actions

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	

2.22.1 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.

2.22.2 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

3 Izmir

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	

3.1.1 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.

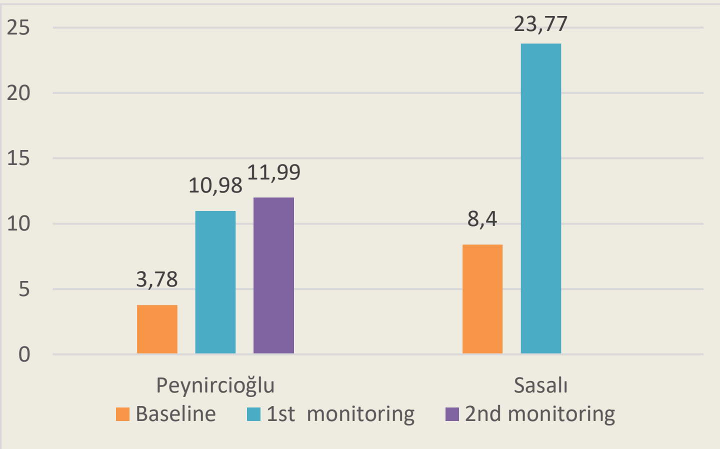
Outdoor green spaces were one of the few recreational places that remained accessible during lockdown periods. The increase of pedestrian and cycle routes combined with increased greenery especially around the Peynircioğlu stream helped the citizens cope with the pandemic.

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

3.1.2 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	-

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	

3.2.1 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.

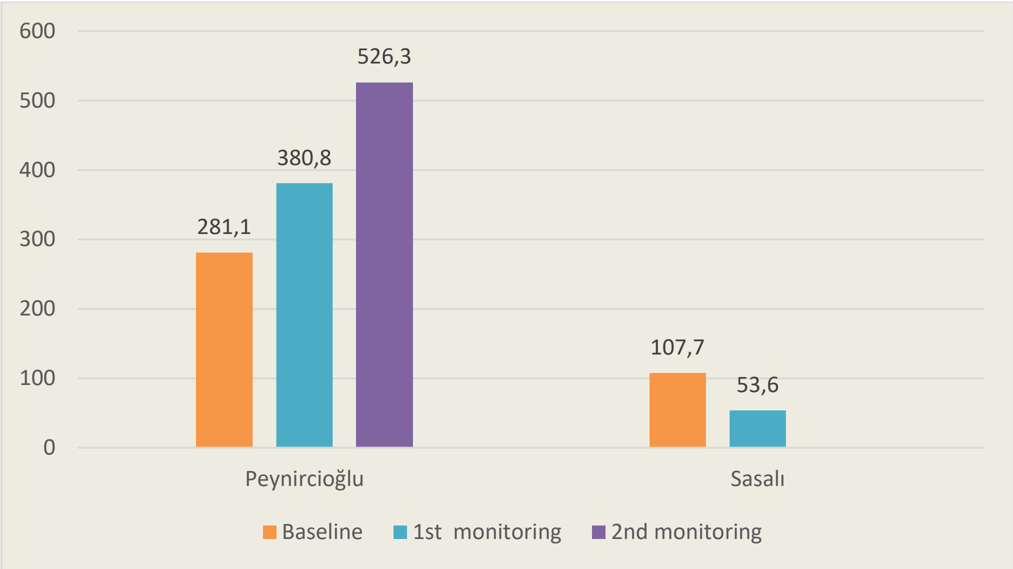
A large number of trees are planted along the new green corridors and Peynircioğlu Stream. The main purpose is to increase the number of wide canopy trees so that carbon sequestration and pollutant's removal level could be maximized. They will improve user's well-being as well as connection to nature. 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.

3.2.2 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	-

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	

3.3.1 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.

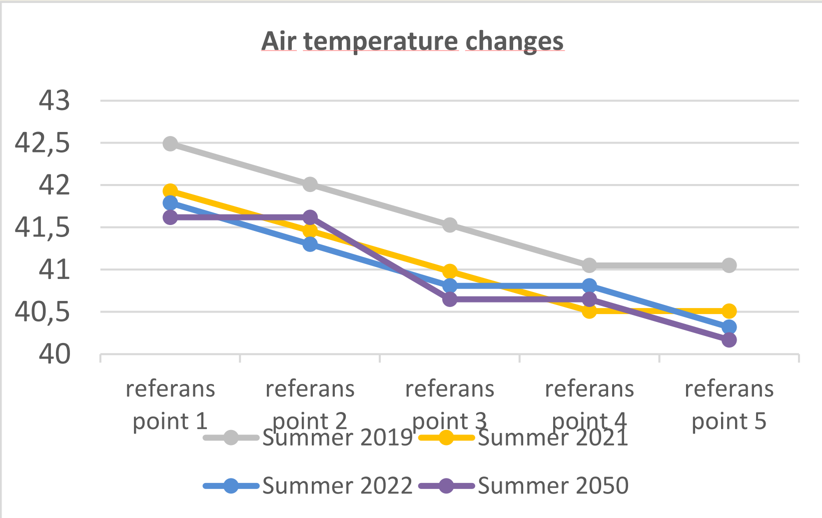
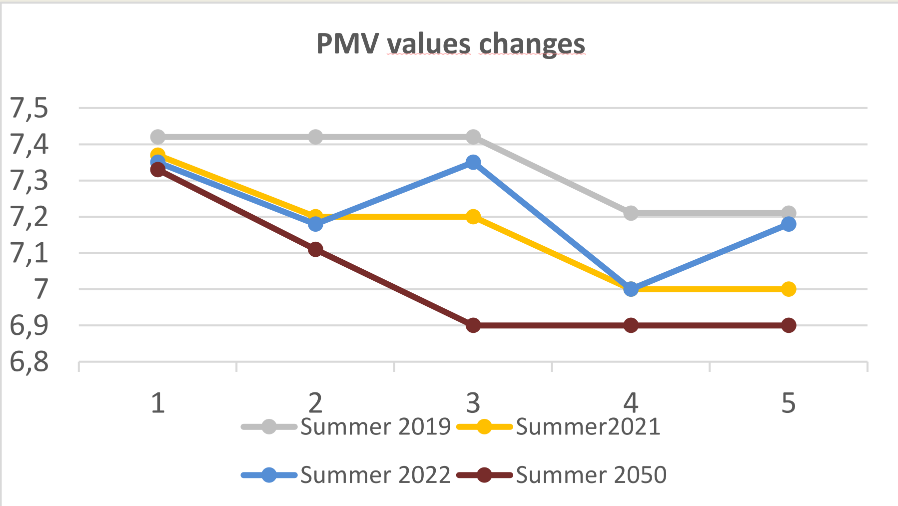
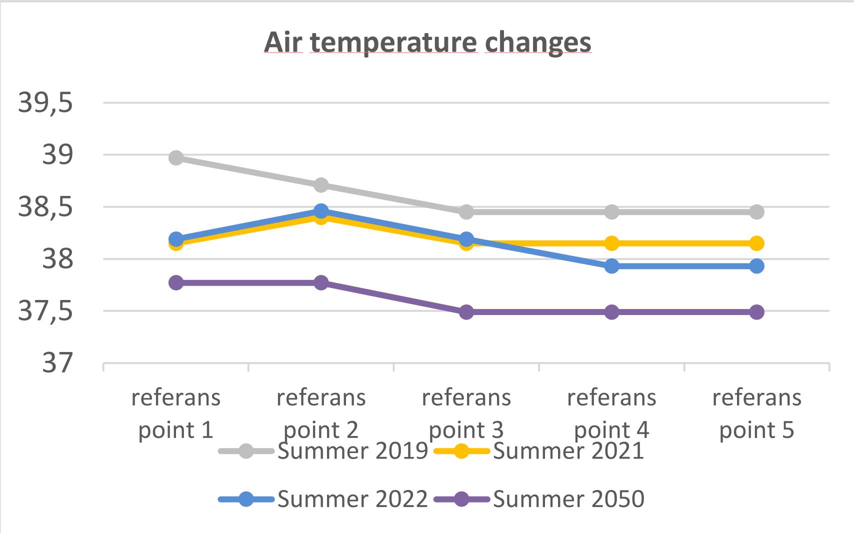


Figure: Air temperature changes and expectations for Vilayetler Evi

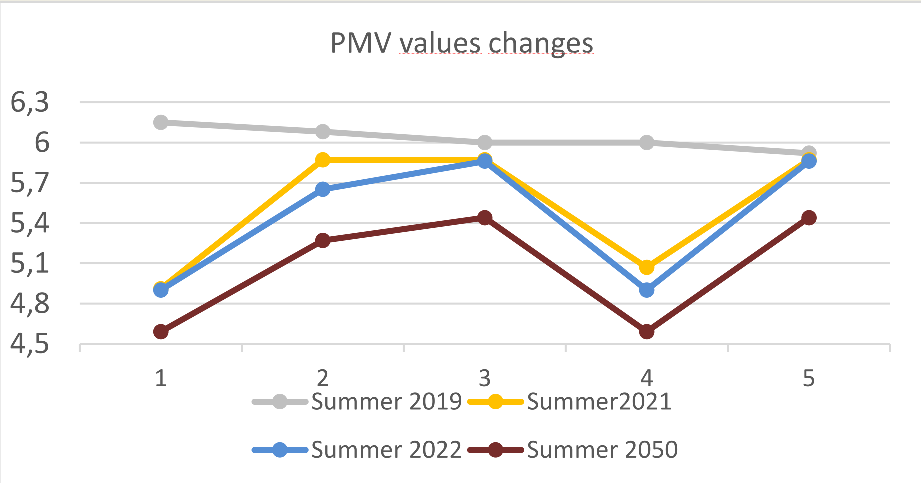
Also, thermal comfort values of the demo areas were calculated with the envi-met software.



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.

3.3.2 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	-

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	

3.4.1 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.

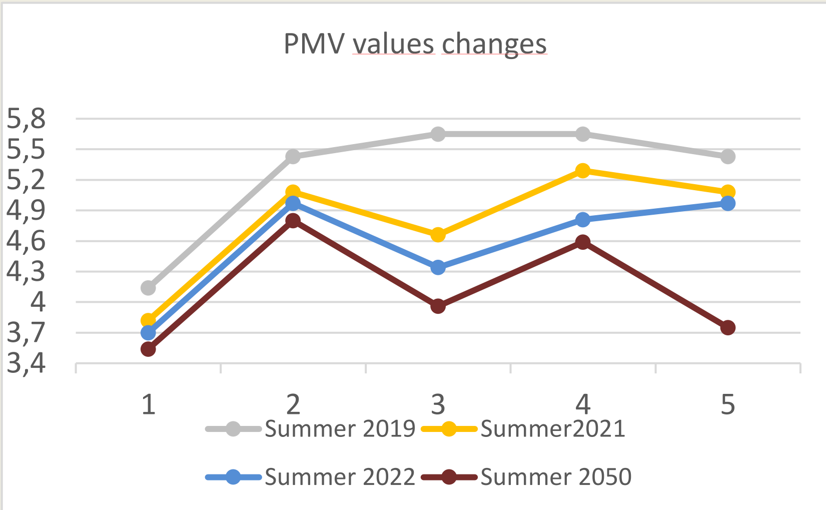
Parklets deployed in Girne Avenue, which is one of the crowded shopping streets in highly urbanized Karşıyaka Metropolitan District. Girne Avenue is surrounded by high-rise buildings on both sides. There is always a busy vehicle and pedestrian traffic flowing both ways throughout the day. It is also 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.

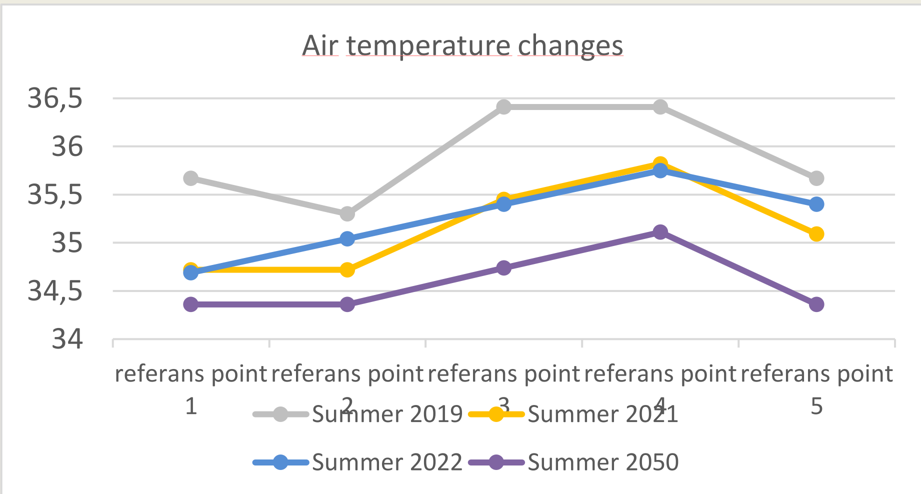
Thermal comfort values of the demo areas were calculated with the envi-met software.

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

3.4.2 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	-

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	

3.5.1 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

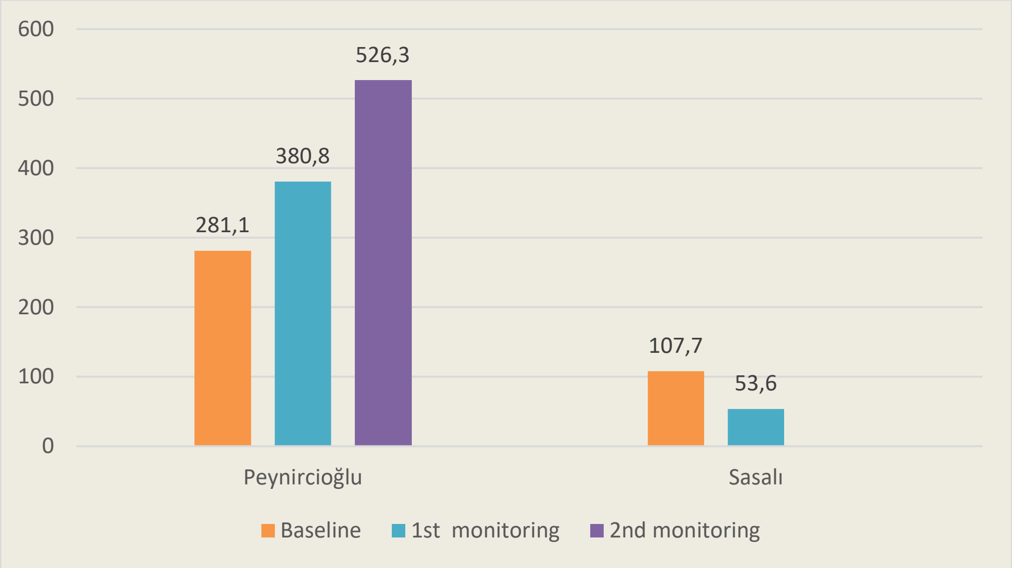
Carbon storage capacity of plant cover in Peynircioğlu increased up to 35 % in the 1st monitoring and 87 % in the 2nd monitoring period compared to baseline value (Table 1).

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

3.5.2 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

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	

3.6.1 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.

3.6.2 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	

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	

3.7.1 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

3.7.2 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	-

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	

3.8.1 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.

3.8.2 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	

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		

3.9.1 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.

3.9.2 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	-

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	

3.10.1 Results and Discussion

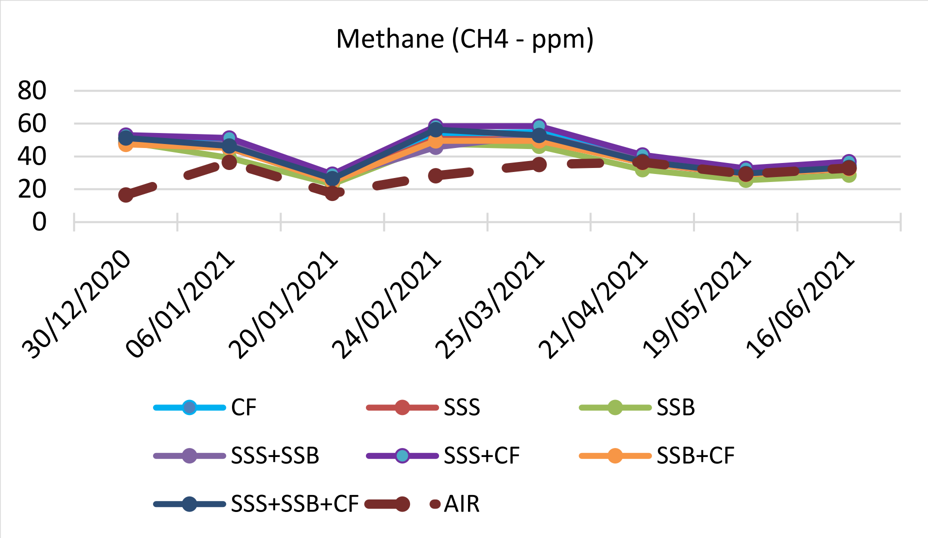
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

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.

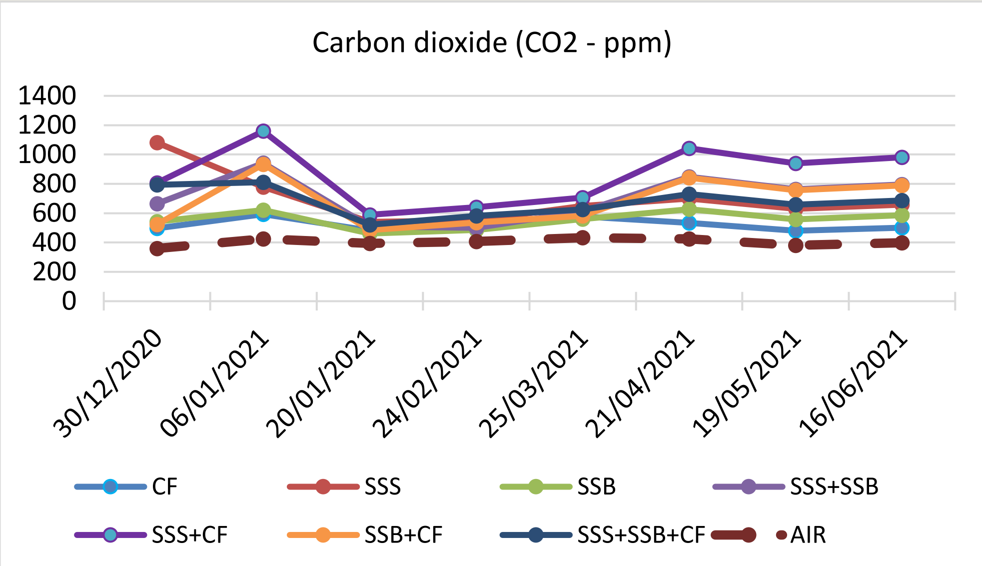
The application of biochar to the soils appears to be one of the ways of atmospheric CO2 sequestration. In this process, carbon is separated from its rapid ecological cycle and participates in a much slower and more stable biochar cycle (Lehmann, 2007). The construction of a strategic pathway to utilize 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.



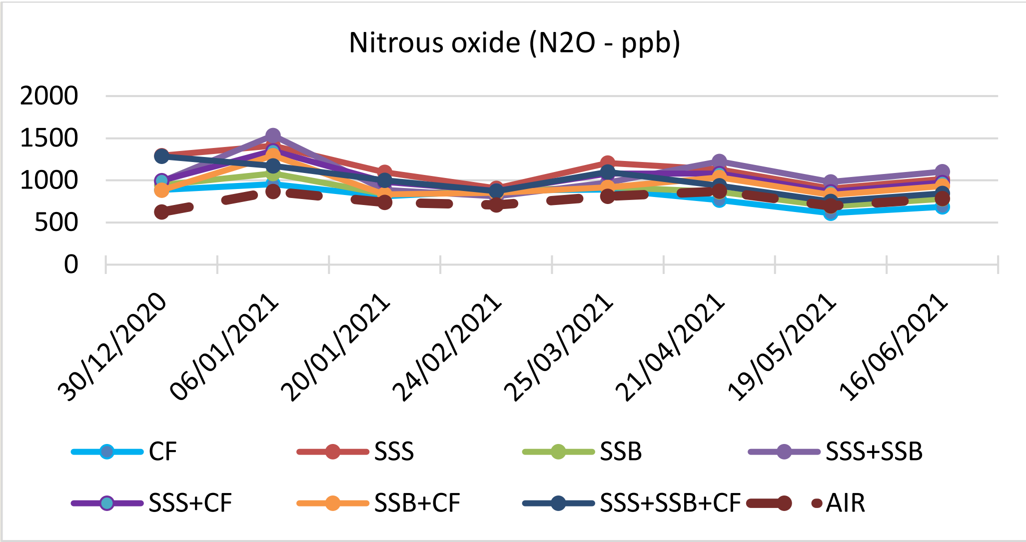
Methane change

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)

3.10.2 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	-

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		

3.11.1 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

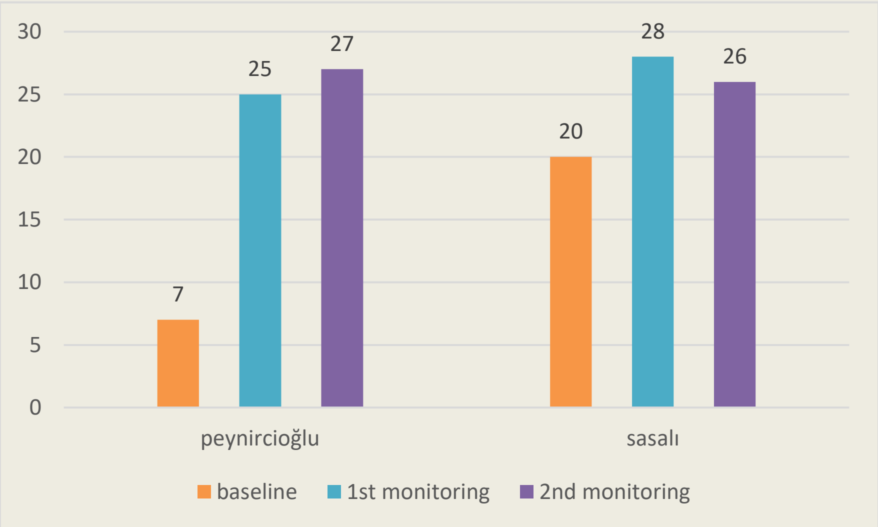
Pollinator species in Peynircioğlu

	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.

3.11.2 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.	

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	

3.12.1 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.

3.12.2 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.	

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	

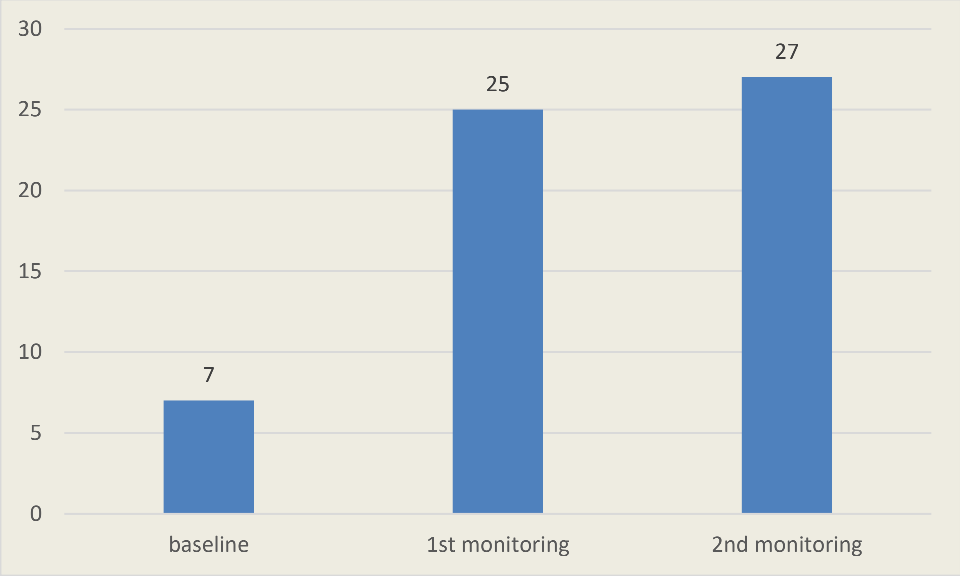
3.13.1 Results and Discussion

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.

<u>Pollinator Species Increase</u>

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.

3.13.2 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	

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	

3.14.1 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.

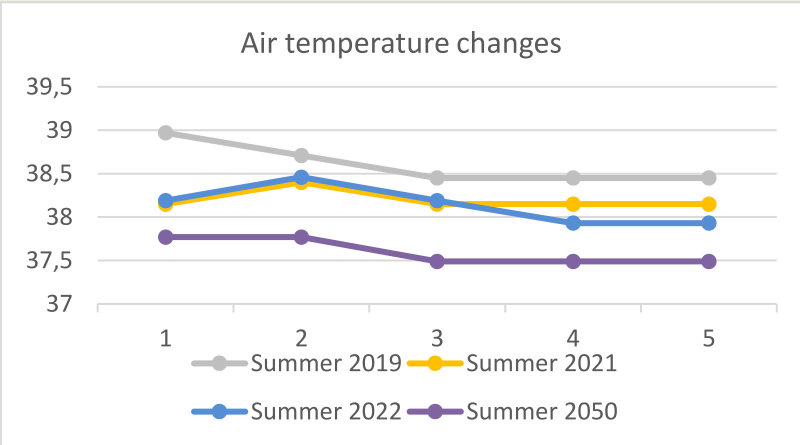
Green covering shelter installed to decrease temperatures and increase pollutant's removal with its planted cover. It is designed to integrate specific vegetation with a minimum maintenance, and their structural features allow providing water for plants, humidity for the ambient, shade for citizens. 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.

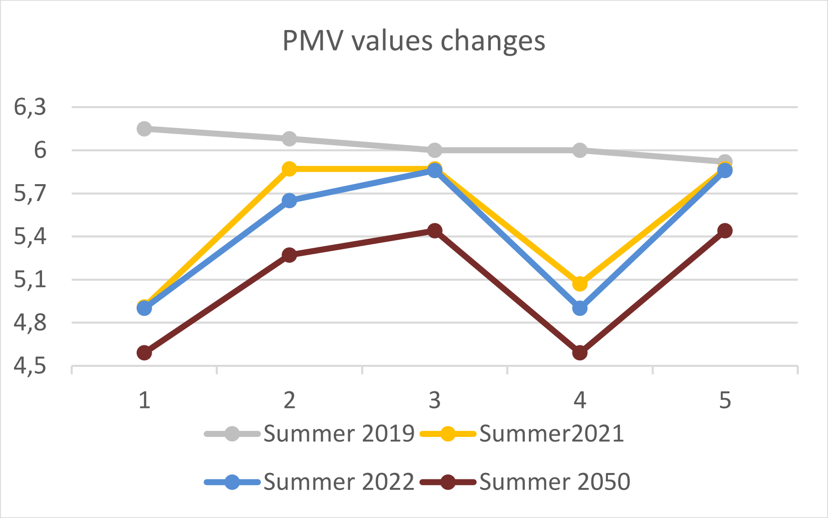
Green covering shelters built in parking lot of Vilayetler Evi and parking lot of Sasalı Natural Life Park. The former is in a very dense urban fabric and completely exposed to adverse effect of sun. The latter is situated adjacent to Sasalı Natural Life Park in a suburban landscape.

Temperature Decrease

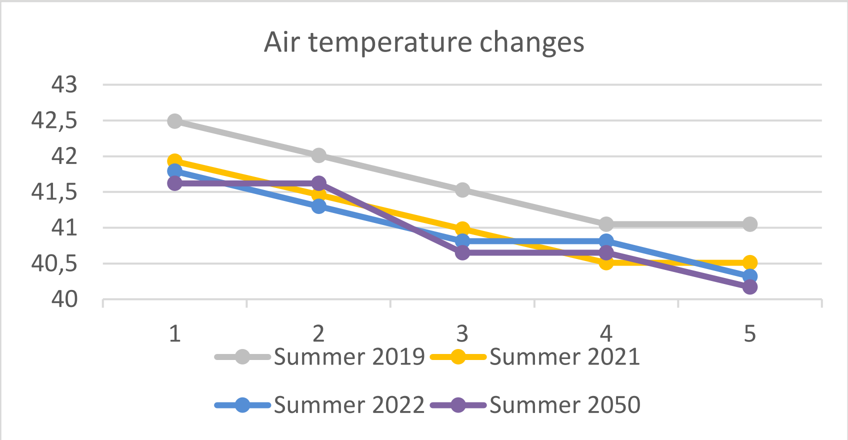
Temperature decrease and PMV values for Sasalı and Vilayetlerevi are shown in the figures below. Thermal comfort values of the demo areas were calculated with the Envi-met software. Although the results for monitoring period for temperature change is not very high the predictions for 2050 is higher especially for Sasalı.



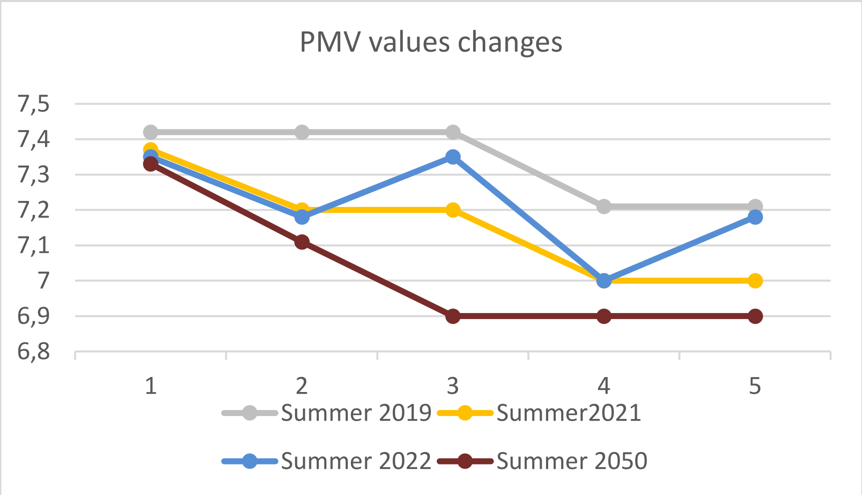
Air temperature changes and expectations for Sasalı



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.

3.14.2 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 the pandemic and after the İzmir earthquake at the end of 2020.	Parks and Gardens department took over the maintenance of the areas.

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	

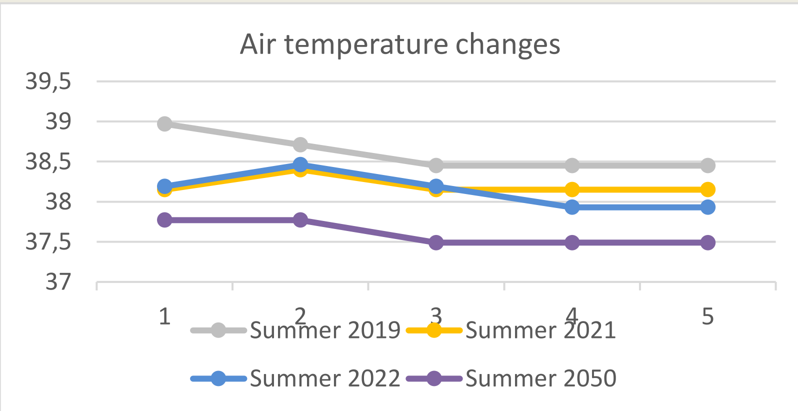
3.15.1 Results and Discussion

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.

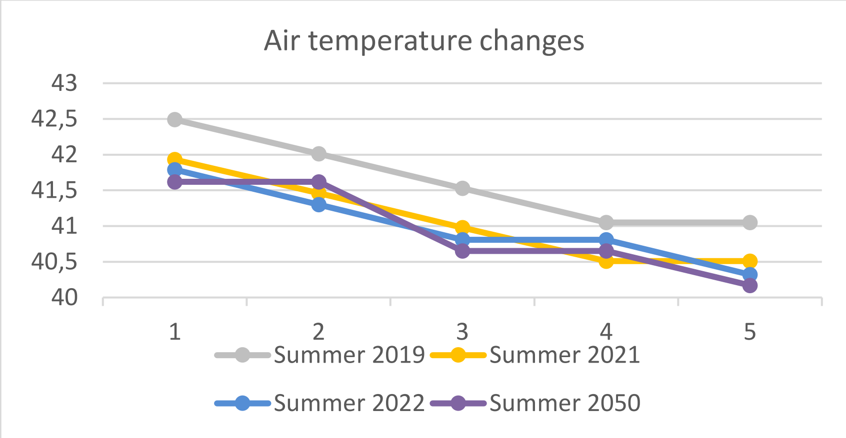
In the case of Izmir demo, conventional pavements replaced with vegetated permeable pavements in two parking lots that are recognized as thermal "hot-spots" in cities. One of them is the parking lot of Vilayetler Evi. It is located in a very dense urban fabric and completely exposed to adverse effect 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

3.15.2 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.	

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	

3.16.1 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

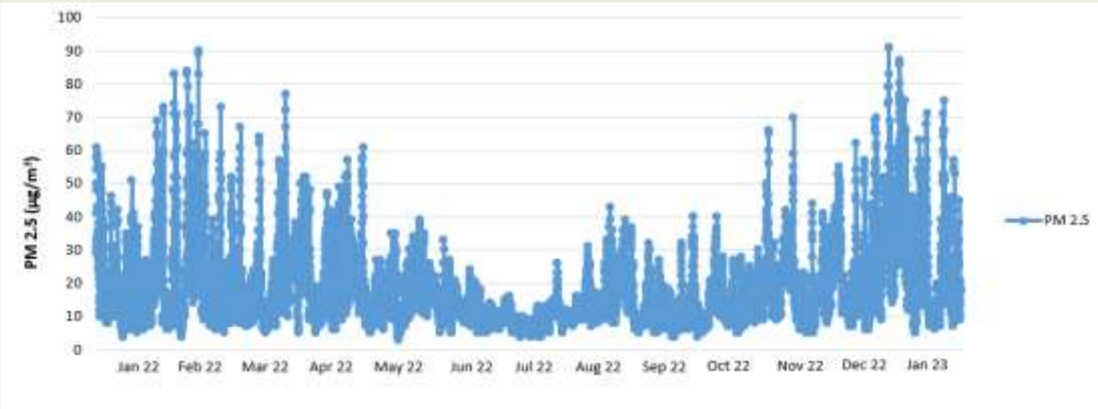
Fine particles ($PM_{2.5}$) are 2.5 micrometers in diameter or smaller, and can only be seen with an electron microscope. Fine particles are produced from all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial 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).

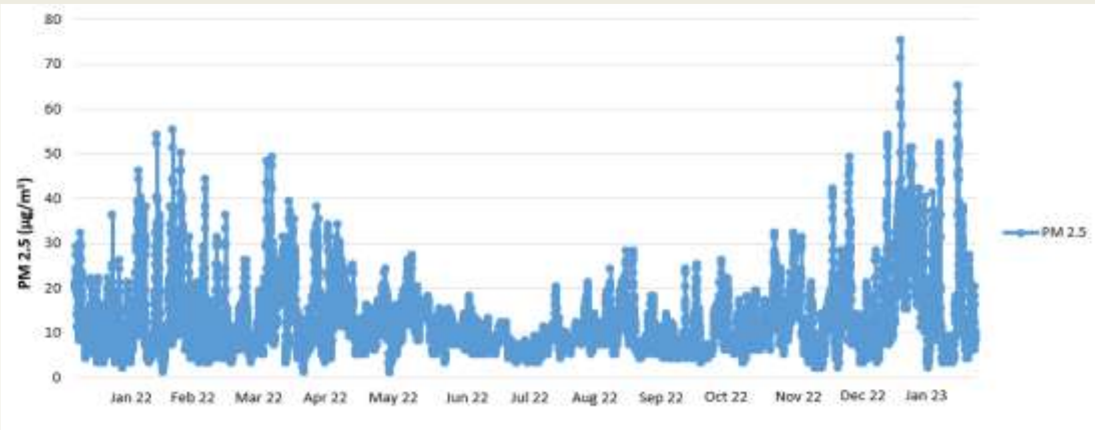
Background Data

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/m³ to 15.697 μg/m³.

Fixed station measurements (av.) on the intervention sites are 13.21 µg/m³ for Sasalı and 16.16 µg/m³ 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/m³ annualy mean.

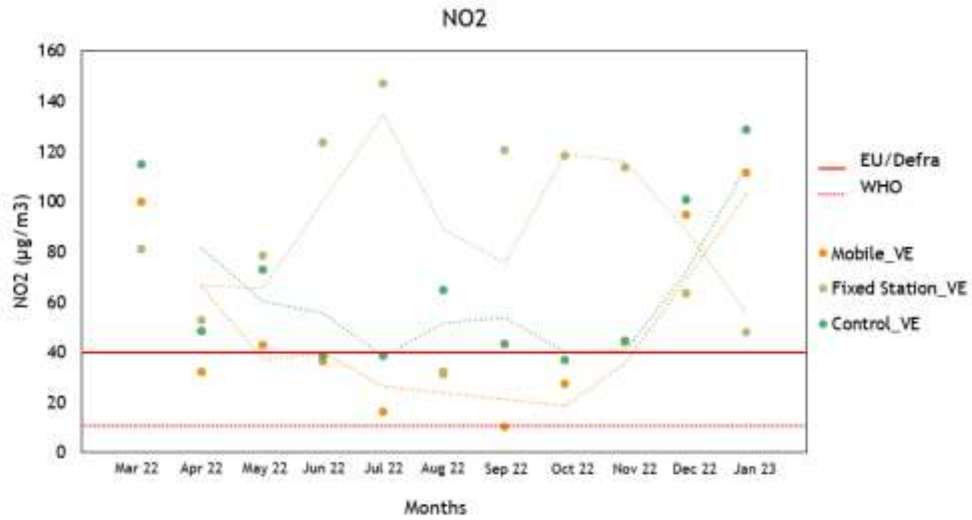
There are similar results for PM10 as explained in KPI0503.

<u>NOx Trends</u>

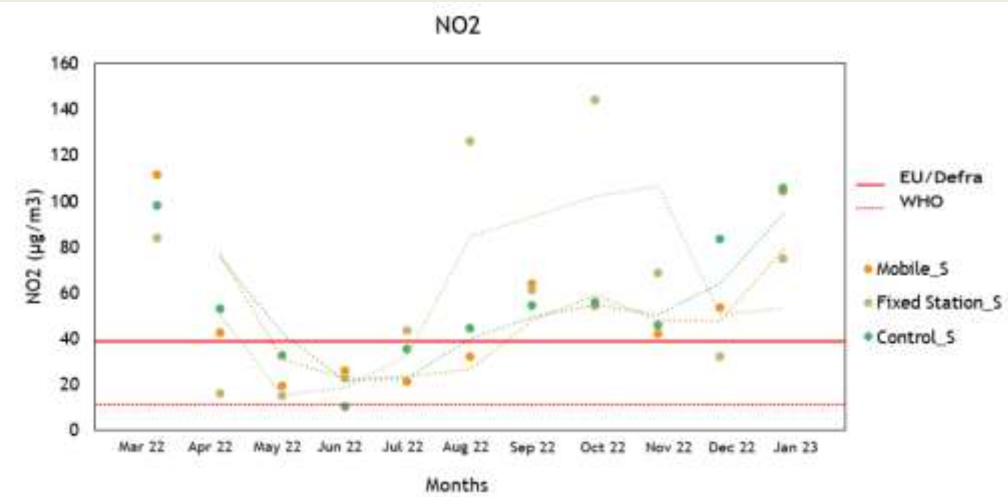
Measurement data and comparison of the mobile measurements for NO2 are shown in the table and figures below.

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/m³)	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).

SO2 Trends

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

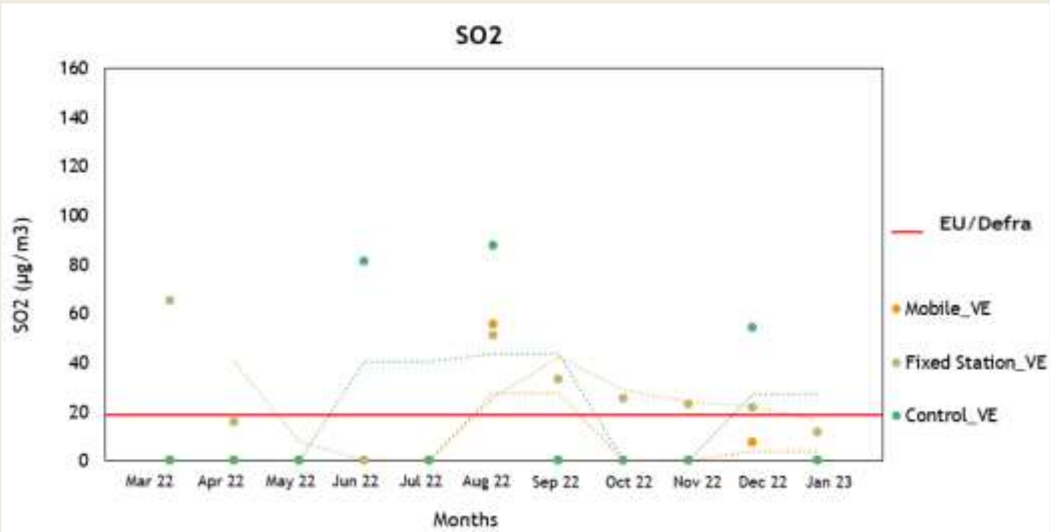


Figure 11: Comparison of the mobile measurement data at Vilayetler Evi (VE) (March 2022 - January 2023).

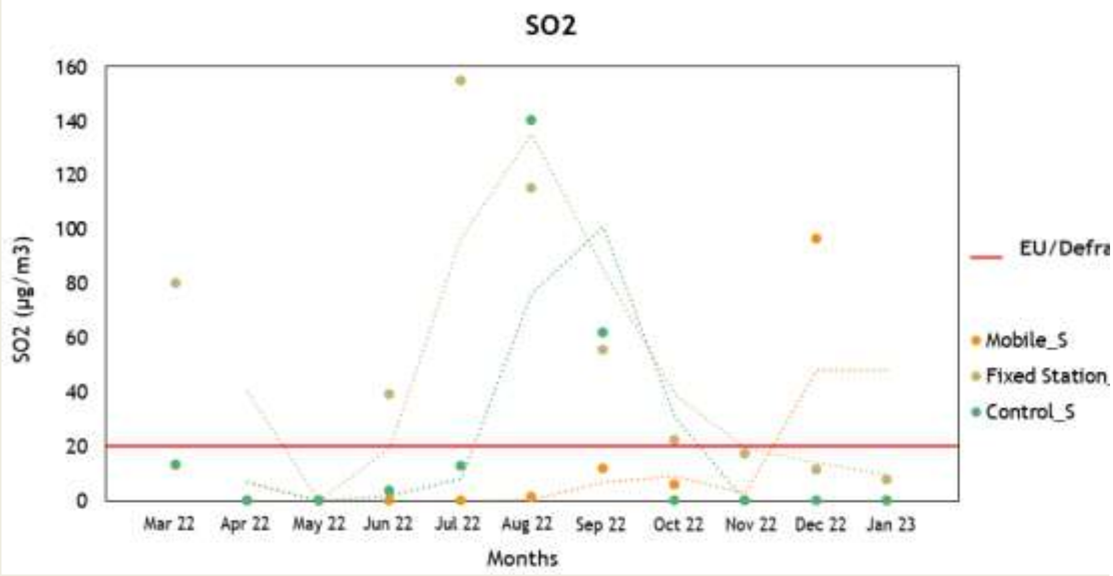


Figure 12: Comparison of the mobile measurement data at Sasali Natural Life Park (S) (March 2022 - January 2023).

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.

3.16.2 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.	-

3.16.3 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.

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	

3.17.1 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.

<u>Energy Saving</u>

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 m²	kW/h m²	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.

3.17.2 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	-

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	

3.18.1 Results and Discussion

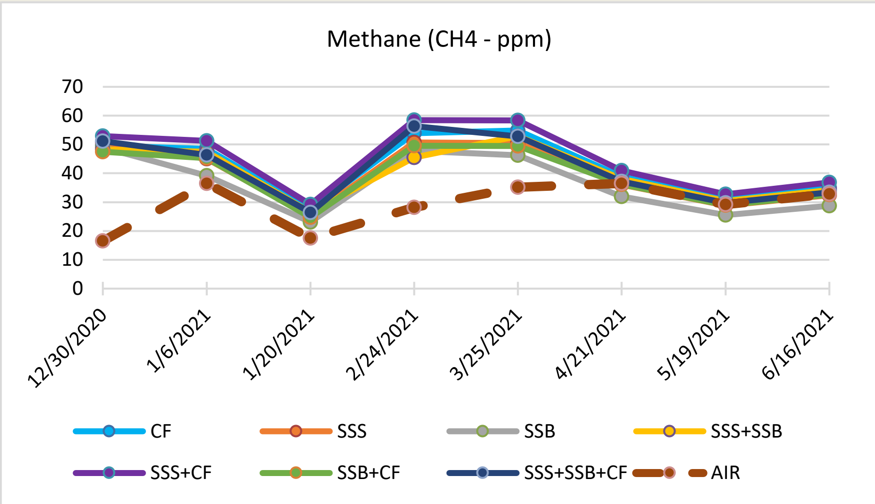
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

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.

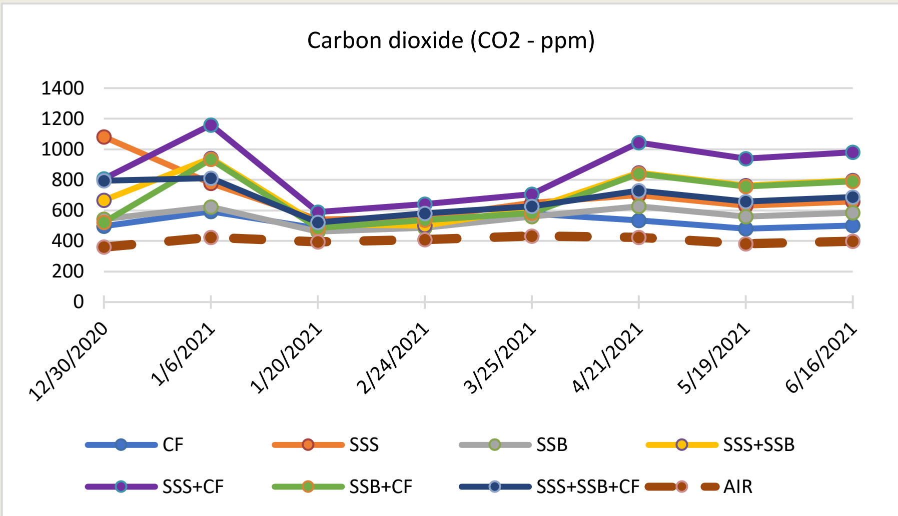
The application of sewage sludge improved the physical and chemical characteristics of the soil, and generally support microbial growth and activity. Depending on the application doses of the treated sewage sludge; a) 1% of the organic carbon content of the experimental soil; b) 10-50% of microbial activity and c) 5% of energy yield, were increased.

Global Warming Potential

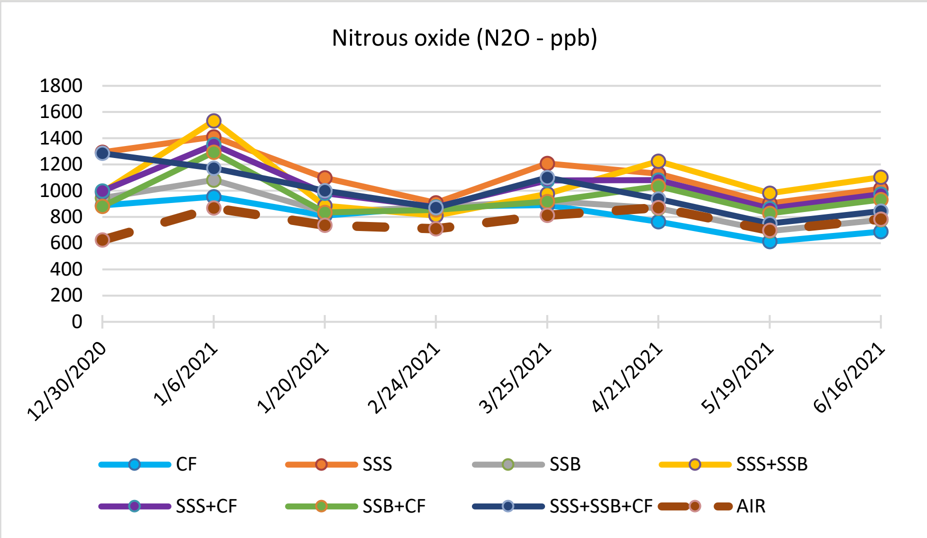
Biochar (SSB) applications caused a 9% reduction in methane emissions from soil to the atmosphere, 21% in CO2 and 22% in N2O compared to sewage sludge (SSS) applications. It is thought that biochar had this effect because it has stable carbon and improves the physical and chemical properties of soils.



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.

3.18.2 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.	

3.19 IAc19 Industrial Heritage Route

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH…; CH…; CH…	Industrial Heritage Route Along the Izmir Urban Green	IZM
CITY	*DATE OF IMPLEMENTATION*	
IZM	February 2020	

3.19.1 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.

3.19.2 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	-

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		

3.20.1 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.




3.20.2 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.	

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		

3.21.1 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*

3.21.2 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.	

3.21.3 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.

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		

3.22.1 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.

3.22.2 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

3.23 IAc23 Engagement Portal

RELATED KPI CODE	*NBS NAME*	*PARTNER(S)*
CH0802	Engagement Portal	IZM
CITY	*DATE OF IMPLEMENTATION*	
IZM		

3.23.1 Results and Discussion

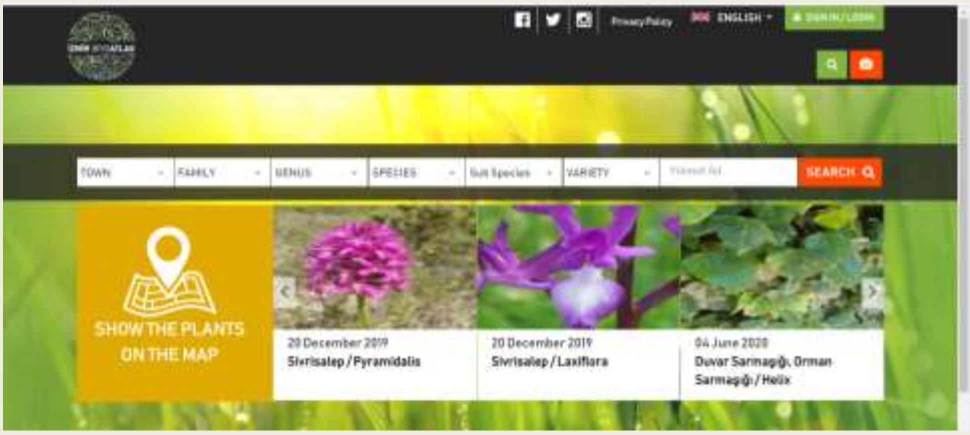
Discussion of results: In the results and discussion section, all the related KPIs will be put in common and contextualized in terms of the challenges addressed. This section should be supported with photos, tables, charts, maps, etc.

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.



3.23.2 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.	

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		

3.24.1 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/.

3.24.2 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.	