URBAN GreenUP

D5.8: Data collection and follow-up data management

WP 5 , T 5.4

31.05.2023

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Technical References

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[1] PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

CO = Confidential, only for members of the consortium (including the Commission Services)

Versions

Table 0-1: Table of contributions & versions of the deliverable

Version	Person	Partner	Date
V0.1	Kaan Emir	DEM	August 2020
V0.2	Clare Olver, Sarah Clement, Kaan Emir	CFT, UOLi DEM	September 2020
V1	Jesús Ortuño	GMV	16 Feb. 2021
V2	Kaan Emir	DEMIR	17 Feb. 2021
V3	Jesús Ortuño	GMV	18 Feb. 2021
V3.1	Clare Olver	CFT	21 Feb 2021
V3.2	Sarah Clement	UOL	28 Feb 2021
V3.3	Stella Shackel	CFT	01 March 2021
V3.4	Şerif Hepcan, Çiğdem Coşkun Hepcan, Merve Ozeren Alkan	EGE Landscape	01 March 2021
V3.5	Yusuf Kurucu, Tolga Esetlili, Hüsnü Kayıkçıoğlu	EGE Soil	01 March 2021
V3.6	Gülden Gökçen Akkurt, Gülşah Kaçmaz, Koray Velibeyoğlu	IZT, EGE	01 March 2021
V3.7	Ali Serdar Atalay	BIT	01 March 2021
V4	Kaan Emir	DEM	02 March 2021
V4.1	Jesús Ortuño	GMV	09 March 2021
V5	Kaan Emir	DEM	10 March 2021
V5.1 V5.2 V5.3	Juliet Staples, Stella Shackel, Sarah Clement	LCC, CFT, UOL	March 2021
V6	Kaan Emir	DEM	16 March 2021
V7	Stella Shackel	CFT	1 February 2023
V8	Gülden Gökçen, Isabel Sanches, Julies Staples, Ali Serdar Atalay, Esra Demir	IZT, VAL, LIV, BIT	10 March 2023
V8.2	Jesús Ortuño	GMV	13 March 2023

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0 Abstract

The current report set the basis and patterns to evaluate the data collection procedure of each frontrunner city during the monitoring period of the URBANGreenUp project. Deliverable 5.8 is a follow up of D5.7 that was conceived as a dynamic document that are developed during the monitoring months and updated with the real information during data collection by the front-runner cities.

Data recovered and KPI results will be evaluated from an overall concept that will assess the performance of the actions implemented.

The report aims to be the definitive version of D5.7 and serve as a guide document that records all the data procedures followed during the time span of the UrbanGreenUP project.

Chapter 2 expose the overview of the data collection or UrbanGreenUP

In Chapter 3, front-runner cities explain their data collection procedures by filling tables including the information for each KPI; the database code, the name of KPI, the unit, scale, metering specifications (Device, program or type of metering item), planned data collection frequency, description of output data, reporting frequency and start/end dates of reporting, baseline information, target to start monitoring (if it is not started), actual start date and actual frequency(if it is different than planned at first).

Chapter 4 is devoted to Success Stories and Failures. What worked and what had to be adapted and reviewed.

The most important outputs of this report is the explanation of current situation related with data collection and how the data is collected, stored and shared by front-runner cities.

1 Introduction

1.1 Purpose and Target Groups

The aim of this document is to present how the front-runner cities planned their data collection procedure to calculate the KPIs identified. It will help the cities follow up the data collection since different data is collected by different stakeholders, project partners.

Another purpose is to identify the global platform and how it will work with the local ones.

1.2 Contribution of Partners

During the preparation stage of this report DEM has prepared the structure in collaboration with CAR, GMV and BIT and coordinated the contributions of all other partners involved. GMV, BIT and DEM established chapter 2 and described the general information about the structure of data collection. All partners involved in monitoring studies from frontrunner cities contributed to chapter 3 and chapter 4. The roles and responsibilities of these partners explained in detail under section 2.3.

1.3 Relation to Other Activities in Project

The previous studies and deliverables of WP5 has set the basis of this document. The information provided under tasks; Technical KPIs definition, Sustainable ICT platform and raw data guidelines and City diagnosis and monitoring procedures updated and adapted into this document.

Besides these relations with other tasks of WP5, the studies under WP2, WP3 and WP4 which are directly related with implementation of NBSs and effecting monitoring activities has been considered during the preparation of this document.

2 Overview of data collection protocol

In this section the procedure followed during the UrbanGreenUP monitoring programme is summarized. Which protocols, data collection methods and procedures were chosen and the reason behind this.

Under task 5.4 the partner in charge, supervised remotely the raw data collected and the implementation of ICT platforms (when applicable, GMV-APP and the Izmir portal), and the implementation of the monitoring programme on each city. To monitor the monitoring to ensure compliance with the given guidelines and established schedule along the period.

This document followed a previous one. The aim of the current text is to explain what worked at the end and what was discarded and why.

2.1 Data Collection structure

The idea envisioned and decided during 5th Valladolid's Progress Meeting, by all partners' participants and demo cities, was to follow a Data collection Structure as the one shown on Figure 2.1. Each city must have their data storage locally and be responsible for their data. Then through a manual drag and drop procedure performed by each city, upload the data to be shared in a global repository. With the final objective to make this data accessible through EU Data Portal.

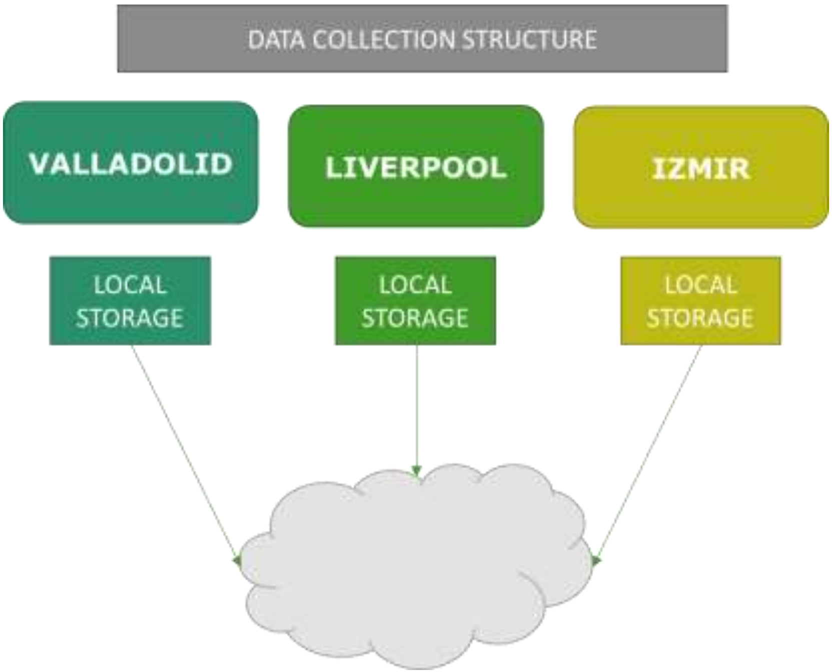


Figure 2-1: Data collection structure visual

One of the first considerations was using EU-Data Portal as a global repository beyond UrbanGreenUP project, this idea was discarded on behalf of a better founded tool that will ease the process and adapt better to UrbanGreenUP data requirements and FAIR principles. Zenodo data repository was selected as tool suitable for the UrbanGreenUP data requirements.

Even the UrbanGreenUP team by participating in the EU – sister projects Tasks Forces activities tried to homogenize the procedures found out that the best approach was to share the sharable data from Zenodo to the public, researchers, citizens and anyone with interest in accessing the data and perform further analysis.

At first the tool selected to comply with UrbanGreenUP requirements was Ckan.org that being open and easily scalable fitted the main purpose.

> *CKAN provides a streamlined ways to make the data discoverable and presentable. It provides datastore extension and has advanced geospatial features covering data preview, search, and discovery. Where structured data with location information is loaded into CKAN's Datastore, CKAN can plot the data on an interactive map. With the spatial extension enabled, CKAN can understand a location associated with a dataset, and use this to offer geospatial search capabilities via the web interface and API. A user searching for datasets can filter the results by geographical location, specifying a bounding box to limit the area they are interested in. CKAN understands different co-ordinate geometries and location information accordingly. CKAN includes tools to import geo-coded metadata in several formats and make it queries ('discoverable') according to the INSPIRE standard. It can import major metadata schemas such as ISO19139, GEMINI 2.1 and FGDC can handle records hosted in a variety of ways, including the geospatial CSW standard, WAFs, ArcGIS portals, Geoportal Servers and Z39.50 databases. CKAN can also serve geospatial packages via its own CSW interface. The architecture is extensible, making it easy to support other standards and distribution services.*

CKAN's data previewing tool has a host of powerful features for previewing data stored in the DataStore.

Table view: If structured data is uploaded or linked to CKAN as a .csv or Excel table, the DataStore loads it into a database, allowing CKAN to give a range of ways to view and process the data. Initially it is displayed as a table. The user can sort the data on particular columns, filter or facet by values, or hide columns entirely.

Graphing data: You can also display the data on a graph, choosing the variables on the axes and comparing a number of variables by graphing them together on the same y-axis.

Mapping data: If the table has columns that CKAN recognises as latitude and longitude, it can plot the data points on a map, which can be panned (dragged) and zoomed. Selecting a data point displays all the field values in the corresponding row.

Image data: CKAN's previewing is not restricted to tabular data. Common image formats will be displayed, and if a resource is a web page, it will also be previewed directly in the CKAN dataset

CKAN supports the [DCAT standard] (https://github.com/ckan/ckanext-dcat) for data catalogue metadata, so data can also be federated from other non-CKAN catalogues.

This plan was made because of a due to ambiguity on the proposal and missing the key parts on the Data Management Plan where wasn't clear the responsibility of the data storage.

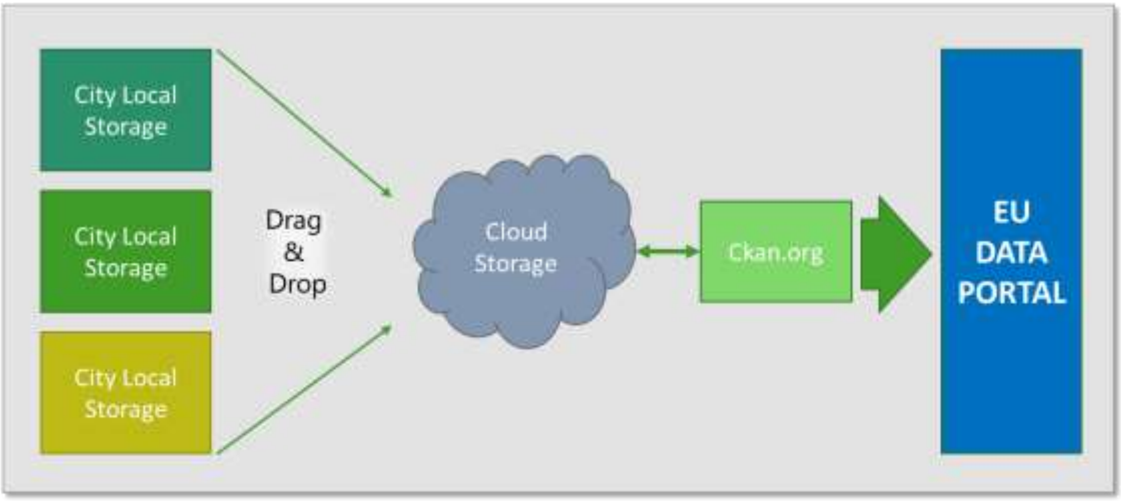


Figure 2-2: Data collection structure visual

Erasing the last bit of what shown in Figure 2.2. UrbanGreenUP Data was already being stored in each of the cities Local Storage, and through our global repository the data could be shared between partners within the project.

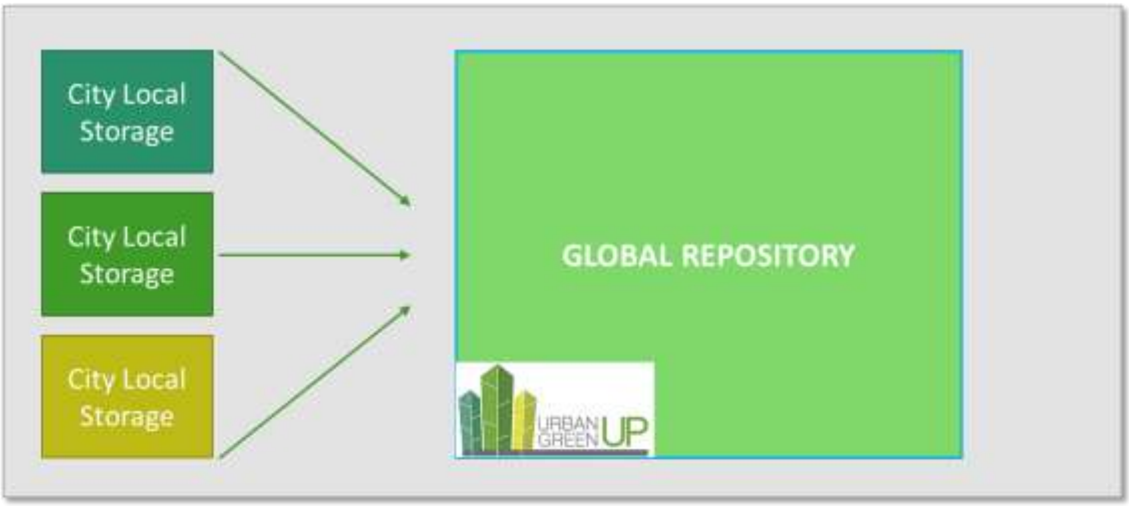


Figure 2-3: Data collection structure visual

To comply with milestone regarding to openness and scalability of the data produced during the monitoring per each city the idea was to use tools already provided and being use in the project. That's where the idea on using NextCloud as Global Repository (Figure 2.3.) falls on it.

NextCould is a Cloud Service that UrbanGreenUP is currently using and will match perfectly with the approach sought here.

In addition, we aimed to share all the sharable data through EC cofounded Open Science portal Zenodo. Zenodo it's a general-purpose open access repository, that allows to upload files up to 50GB, provides a Digital Object Identifier (DOI) for citations and could be linked with GitHub and Binder for further developments, and free. Zenodo follows the FAIR principles (Findable, Accessible, Interoperable, Reusable) that complies and go beyond UrbanGreenUP requirements. Allowing the project to have the knowledge and data produced secured forever, as Zenodo will be online at least for the next 50 years.

2.1.1 Supervision data sheet (city_template)

The information about data collection is provided by each frontrunner city within this report. Supervision data sheets have been prepared and specialized for each KPI going to be measured or calculated by partners involved. These supervision data sheets have been prepared by taking into consideration the outputs of the report and delivered to each partner to follow their studies in terms of the frequency of data collection described by those partners.

2.1.2 Data Format

The rationale followed on the choice for a data format has been versatility and compatibility. Having in mind the variety of indicators calculated by different partners can lead to a variety of types of formats the main challenge here is to identify the most common and spread indicators that can match our final goal, which is scalability and openness to a broad public.

In that sense the preference for .csv type files has been major, due to versatility and indicators' requirements. Nevertheless, there will be some indicators that could be stored and serve into a spatial format that can be shapefile (.shp) for spatial vector data or TIFF for raster imagery. As well that GeoJSON format due to compatibility could be use as well. As long as PDF for key performance indicators that will be deliver as reports.

2.1.3 Data Folder Structure

In order to create paths that can be easily followed, and other tools could, if there is a will, scaffold on the information created. Is one of the most essential aspects considered in data management to have an organized data repository.

The key elements to consider must be the names, therefore we established code for each of the indicators. Also, the structure of the data, that's why was created a guideline of a proposed structure for each of the cities local storage that then will be easily merge into the global repository, and the relationships between the data.

Filing structure enable research process and helps the user accessing the requested information, file plans build consistency and continuity. Creating a standard for the project have help the team to collect and work through the data analysis. It was proposed a simple structure:

Each of the cities will have they folder in the root folder of the project:

```
//URBANGREENUP/<City>
```

In each of the city folders will be contain a city KPI template of the indicators collected with all the information requested, in excel format:

```
URBANGreenUP/<City>/City_Template_Final.xls .
```

This is a summary document shared by cities, shows the owner of KPIs, Overall status, detail, and start- last measurement date.

In each city folder there will be folder per KPI, named after their KPI CODE:

`URBANGreenUP /<City>/KPI-<Number>/`

The folder will contain information of the indicator, in the collected format and also a metadata file:

`URBANGreenUP /<City>/KPI-<Number>/Readme.Metadata`

In the case in which the indicator as to be collected in different periods could be use the following structure for each of temporal collections:

`URBANGreenUP /<City>/KPI-<Number>/YYYY-MM-DD/`

The mandatory rules are collecting the data format in the KPI CODE folder, the rest are optional, as each of the KPI could present variations and allowing some flexibility, that helped in the adaptation for all the entities working in the same process.

2.2 Datasets

The collection of data for the UrbanGreenUP project as being selected following principles of using what is already working and in use, worth exploring or practical. Therefore, one of the main elements was provide a guide that will encourage this, focusing on the long run for the sustainability of the procedures.

The basic and essential guide for the data was served to all partners following the next conventions:

Title
Name of the dataset or research project that produced it

Creator (Owner of KPI)
Names and addresses of the organization or people who created the data

Identifier
Number used to identify the data, even if it is just an internal project reference number

Dates
Key dates associated with the data, including KPI measurement start, end date, data modification data release date, and time period covered by the data

Subject
Keywords or phrases describing the subject or content of the data

Rights
Any known intellectual property rights held for the data

Language
Language(s) of the intellectual content of the resource, when applicable

Location

Where the data relates to a physical location, record information about its spatial coverage, Sensor number etc.

File Types, Data Formats used in the data sets

This will include description of all file types and data formats contents of csv file if any. For example, simple folder may include, QGIS project file in XML format (.qgz), data file (.csv), KMZ file (.kmz), shp file ESRI shape file format and. json based Questionnaire file. It is also important to show the location of the KPI result location. This can be in one the existing input files (such as .csv) or may be new output file. First row in the csv headers is expected to include columns representing the data format of the measurements

Data Format Checker

It was an early idea on having a data format checker in python environment code that can be supplied to all cities and will run periodically with or without Jenkins to check the format of the data supplied, to confirm automatically the consistency with metadata and the guides provided. After some trials the procedure was discarded, as it wasn't appropriate for the purpose and didn't cover all the needs that the team could performed by doing it manually.

2.2.1 Global data repository

One of the early practices while the team was building the best solution for the global repository was having all collected in GMV Drive that was substituted by the global UrbanGreenUP repository in the NextCloud provided by ICONS as repository for all the data shared during the project life and two more years.

Following task forces it was adapted the Data management system may be managed with CKAN. CKAN is a powerful data management system and tools that makes data accessible – by providing tools to streamline publishing, sharing and visualization. The technical team ended discarding this solution in favour to additional most suitable solutions.

After exploring several options as the EuropeanDataPortal.EU to be the global repository of the monitoring data for beyond the project, the team found out that the best available option was Zenodo. As commented before. An EC cofounded open science data portal in which the UrbanGreenUP project can gather all the data produce during the project life and served it to the citizens by a well-known and used portal. As well as having the data stored forever free of charge, as being a free, public, and science-oriented portal not only allows researchers to upload data up to 50GB for free, but also ensure the availability of the data for the following 50 years.

2.2.2 Local data platforms

Valladolid

Valladolid city council uses a suite of client-server software that serves the purpose of using file hosting services and functions as other widely known cloud applications services. In the case of

Valladolid city, the suite is ownCloud. It is an open-source server with editing capabilities that allows anyone installing and operating without changes on their own private server. In that sense matches the main challenges that city local data must face. First store and protect the data. As well as being able to, eventually, have the capability to upscale and perform further uses with the data.

The capacity of the Local Storage is set by default on 10GB, with the possibility of expansion if needed. So far, that need hasn't been required. Less than 10GB of data is being storage until date (February 2021). Our estimations consider that more storage will be needed, and the queries have been sent already to be prepared and have enough space to continue the established roadmap of data production.

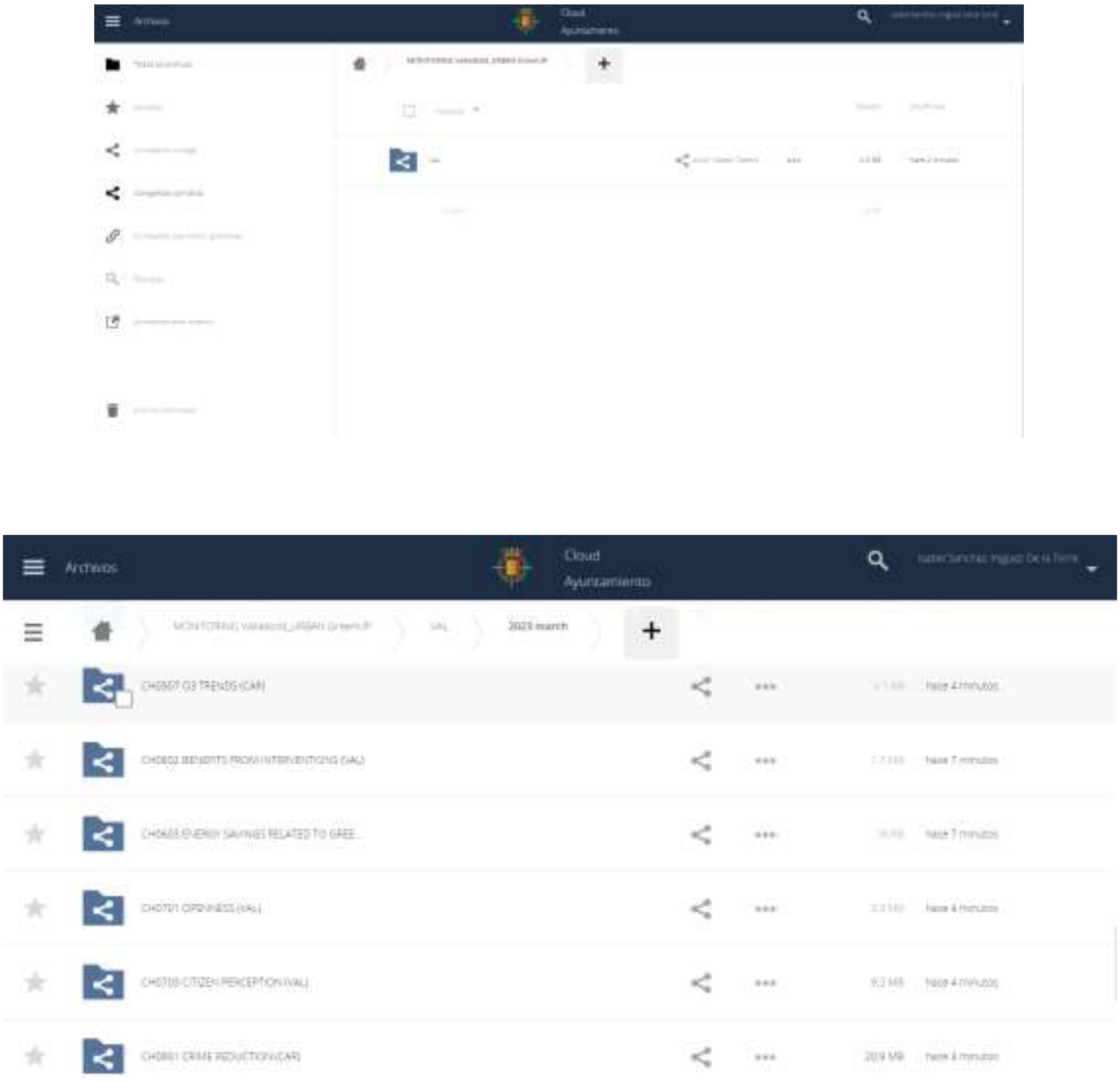


Figure 2-4: Screenshots of Valladolid local platform

Liverpool

Local data storage has continued to be on the Mersey Forest Sharefile, but in addition, the data has also been stored on the local portal site (see below).

In Liverpool the URBAN GreenUP partners worked with Liverpool John Moores University to develop a local data platform that would store the data and summary graphs and plots and be fully accessible to any interested parties after the project completed. The local portal data are equivalent to the EU repository and wider raw data and provide an initial visual interpretation of key project data and outputs. The portal has been designed with a home page that provides options for exploring the local data repository.

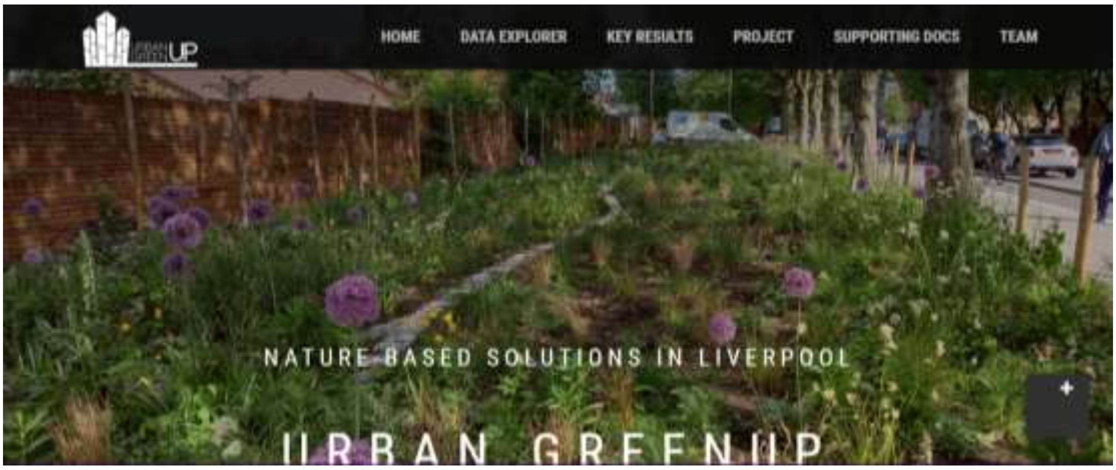


Figure 2-5: Screen shot of the Liverpool local portal home page.

The Home page provides a number of options to view information about the project, the project team or just some key headline data as shown below.

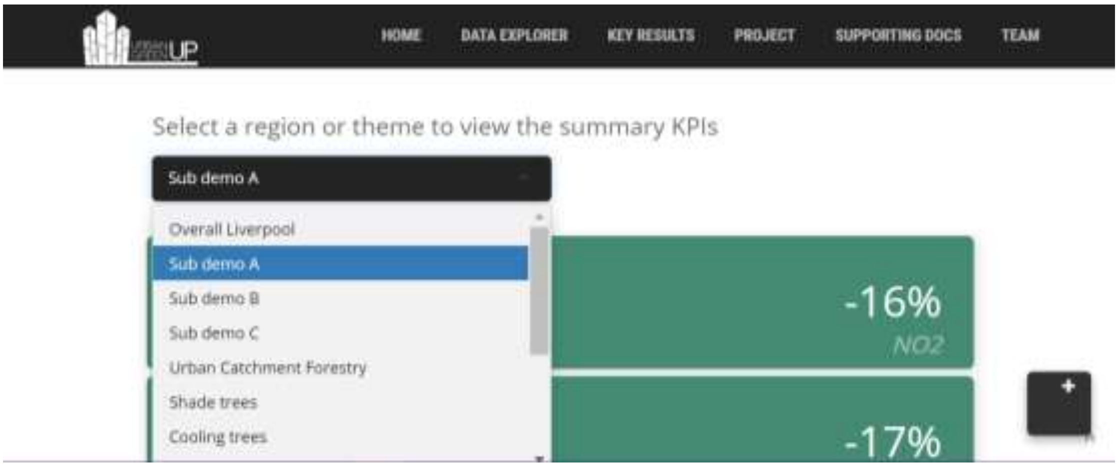


Figure 2-6: Key headline data is available for selected parameters across the different project areas and interventions

The key results tab accesses a city overview and allows the user to run a mouse over the highlighted sites where Nature Based Solutions have been installed. Each highlighted area reveals an image of the site and provides an option to click further to reveal a drop-down menu of data under various headings such as air quality, water quality, biodiversity etc.

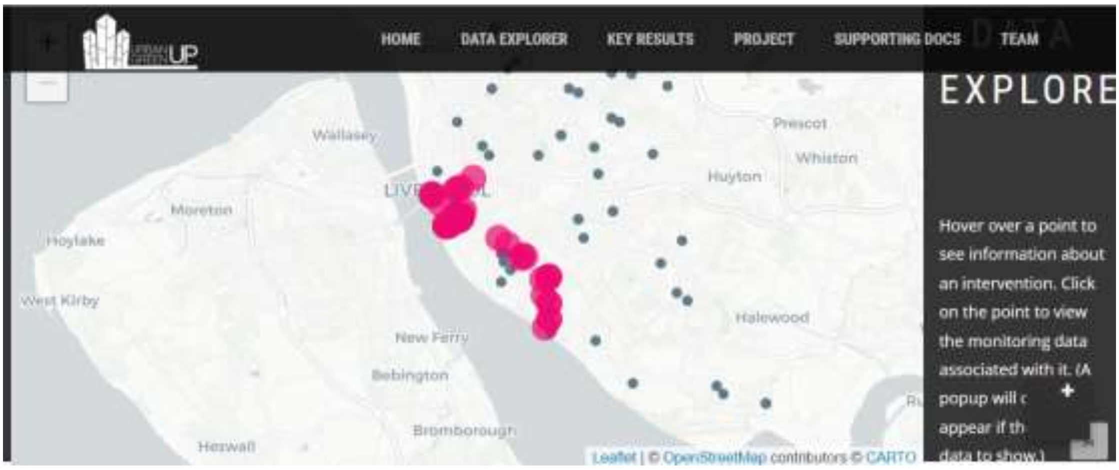


Figure 2-7: Highlighted circles on the map indicate the location of Nature Based Solutions

Figure 2-8: Hovering over a selected site reveals an image and by clicking further there is a drop-down menu of the different results available for the site

Figure 2-9: Tabs at the top of the screen provide drop down menus where data is presented graphically together with influencing variable data for factors like wind speed and direction.

The data graphs and plots are self-explanatory and include reference data for a control and baseline to allow fuller interpretation. WHO or other guideline thresholds are indicated on graphs. Social and economic data will also be included on the final portal. The local portal will include a weblink back to the EU portal for access to the raw data and will be read only, publicly accessible, and free of charge.

Storing the local data in this format ensures that it is easily accessible to a wide range of interested parties and that key project outcomes are promoted and communicated consistently.

İzmir

The local platform of the activities carried out in İzmir within the scope of the Urban GreenUp Project was created through ESRI software. The introduction page of the local platform was made available via ArcGIS Online, a cloud-based GIS software. Designed with various web applications of ArcGIS Online, web applications such as Experience Builder, Attachment Viewer, and StoryMaps are integrated into the platform.

Access to the platform is provided through the Experience Builder application and the home page is given in figure below.

Figure 2-10:. Izmir Local Platform Home Page

Nature Based Solutions, realized in İzmir within the scope of the project, has been integrated into the platform through the Attachment Viewer application. As a first step, ArcMap 10.8.1. A geodatabase of the solutions was designed with the software, this geodatabase was transferred to the online platform and displayed via Attachment Viewer. The code, name, description and image of the intervention made with the application can be displayed together with an interactive web map. The visual of the application is as in figure below.

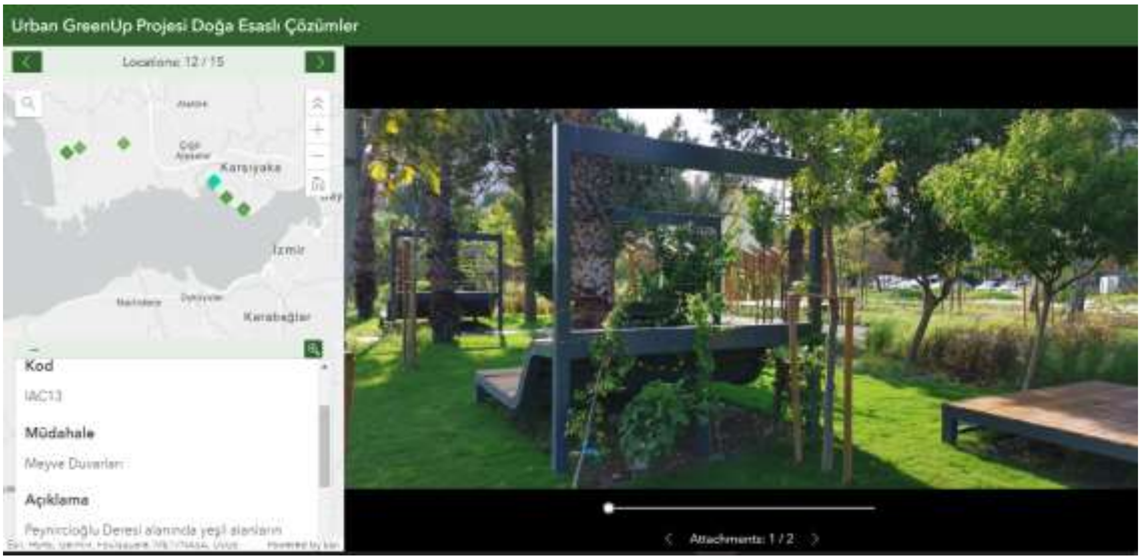


Figure 2-11: Details about Local intervention, locations

In addition, videos related to the project, air quality measurements and KPI results can be accessed through the local platform created.

The real-time, historical data for Air pollution, and meteoritical measurements is also available from link from the local program, This real-time Airqoon platform dashboard, historical data is shown as below, each location sensor data can be displayed and figure drawn for predetermined time interval as shown.

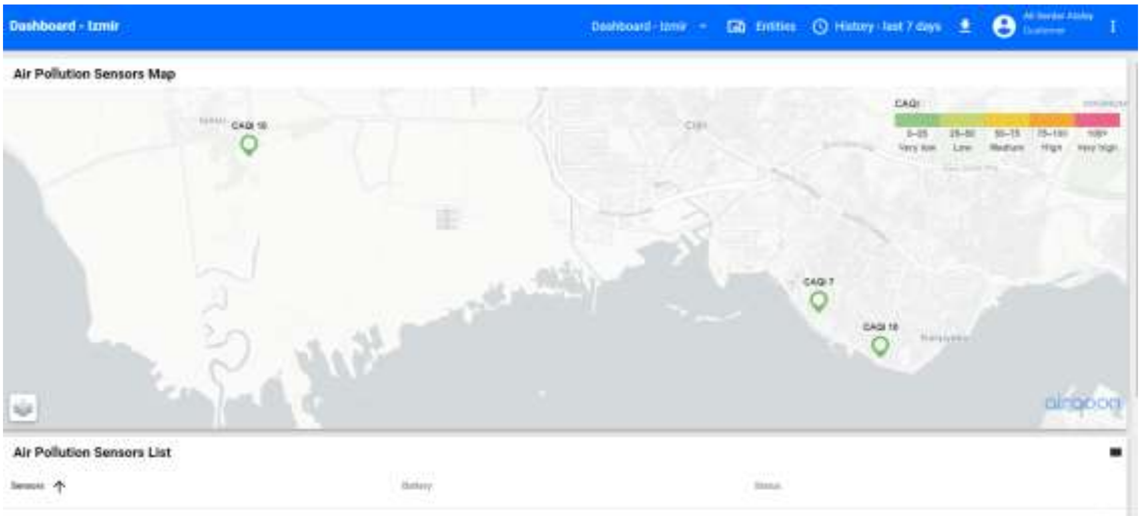
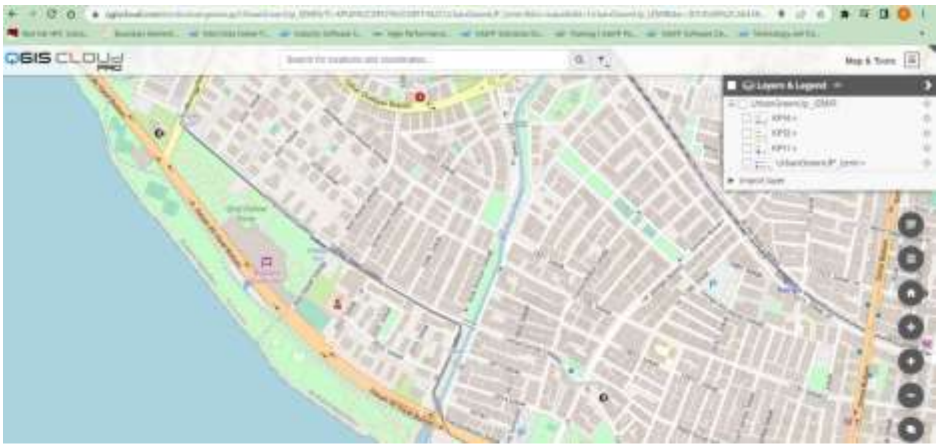


Figure 2-12: Screenshots of different KPIs.

QGIS CLOUD –

There is an open-source alternative to ESRI platform also developed but not deployed due to the requirements by Izmir city. The figures below show KPI level dashboard and local interventions list.



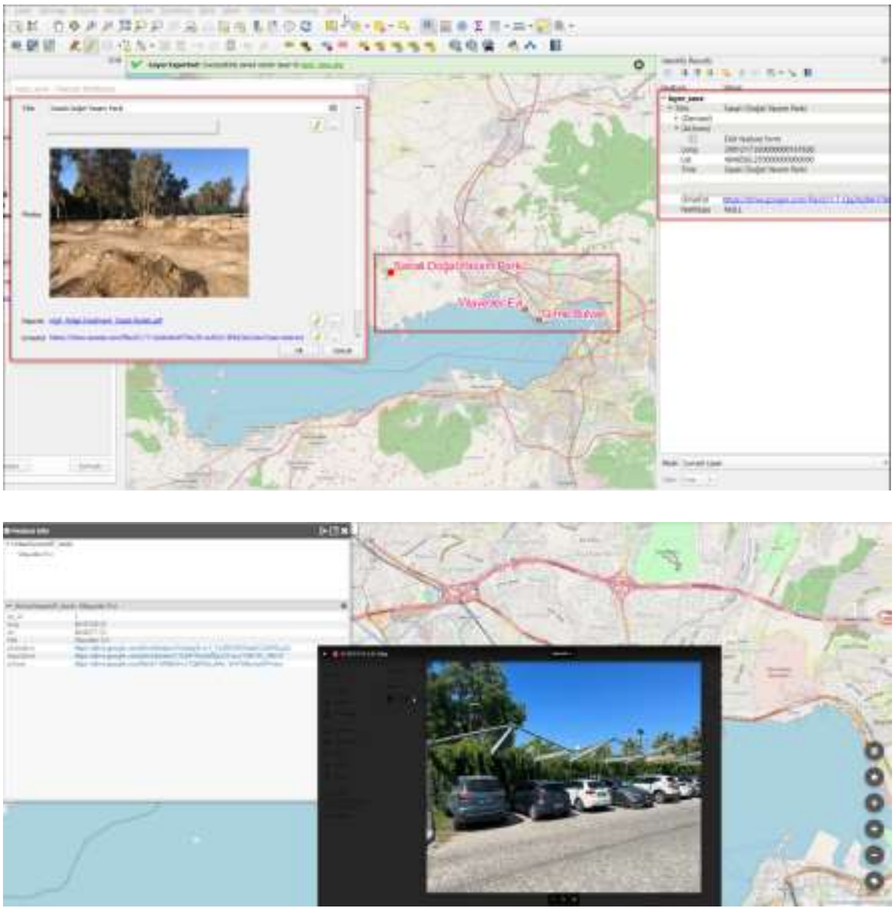


Figure 2-13: Qgis Cloud screenshots

Quarterly, Cumulative comparison reports can also be found using airgoon.notion.site[2]. The websites of the municipality, universities or other partners can also be linked by embedding the links of these applications.

2.3 Roles and Responsibilities

The roles and responsibilities of each city data collection procedure and the global data is explained in this section.

[2] https://airqoon.notion.site/2022-4-zmir-Urban-GreenUP-32e79335e5be4ccfafaacf93e5801895; https://airqoon.notion.site/2022-3-zmir-Urban-GreenUP-db5f85f584284dad8fe274f10909094c; https://airqoon.notion.site/2022-2-zmir-Urban-GreenUP-829b611bf06e4fd79081e33bb8c171b1; https://airqoon.notion.site/2022-zmir-Urban-GreenUP-d0c4e4e3a7b54ee79df876429bb3c0bc; https://see.airqoon.com/dashboard/a10046a0-7eab-11ec-b96e-d12d30e3aed0

2.3.1 Valladolid

2.3.1.1 Roles & responsibilities

The responsibility and the role of **Valladolid Local Data admin** shall be to securely store the data and 'drag and drop' the data to the global repository in the established timeframe.

In Valladolid demo city there are seven different partners providing data to calculate the KPI, during the time that Valladolid city council was preparing its own data storage, it was proposed to test the established procedure on a temporal data storage, and at the same time, monitor the performance of the indicators in order to being able to detect deviations, if any.

For that matter, GMV as leader of the WP and partner involved on the coordination of the monitoring for Valladolid demo, provided a cloud storage service, GMVDrive, to test the procedures.

GMV provided access to a project folder in GMVDrive where each of the partners could upload, edit, and download data. A specification sheet was provided and a KPI metadata templated too (shown in next section).

As the functions are widely and commonly spread (drag & drop) partners shall get used quickly to the service. As the same time that it can be monitor the production on data, it will be a good approach to estimate all data storage needs for the demo city.

Once the test shall finish the migration to the Valladolid Data Storage will be performed. Following the same folder structure, same procedures to lessen the impact of the change of platform.

For the metadata, start having a look to the example provided, and fill in for your KPI accordingly. Could happen that for the indicator that you are in charge of you don't have to complete certain field, because is not applicable. In that case don't complete it. Don't hesitate if you check the metadata template and you would like to suggest more fields, now there is still room for improvement.

The calculation of the KPIs is assumed by the entity with the best expertise among the partners of the Valladolid Demo. The following table contains the KPIs of Valladolid associated with the entity that calculates, where the reason for that expertise is included. Note that we have differentiated the entity responsible for the calculation (*Leader calculation*) from the entity providing the data (*Data provider/measure*).

Table 2-1: Leaders and expertise of the calculation of Valladolid Demo KPIs

Expertise	Challenge	Type	Code	KPI (D5.5)	Leader calculation	Data provider / measure
[CAR] CARTIF Technology Center						
[CAR] Technology center with expertise on Climate change	CHALLENGE 1: Climate mitigation & adaptation	Carbon savings	CH0101	Ton C02 CARBON REMOVED per Ha	CAR	VAL
		Carbon storage	CH0102	Ton C02 CARBON REMOVED per year	CAR	VAL
		Temperature reduction	CH0105	TEMPERATURE DECREASE	CAR	CAR
			CH0108	HEATWAVE RISK	CAR	CAR
	CHALLENGE 2	Physical	CH0207	TEMPERATURE REDUCTION	CAR	VAL
[CAR] Technology center with expertise on Spatial planning and GIS	CHALLENGE 4: Green Space Management	Social indicators (benefits)	CH0401	GREEN SPACE DISTRIBUTION (m2/capita)	CAR	VAL
			CH0402	GREEN SPACE DISTRIBUTION (km cycle lane/capi	CAR	VAL
			CH0403	GREEN SPACE ACCESSIBILITY	CAR	VAL
			CH0408	GREEN INFRASTRUCTURE CONNECTIVITY	CAR	VAL
	CH9: Public Health and ...	Health indicators	CH0902	WALKING AREA INCREASE	CAR	VAL/GMV
			CH0903	CYCLING AREA INCREASE	CAR	VAL/GMV
[CAR] Expertise on Biodiversity	CHALLENGE 4	Biological	CH0412	POLLINATOR SPECIES INCREASE	CAR	CAR
[CAR] Expert on Air pollution	CHALLENGE 5: Air Quality	Social (physiological)	CH0509	AIR QUALITY PARAMETERS NO2	CAR	CAR
			CH0510	AIR QUALITY PARAMETERS O3	CAR	CAR
			CH0511	AIR QUALITY PARAMETERS PM	CAR	CAR
[CAR] Expert on Sustainability and NBS	CHALLENGE 8	Social justice	CH0801	CRIME REDUCTION	CAR	VAL
	CHALLENGE 9	Psychological	CH0901	NOISE REDUCTION	CAR/SGR	VAL
[LEI] LEITAT Technology Center						
[LEI] Technology center with expertise on Energy efficiency	CH7: Participatory Planning and	Economic	CH0109	ENERGY SAVINGS FROM REDUCED BUILDING ENE	LEI	VAL
			CH0110	CARBON SAVINGS FROM REDUCED BUILDING ENE	LEI	VAL
	CH6: Urban Regeneration	Economic	CH0603	ENERGY SAVINGS RELATED TO GREEN INFRASTRUCTURE	LEI	VAL/LEI
[LEI] Expertise on Waste water treatment systems	CHALLENGE 2: Water Management	Chemical indicators (water quality)	CH0211	NUTRIENT ABATEMENT (COD)	LEI	VAL
			CH0212	NUTRIENT ABATEMENT (BOD)	LEI	VAL
			CH0213	NUTRIENT ABATEMENT (Total Solids, SST)	LEI	VAL
[CEN] CENTA, Technology Center						
[CEN] Technology center with expertise on Sustainable Water Management.	CHALLENGE 2: Water Management	Physical indicators	CH0201	RUN-OFF COEFFICIENT	CEN	VAL
			CH0204	ABSORPTION CAPACITY (m3/m2)	CEN	VAL
			CH0205	ABSORPTION CAPACITY (m3/tree)	CEN	VAL
		Economic	CH0216	IRRIGATION WATER PROVISION	CEN	VAL
			CH0217	WATER REMOVED FROM THE WATER TREATMENT	CEN	VAL
			CH0218	SAVINGS IN TREATMENT OF STORMWATER	CEN	VAL
		Spatial	CH0208	INTERCEPTED RAINFALL	CEN	VAL
[VAL] Valladolid City Council						
[VAL] Local Entity that analyses the citizen's response.	CHALLENGE 6: Urban Regeneration	Socio-cultural	CH0602	BENEFITS FROM INTERVENTIONS	VAL	VAL
	CHALLENGE 7: Participatory Planning and	Social	CH0701	OPENNESS	VAL	VAL
			CH0704	CITIZEN PERCEPTION	VAL	GMV
	CHALLENGE 4: Green Space Management	Social indicators (benefits)	CH0406	RECREATIONAL VALUE	VAL	GMV
			CH0410	GREEN AREAS SUSTAINABILITY	VAL	GMV
[VAL] Manage municipal orchards			CH0411	FOOD PRODUCTION	VAL	VAL
[VAL] Local Entity in charge of local communication	CHALLENGE 8: Social Justice and Social Cohesion	Social cohesion	CH0802	GREEN INTELLIGENCE AWARENESS (Educational actions)	VAL	VAL
			CH0803	GREEN INTELLIGENCE AWARENESS (Communication activities)	VAL	VAL/GMV
[GMV-S] GMV, SA (company)						
[GMV-S] IT private company that programes the Mobile App	CH4: Green Space Management	Social indicators (benefits)	CH0407	ELDERLY PEOPLE LIFE QUALITY	GMV	GMV
			CH0409	CONNECTIVITY PERCEPTION	GMV	GMV

[ACC] Acciona Ingeniería, SA (company)						
[ACC] Private company with expertise on economic analysis.	CHALLENGE 5	Economic	CH0508	AIR QUALITY MONETARY VALUES	ACC	VAL
	CH10: Potential of economic opportunities and green jobs	Economic	CH1001	TAX REDUCTION	ACC	VAL
			CH1002	SUBSIDIES	ACC	VAL
			CH1003	JOB CREATION	ACC	VAL
			CH1005	NEW BUSINESSES	ACC	VAL
			CH1006	CONSUMPTION BENEFITS	ACC	VAL

2.3.1.2 Process

In Valladolid a first version of the data storage was stored in GMV's cloud, as responsible for the monitoring of WP2. Once it is up and running, and the technical requirements have been determined, the information has been migrated to Valladolid City Council's cloud. This has taken place in good time before the end of the project (expected June 2022).

During the duration of the European project, the partners responsible for the calculation of each KPI have uploaded the result to the City Council's cloud. Once the project is finished, it is difficult for the partners to continue this manual work, due to lack of personnel attached to the EU project. However, the storage system will continue to operate with the automatic capture data.

2.3.2 Liverpool

2.3.2.1 Roles & responsibilities

The responsibility for local data admin in Liverpool will be split between the partners. Mersey Forest will provide digital data storage space (unlimited) on a shared site (ShareFile) to which all partners have controlled access and can upload, and store collected data in agreed formats.

In Liverpool the role of the Local Data admin is to ensure that the data is securely stored and periodically, at an agreed time, uploaded to the global repository.

The data across Liverpool is stored locally in the Mersey Forest ShareFile. This is a secure cloud-based storage system with unlimited storage. It is also backed up to the Research Data Store at the University of Liverpool, with a capacity of 1 TB. These data stores are password protected, comply with the GDPR, and can only be accessed by those directly associated with the project. There is more than enough capacity for all project data to be stored in these sites.

In line with ethical approval conditions, only aggregated social and economic data is backed up to shared files during the project to protect the anonymity of respondents. Once data collection is complete, all socio-economic data will be anonymised, aggregated, and uploaded to shared drives for sharing with project partners. This data will be reviewed by all partners (UOL, LCC, and CFT) to ensure it does not compromise confidentiality requirements.

Data will be uploaded by identified project partners at agreed intervals for each KPI. Checks on uploaded data will be made by the LCC Project Officer (or another identified project partner) who will have responsibility to drag and drop the data in the global repository in the established time frame.

The data collection and analysis of the KPIs within Liverpool has been undertaken by the organisation with the appropriate expertise among the partners. It should be noted that most of the environmental monitoring outlined in the research proposal was planned to be undertaken by a PhD candidate at the University of Liverpool, however following their departure, the biophysical KPIs as well as a few others were picked up by Community Forest Trust. The University of Liverpool, in collaboration with the University of Manchester, have focused on the socio-economic KPIs and have financially supported the biophysical monitoring and analysis in several ways as well as developing postgraduate research projects to support the project and explore these KPIs in new ways.

The following tables show the lead partners for the different KPIs within Liverpool.

Table 2-2: Leaders and expertise of the calculation of Liverpool Demo KPIs

CHALLENGES	TYPE OF INDICATORS	CODE	KPI NAME	Lead
CHALLENGE 1: Climate mitigation & adaptation	**Carbon savings per unit area**	**CH0103**	CARBON STORED	CFT with LJMU
		CH0104	CARBON SEQUESTRATION	CFT with LJMU
	Temperature reduction (environmental, physical)	**CH0105**	TEMPERATURE DECREASE	CFT
		CH0106	TEMPERATURE REDUCTION (PROJECTION)	CFT with LJMU
		CH0108	HEATWAVE RISK	CFT with LJMU
	Other	**CH0111**	SPECIES MOVEMENT	CFT with LJMU
CHALLENGE 2: Water Management	**Physical indicators**	**CH0201**	RUN-OFF COEFFICIENT	CFT
		CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	CFT
	Chemical indicators (water quality)	**CH0207**	NUTRIENT ABATEMENT (COD)	CFT
			NUTRIENT ABATEMENT (BOD)	not monitored
		CH0209	NUTRIENT ABATEMENT (SST)	CFT
	Chemical indicators (water quality)	**CH0211**	WATER REMOVED FROM THE WATER TREATMENT	CFT with LJMU
		CH0212	SAVINGS IN TREATMENT OF STORMWATER	CFT with LJMU
CHALLENGE 4: Green Space Management	**Social indicators (benefits)**	**CH0403**	GREEN SPACE ACCESSIBILITY	UOL/UOM
		CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	UOL/UOM with CFT
	Environmental (biological)	**CH0410**	POLLINATOR SPECIES INCREASE	CFT
		CH0412	FLORAL RESOURCES INCREASE	CFT
		CH0411	PLANT SPECIES INCREASE	CFT
		CH0413	INSECTIVORE INCREASE	CFT
CHALLENGE 5: Air Quality	**Social (physiological)**	**CH0501**	DEATHS RELATED TO POLLUTION AND CONTAMINATION	CFT

CHALLENGES	TYPE OF INDICATORS	CODE	KPI NAME	Lead
		CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	CFT and LCC
		CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	CFT and LCC
		CH0504	NOx TRENDS	CFT and LCC
		CH0505	Sox TRENDS	Stopped
		CH0506	VOC TRENDS	not monitored
	Economic	CH0508	Mitigation through cooling and sequestration	CFT with LJMU
		CH0509	Energy savings	CFT with LJMU
		CH0510	Increase in property value	UOL/UOM
		CH0511	Value of air quality improvements	CFT with LJMU
		CH0512	Value of air pollution reduction	CFT with LJMU
		CH0513	Total monetary value of urban forests including air quality	CFT with LJMU
CHALLENGE 6:	**Socio-cultural indicators**	CH0602	Benefits from Interventions	UOL/UOM
CHALLENGE 7: Participatory Planning and Governance	**Social**	CH0703	Social learning	UOL/UOM
		CH0702	Citizen perception	UOL/UOM
		CH0705	Engagement with NBS	UOL/UOM
CHALLENGE 8: Social Justice and Social Cohesion	**Social justice**	CH0801	Crime reduction	UOL with LCC
CHALLENGE 9: Public Health and Well-being	Health indicators related to ecosystem service provision (Buffering of noise and air pollution, reduced heat, exposure to microflora).	CH0902	Walking area increase	**CFT with LCC**
		CH0903	Cycling area increase	**CFT with LCC**
		CH0904	Health quality perception	UOL/UOM
Potential of economic opportunities and green jobs	**Economic**	CH1002	Job creation	UOL/UOM
		CH1004	Land and property price change	UOL/UOM
		CH1005	New businesses	UOL/UOM
			Job creation	NOT DOING

2.3.2.2 Process

In Liverpool the final data is being uploaded to the local portal and will be made publicly available and free of charge at the end of the project (expected June 2023). The city will promote the portal and ensure that there is a weblink that allows users to access the raw data stored in the EU repository site.

The value of the local portal is to ensure that the data is accessible in an easy format to all and to ensure that we can promote the key benefits and outputs consistently after the project has finished.

2.3.3 Izmir

2.3.3.1 Roles & responsibilities

BitNet and DEM handled the responsibility of periodically collecting and administrating the data for Izmir. Other project partners responsible for KPIs uploaded the data to the google drive provided by BITNet. The capacity of Local storage will be 1TB allowing enough redundancy.

DEM also has the responsibility for delivering data to global cloud periodically. This ise handled by additional server and network in off business hours to make sure to provide no load to user accesses by local teams.

Table 2-3: Leaders and expertise of the calculation of Izmir Demo KPIs

CHALLENGES	TYPE OF INDICATORS	CODE	KPI NAME	Lead
CHALLENGE 1: Climate mitigation & adaptation	**Carbon savings per unit area**	**CH0102**	Ton C02 CARBON REMOVED per year	EGE Landscape
		CH0103	CARBON STORED by soil	EGE Landscape
		CH0104	CARBON SEQUESTRATION	Ege Landscape
	Temperature reduction (environmental, physical)	**CH0105**	TEMPERATURE DECREASE	IZT+EGE Landscape+BIT
		CH0106	TEMPERATURE REDUCTION (PROJECTION)	IZT+EGE Landscape+BIT
		CH0107	MEASURES OF HUMAN COMFORT	IZT+EGE Landscape
		CH0108	HEATWAVE RISK	IZT+EGE Landscape
	Energy and carbon savings from reduced building energy consumption (environmental, physical)	**CH0109**	kWh savings per year	IZT
		CH0110	t C/y savings per year	IZT
	Other	**CH0112**	Global Warming Potential (GWP; 100-year horizon)	EGE Soil

CHALLENGES	TYPE OF INDICATORS	CODE	KPI NAME	Lead
CHALLENGE 2: Water Management	**Physical indicators**	**CH0213**	RUNOFF ESTIMATION OF BIOSWALES IN BIOBOULEVARD	EGE Landscape
CHALLENGE 4: Green Space Management	**Social indicators (benefits)**	**CH0403**	GREEN SPACE ACCESSIBILITY	IZT
		CH0406	RECREATIONAL VALUE	IZT
		CH0409	FOOD PRODUCTION	IZM
	Environmental (biological)	**CH0410**	POLLINATOR SPECIES INCREASE	EGE Landscape
		CH0411	PLANT SPECIES INCREASE	EGE Landscape
CHALLENGE 5: Air Quality	**Social (physiological)**	**CH0502**	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	IZT+BIT
		CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	IZT+BIT
		CH0504	NOx TRENDS	IZT+BIT
		CH0505	Sox TRENDS	IZT+BIT
		CH0508	POLLUTANT REMOVED BY VEGETATION	EGE Landscape
CHALLENGE 6:	**Socio-cultural indicators**	**CH0601**	Green Space Quantity	IZT
CHALLENGE 7:	**Social**	**CH0702**	Citizen Perception	IZT
Participatory Planning and Governance		**CH0704**	Urban Farming Educative/ participate activities, Learning for producers	IZT+EGE Soil
		CH0706	Urban Farming Activities - Energy Saving Kwh	EGE Soil
		CH0707	Urban Farming Activities - Water Savings	EGE Soil
CHALLENGE 8: Social Justice and Social Cohesion	**Social justice**	**CH0802**	Green Intelligence Awareness (Educational Actions)	IZT+IZM
		CH0803	Green Intelligence Awareness (Inhab. Attended)	IZT+IZM
CHALLENGE 9: Public Health and Well-being	**Health indicators related to ecosystem service provision (Buffering of noise and air pollution, reduced heat, exposure to microflora).**	**CH0902**	Walking area increase	**IZT**
		CH0903	Cycling area increase	**IZT**

CHALLENGES	TYPE OF INDICATORS	CODE	KPI NAME	Lead
Potential of economic opportunities and green jobs	**Economic**	**CH1002**	Job creation	UOL/UOM

2.3.3.2 Process

In Izmir the data was stored in BIT's cloud, as responsible for the helping the consortium of Izmir. The KPI's are calculated by the responsible parties. Once all the KPI's are calculated they are uploaded to the local platform. The data then is uploaded to the global platform in the format required towards the end of the project (December 2022).

The local platform has been chosen to with a lot of visuals for the public to easily understand. It will be embedded to the city website so that citizens will be able to reach easily.

2.3.4 Global Data Format Checker

For the metadata, shown in Figure 2.3. it was created a metadata checker to see if all the fields where in place per each KPI. Could happen that for each indicator that don't apply a certain field. In that case is not necessary. Some suggestions have been made and some new fields to the metadata may be added in the following months, once it is agreed upon all partners involved.

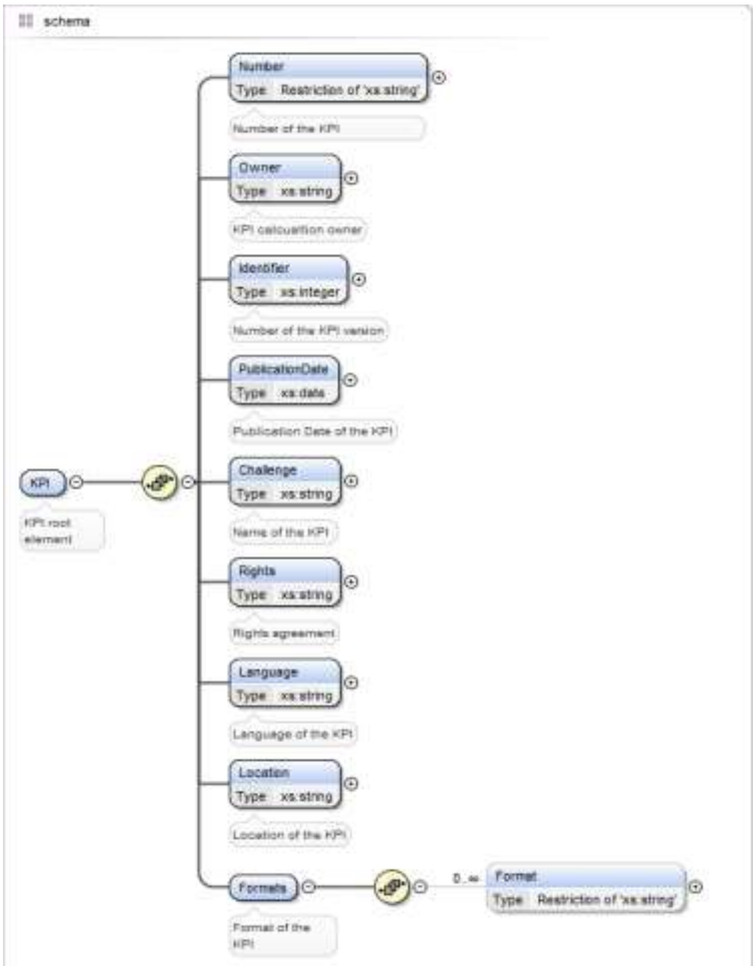


Figure 2-14: Metadata template

3 City Specific Data Collection Details

3.1 Valladolid

Table 3-1: Data Collection Details of Valladolid Demo

KPIs List Valladolid

CHALLENGES	TYPE OF INDICATORS	Code	KPI	Unit	SCALE R=Regional M=Metropolitan U=Urban S=Street B=Building	ECOSYSTEM SERVICES P. provisioning; R. regulating; S. supporting; C. cultural.	Metering specifications	DATA COLLECTION: FRECUENCY	DATA COLLECTION: OUTPUT DATA	REPORTING PERIOD: START/END	REPORTING PERIOD: FRECUENCY OF REPORTING	MONITORING RESULTS: BASELINE	MONITORING RESULTS: Target to Start	MONITORING RESULTS: Start	MONITORING RESULTS: Frequency
CHALLENGE 1: Climate mitigation & adaptation	Chemical	CH0101	Ton C02 CARBON REMOVED per Ha	(t CO2 / Ha)	>R	Regulation	Estimated (model, software)	Quarterly/Annual	Table values (csv, xlsx)	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
		CH0102	Ton C02 CARBON REMOVED per year	(t CO2/year)	>R	Regulation		Quarterly/Annual	Table values (csv, xlsx)	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
	Physical	CH0105	TEMPERATURE DECREASE	(°C)	R M U	Regulation	Sensor UGU	Hourly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M33	M41	Annual
		CH0108	HEATWAVE RISK	(nº days)	R M U	Regulation	Sensor UGU	Hourly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M33	M41	Annual
	Economic	CH0110	ENERGY SAVINGS FROM REDUCED BUILDING ENERGY CONSUMPTION	(kWh/year)	R M U S B	Regulation	Statistical data measured UGU	Daily	Table values (xlsx)	M36/M60	Quarterly	0	M36	M39	Quarterly
		CH0111	CARBON SAVINGS FROM REDUCED BUILDING ENERGY CONSUMPTION	(t C/year)	R M U S B	Regulation	Estimated (model, software)	Daily	Table values (xlsx)	M36/M60	Quarterly	0	M36	M39	Quarterly
CHALLENGE 2: Water Management	Physical indicators	CH0201	RUN-OFF COEFFICIENT	(mm/%)	R M U S B	Regulation	Estimated (model, software)	Calculated just one time	Table values (csv, excel)	M36/M60	Quarterly/annual	On going	M36	M47	Annual
		CH0204	ABSORPTION CAPACITY (m3/m2)	(m3/m2)	U S B	Supporting	Statistical data existing	Calculated just one time	Table values (csv, excel)	M36/M60	Quarterly/annual	On going	M36	M47	Annual
		CH0205	ABSORPTION CAPACITY (m3/tree)	(m3/tree)	U S B	Supporting	Statistical data existing	Calculated just one time	Table values (csv, excel)	M36/M60	Quarterly/annual	On going	M36	M47	Annual
		CH0206	TEMPERATURE REDUCTION	(°C)	R M U S	Regulation	Sensor UGU	Hourly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M33	M41	Annual
		CH0207	INTERCEPTED RAINFALL	(m3 /year)	U S B	Regulation	Sensor UGU	Monthly	Table values (csv, excel)	M36/M60	Quarterly/annual	On going	M36	M47	Annual
	Chemical	CH0211	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	(mg O2/l) (kg O2/year)	R	Regulation	Statistical data measured UGU	Every 2 weeks	Table values (xlsx)	M36/M60	Quarterly	0	M36	M44	Quarterly
		CH0212	NUTRIENT ABATEMENT (Biochemical Oxygen Demand, BOD)	(mg O2/l) (kg O2/year)	R	Regulation		Every 2 weeks	Table values (xlsx)	M36/M60	Quarterly	0	M36	M44	Quarterly
		CH0213	NUTRIENT ABATEMENT (Total Solids, TSS)	(mg TSS/l) (kg TSS/year)	R	Regulation		Every 2 weeks	Table values (xlsx)	M36/M60	Quarterly	0	M36	M44	Quarterly
	Socioeconomic indicators	CH0215	IRRIGATION WATER PROVISION	(m3)	M U	Provisioning	Sensor UGU	Monthly	Table values (csv, excel)	M36/M60	Quarterly/annual	On going	M36		Annual
		CH0216	WATER REMOVED FROM THE WATER TREATMENT	(m3/s)	U S B	Regulation	Estimated (model, software)	Monthly	Table values (csv, excel)	M36/M60	Quarterly/annual	On going	M36	M47	Annual
	Economic	CH0218	SAVINGS IN TREATMENT OF STORMWATER	(€/m3)	R M U S B	Supporting	Statistical data existing	Monthly	Table values (csv, excel)	M36/M60	Quarterly/annual	On going	M36	M47	Annual

CHALLENGES	TYPE OF INDICATORS	Code	KPI	Unit	SCALE R=Regional M=Metropolitan U=Urban S=Street B=Building	ECOSYSTEM SERVICES P. provisioning; R. regulating; S. supporting; C. cultural.	Metering specifications	FRECUENCY	OUTPUT DATA	START/END	FRECUENCY OF REPORTING	BASELINE	Target to Start	Start	Frequency
CHALLENGE 4: Green Space Management	Spatial	CH0401	GREEN SPACE DISTRIBUTION (m2/capita)	(m2/capita) (%)	R M U	Cultural	GIS analysis	Yearly	GIS data (vectorial)	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
		CH0402	GREEN SPACE DISTRIBUTION (km cycle lane/capita)	(km cycle lane/capita)	R M U	Cultural		Yearly	GIS data (vectorial)	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
		CH0405	GREEN SPACE ACCESSIBILITY	(m) ~~(min)~~	R M U S	Cultural	GIS analysis	Yearly	GIS data (vectorial)	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
		CH0406	GREEN INFRASTRUCTURE CONNECTIVITY	(%)	U	Supporting	GIS analysis	Yearly	GIS data (vectorial)	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
	Social	CH0408	RECREATIONAL VALUE	(people/year)	R M U S	Cultural	Mobile App / Statistical data measured UGU	Monthly	Table values (.xlsx)	M1/M60	Annual	502 people	M6	M6	Month
		CH0410	ELDERLY PEOPLE LIFE QUALITY	Survey (%)	U	Cultural	Mobile App	Monthly	Table values (csv)	M36/M60	Annual	n/a	October 2020 (M41)	2020	Annual
		CH0411	CONNECTIVITY PERCEPTION	Survey (%)	U	Cultural	Mobile App	Monthly	Table values (csv)	M36/M60	Annual	n/a	October 2020 (M41)	2020	Annual
		CH0412	FOOD PRODUCTION	(ton/year) Other: (kg/m2) (t/plot)	U S B	Provisioning	Statistical data measured UGU	Yearly	Table values (.xlsx)	M1/M60	Annual	54.21 t	Ex-ante scenario (2017-2018-2019)	2017	Annual
	Biological	CH0413	POLLINATOR SPECIES INCREASE	(%) (nº)	U S	Supporting	Statistical data measured UGU	Monthly/ depending on weather	Table values (.xlsx)	M36/M60	Annual	On going	M33	M36	Annual
		CH0417	GREEN AREAS SUSTAINABILITY	Score (0%-100%)	U	Cultural	Mobile App / Statistical data measured UGU	Yearly	Table values (.xlsx)	M36/M60	Annual	n/a	M41	2020	Annual
CHALLENGE 5: Air Quality	Physical indicators	CH0509	AIR QUALITY PARAMETERS NO2	(µg/m3) NOx	M U	Regulation	Sensor UGU	Hourly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
		CH0510	AIR QUALITY PARAMETERS O3	(µg/m3) O3	M U	Regulation	Sensor UGU	Hourly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
		CH0511	AIR QUALITY PARAMETERS PM	(µg/m3) PM	M U	Regulation	Sensor UGU	Hourly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
	Economic	CH0507	AIR QUALITY MONETARY VALUES	(€)	M U	Supporting	Statistical data measured UGU	Yearly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M36	M41	Quarterly/Annual

CHALLENGES	TYPE OF INDICATORS	Code	KPI	Unit	SCALE	ECOSYSTEM SERVICES	Metering specifications	FRECUENCY	OUTPUT DATA	START /END	FRECUENCY OF REPORTING	BASELINE	Target to Start	Start	Frequency
CHALLENGE 6: Urban Regeneration	Socio-cultural indicators	CH0602	BENEFITS FROM INTERVENTIONS	(%)	U	Cultural	Statistical data existing	Yearly	Table values (.xlsx)	M1/M60	Annual	On going	M1	On going	Annual
	Economic	CH0112	SAVINGS IN ENERGY USE DUE TO IMPROVED GI	(kWh/year)	R M U S	Regulation	Estimated (modl. software)	Daily	Table values (.xlsx)	M36/M60	Quarterly	0	M36	M44	Quarterly
CHALLENGE 7: Participatory Planning and Governance	Social	CH0701	OPENNESS	(average score) Other: (#Participatory actions/year) (# attendees)	M U	Cultural	Statistical data measured UGU	Monthly	Table values (.xlsx)	M1/M60	Annual	3.48 score	June 2017 (M1)	July 2018 (M14)	Annual
		CH0703	CITIZEN PERCEPTION	Likert scale (1-5) Other: (% satisfaction) (nº users)	M U S B	Cultural	Mobile App	Monthly	Table values (.xlsx)	M1/M60	Annual	On going	June 2017 (M1)	November 2020 (M42)	Annual
CHALLENGE 8: Social Justice and Social Cohesion	Social justice	CH0801	CRIME REDUCTION	(nº crimes) (%)	U S B	Cultural	GIS analysis	awaiting data and formatting available	awaiting data and formatting available	awaiting data and formatting available	awaiting data and formatting available	awaiting data and formatting available	awaiting data and formatting available	awaiting data and formatting available	awaiting data and formatting available
	Social cohesion	CH0802	GREEN INTELLIGENCE AWARENESS (Educational actions)	(nº people) Other: (nº educ. actions)	M U	Cultural	Mobile App	Monthly	Table values (.xlsx)	M1/M60	Annual	2,234 people	June 2017 (M1)	January 2018 (M8)	Annual
		CH0803	GREEN INTELLIGENCE AWARENESS (Communication activities)	(nº publications)	R M U	Cultural		Monthly	Table values (.xlsx)	M1/M60	Annual	16 publications	June 2017 (M1)	June 2017 (M1)	Annual
CHALLENGE 9: Public Health and Well-being	Psychological	CH0901	NOISE REDUCTION	(dB(A)/m2 green unit)	S B	Regulation	Sensor UGU / Estimated (modl. software)	Yearly	Table values (.xlsx)	M36/M60	Quarterly/Annual	On going	M36	M41	Annual
	Health	CH0902	WALKING AREA INCREASE	(users)	M U	Cultural	Mobile App	Monthly	?	M36/M60	Quarterly	On going	?	?	?
		CH0903	CYCLING AREA INCREASE	(bicycles)	M U	Cultural		Monthly	?	M36/M60	Quarterly	On going	?	?	?
CHALLENGE 10: Potential of economic opportunities	Economic	CH1001	TAX REDUCTION	(nº tax reductions)	R M U S B	Supporting	Statistical data measured UGU	Yearly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M36	M41	Quarterly/Annual
		CH1002	JOB CREATION	(jobs) (GDP)	R M U	Supporting		Yearly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M36	M41	Quarterly/Annual
		CH1003	BUSINESS REVENUE	(business)	R M U	Supporting		Yearly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M36	M41	Quarterly/Annual
		CH1005	CONSUMPTION BENEFITS	(€)	R M U	Supporting		Yearly	Table values and Graphs	M36/M60	Quarterly/Annual	On going	M36	M41	Quarterly/Annual

3.2 Liverpool

Table 3-2: Data Collection Details of Liverpool Demo

FINAL KPI CODE	KPI	Unit	R	M	U	S	B	ECOSYSTEM SERVICES	Metering specifications	Frequency of data collection	Output data	Start/End	Frequency of reporting	BASELINE	Target to Start	Start	Frequency
CH0103	CARBON STORED	tC			Y			R	GIS model - EcoservR	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0104	CARBON SEQUESTRATION	tC			Y			R	GIS model - GIValEcoservR	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0105	TEMPERATURE DECREASE	(°C)	Y	Y	Y			R	Thermal Imaging camera	Monthly (Summer months)	xls/csv	2019/2022	Monthly	Ongoing	2019	01/05/2019	Monthly
CH0106	TEMPERATURE REDUCTION (PROJECTION)	(°C)			Y			R	GIS model: Star tools/GIValEcoservR	Before and after	xls/csv/pdf	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0108	HEATWAVE RISK	(°C)	Y	Y	Y			R	GIS model: Star tools	Before and after	xls/csv/pdf	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0111	SPECIES MOVEMENT	(population)			Y			R	GIS model: Condatis	Before and after	xls/csv/pdf	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0201	RUN-OFF COEFFICIENT	(mm)(%)	Y	Y	Y	Y	Y	R	GIS model: Star tools	Before and after	xls/csv/pdf	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0204	WATER SLOWED DOWN FROM SEWER SYSTEM	(m3/sec)			Y	Y		R	GIS model: GIVal/EcoservR	daily	xls/csv	2018/2022	Once in 2022	Ongoing	2021	01/04/2020	Once in 2022
CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	COD (mg/l)	Y		Y	Y		R	Water collection & Sampling	monthly	xls/csv	2018/2022	Monthly	Ongoing	2019	01/11/2018	Monthly
CH0209	NUTRIENT ABATEMENT (Total Solids, TSS)	SST (mg/l)	Y		Y	Y		R	Water collection & Sampling	Six monthly	xls/csv	2018/2022	Six monthly	Ongoing	2019	01/08/2019	Six monthly
CH0211	WATER REMOVED FROM THE WATER TREATMENT	(l/m3) & (m3)			Y	Y	Y	R	flow meter/model	daily	xls/csv	2020/2022	Once in 2022	Ongoing	2021	01/04/2020	Once in 2022
CH0212	SAVINGS IN TREATMENT OF STORMWATER	(l/m3)			Y	Y		R	GIS model - GIVal	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0403	GREEN SPACE ACCESSIBILITY	(m) (min)	Y	Y	Y	Y		C	GIS model - GIValEcoservR; Socio-economic data	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0404	GREEN INFRASTRUCTURE CONNECTIVITY	(m)(%)	Y		Y			S	Socio-economic data	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0410	POLLINATOR SPECIES INCREASE	(n°)(%)	Y		Y			R	Physical observation; GIS model - EcoservR	Monthly (Summer months)	xls/csv	2018/2022	Monthly	Ongoing	2018	01/05/2019	Monthly
CH0411	PLANT SPECIES INCREASE	(n°)(%)	Y		Y			R	Physical observation	Monthly (Summer months)	xls/csv	2018/2022	Monthly	Ongoing	2018	01/05/2019	Monthly
CH0412	FLORAL RESOURCES INCREASE	(n°)(%)	Y		Y			R	Physical observation	Monthly (Summer months)	xls/csv	2018/2022	Monthly	Ongoing	2018	01/05/2019	Monthly
CH0413	INSECTIVORE INCREASE	(n°)(%)	Y		Y			R	Physical observation; Acoustic sound analysis	Monthly (Summer months)	xls/csv	2018/2022	Monthly	Ongoing	2018	01/05/2019	Monthly

FINAL KPI CODE	KPI	Unit	R	M	U	S	B	ECOSYSTEM SERVICES	Metering specifications	Frequency of data collection	Output data	Start/End	Frequency of reporting	BASELINE	Target to Start	Start	Frequency
CH0501	DEATHS RELATED TO POLLUTION AND CONTAMINATION	(n° deaths)						R	GIS model - GiVal	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	(µg/m3) PM2.5		Y	Y			R	Mobile sensor; GIS model - GiVal	monthly	xls/csv	2018/2022	Monthly	Ongoing	2019	01/03/2019	Monthly
CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	(µg/m3) PM10		Y	Y			R	Mobile sensor	monthly	xls/csv	2018/2022	Monthly	Ongoing	2019	01/03/2019	Monthly
CH0504	NOx TRENDS	(µg/m3) NO2		Y	Y			R	Diffusion tubes; GIS model - GiVal	monthly	xls/csv	2018/2022	Monthly	Ongoing	2018	01/01/2019	Monthly
CH0505	Sox TRENDS	(µg/m3) SO2		Y	Y			R	Diffusion tubes; GIS model - GiVal	monthly	xls/csv	2018/2019	Monthly	Ongoing	2018	01/11/2018	Monthly
CH0508	Mitigation through cooling and sequestration	(l)		Y	Y			S	GIS model - GiVal	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0509	Energy savings	(l)		Y	Y			S	GIS model - GiVal	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0510	Increase in property value	(l)		Y	Y			S	GIS model - GiVal; Socio-economic data	Before and after	xls/csv, rtf	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0511	Value of air quality improvements	(l)		Y	Y			S	GIS model - GiVal/EcoservR	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0512	Value of air pollution reduction	(l/m3)		Y	Y			S	GIS model - GiVal	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0513	Total monetary value of urban forests including air quality	(l)		Y	Y			S	GIS model - GiVal	Before and after	xls/csv	2018/2022	Once in 2022	Ongoing	2021	2022	Once in 2022
CH0602	BENEFITS FROM INTERVENTIONS	area, numeric			Y	Y	Y	S	GIS model - GiVal; Socio-economic data	Before and after	xls/csv, rtf	2018/2022	Once in 2022	Ongoing	01/06/2021	2022	Once in 2022
CH0702	CITIZEN PERCEPTION	N/A			Y	Y		S	GIS model - GiVal; Socio-economic data; Non-technical data	Before and after	xls/csv, rtf	2019/2022	Once in 2022	Ongoing	01/10/2020	2022	Once in 2022
CH0703	SOCIAL LEARNING	N/A		Y	Y			S	Socio-economic data; Non-technical data	Before and after	xls/csv, rtf	2019/2023	Once in 2022	Ongoing	01/10/2020	2022	Once in 2022
CH0705	ENGAGEMENT WITH NBS	N/A			Y	Y		S	GIS model - GiVal; Socio-economic data; Non-technical data	Before and after	xls/csv, rtf	2019/2022	Once in 2022	Ongoing	01/10/2020	2022	Once in 2022
CH0801	CRIME REDUCTION	(n° crimes) + type				Y		S	Socio-economic data	monthly	xls/csv, rtf	2018/2022	Once in 2022	Ongoing	01/10/2020	2022	Once in 2022
CH0902	WALKING AREA INCREASE	(users)				Y		S	Vivacity sensors; Non-technical data	daily	xls/csv/pdf	2020/2022	Once in 2022	Ongoing	2020	01/02/2020	Once in 2022
CH0903	CYCLING AREA INCREASE	(bicycles)				Y		S	Vivacity sensors; Non-technical data	daily	xls/csv/pdf	2020/2022	Once in 2022	Ongoing	2020	01/02/2020	Once in 2022
CH0904	HEALTH QUALITY PERCEPTION	N/A			Y	Y		S	Socio-economic data	Before and after	xls/csv/pdf	2019/2022	Once in 2022	Ongoing	01/10/2020	2022	Once in 2022
CH1002	JOB CREATION	(jobs)			Y			S	GIS model - GiVal; Socio-economic data	Before and after	xls/csv/pdf	2019/2022	Once in 2022	Ongoing	01/01/2021	2022	Once in 2022
CH1004	LAND AND PROPERTY PRICE CHANGE	€ (median)				Y		S	Socio-economic data	Before and after	xls/csv/pdf	2018/2022	Once in 2022	Ongoing	01/01/2021	2022	Once in 2022
CH1005	NEW BUSINESSES	(business)				Y		S	Socio-economic data	Before and after	xls/csv/pdf	2018/2022	Once in 2022	Ongoing	01/01/2021	2022	Once in 2022

3.3 Izmir

Table 3-3: Data Collection Details of Izmir Demo

			SCALE							DATA COLLECTION		REPORTING PERIOD		MONITORING RESULTS			
DB_Code	KPI	KPI Unit	R	M	U	S	B	ECOSYSTEM SERVICES	METERING SPECIFICATIONS	FRECUENCY	OUTPUT DATA	START/END	FRECUENCY OF REPORTING	BASELINE	Target to Start	Start	Frequency
CH0101	Ton C02 CARBON REMOVED per Ha	ton CO2/Ha					X	D	The land use-land cover map will be derived from WorldView2 satellite images using screen digitalizing in ArcGIS 10. The percentage of tree cover is calculated for each Demo Site separately in ArcGIS 10. Izmir Municipality currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS	The GHGs will be sampled once a day during the first week of experimental period, every two days for the following three weeks and then every ten days until the end of the experiment.	Numerical Trend Graph overtime	Fixed and mobile sensors will be started in June-July 2019 and run for 3 years	every month	On-going calculations	2020	2020	Once
CH0102	Ton C02 CARBON REMOVED per year	ton CO2/yr					X	D		The GHGs will be sampled once a day during the first week of experimental period, every two days for the following three weeks and then every ten days until the end of the experiment.	Numerical Trend Graph overtime	Fixed and mobile sensors will be started in June-July 2019 and run for 3 years	every month	On-going calculations	2020	2020	Once
CH0103	CARBON STORED by vegetation	tC				X	X	R	I-Tree Eco software	The measurement results will be given once a year.	xls/pdf	2020/2021	Annually	357	2020	2020	Once
CH0104	CARBON SEQUESTRATION	tC/y				X	X	R	I-Tree Eco software	The measurement results will be given once a year.	xls/pdf	2020/2021	Annually	5.59	2020	2020	Once
CH0105	TEMPERATURE DECREASE	°C				X	X	R	Fixed and mobil sensors+ thermal camera	Android fixed Sensors: every half hour measurement. Mobil sensors: hottest days every summer Thermal sensors: hottest days every summer	Numerical Trend Graph overtime	Thermal Measurement : August 2020- repeats, hottest days every summer for 2 years. Mobile and fixed sensors have started in August 2020 and will be run for 2 years. But, fixed sensor hasn't yet been installed on the one of the demo sites.	every month	On-going calculations	2019	started in 2020 in one of the locations and in 2021 for the other location	Annual
CH0106	TEMPERATURE REDUCTION (PROJECTION)	°C				X	X	R	Fixed and mobil sensors+ thermal camera	Android fixed Sensors: every half hour measurement. Mobil sensors: hottest days every summer Thermal sensors: hottest days every summer	Numerical Trend Graph overtime	Thermal Measurement : August 2020- repeats, hottest days every summer for 2 years. Mobile and fixed sensors have started in August 2020 and will be run for 2 years. But, fixed sensor hasn't yet been installed on the one of the demo sites.	every month	On-going calculations	2020	2021	Once
CH107	HUMAN COMFORT	°C				X	X	R	Fixed and mobil sensors	Android fixed Sensors: every half hour measurement. Mobil sensors: hottest days every summer	Numerical Trend Graph overtime	Mobile and fixed sensors have started in August 2020 and will be run for 2 years. But, fixed sensor hasn't yet been installed on the one of the demo sites.	Annually	Completed	2020	2020	Annual

			SCALE							DATA COLLECTION		REPORTING PERIOD		MONITORING RESULTS			
DB_Code	KPI	KPI Unit	R	M	U	S	B	ECOSYSTEM SERVICES	METERING SPECIFICATIONS	FRECUENCY	OUTPUT DATA	START/END	FRECUENCY OF REPORTING	BASELINE	Target to Start	Start	Frequency
CH0108	HEATWAVE RISK	num. of nights >20°C days >35°C	X	X	X			R	Sensors	Android Sensors: every half hour measurement. Thermal sensors: hottest days every summer	Numerical Trend Graph overtime	Mobile and fixed sensors have started in August 2020 and will be run for 2 years. But, fixed sensor hasn't yet been installed on the one of the demo sites.	July-August-September	On-going calculations	2020	2021 summer	Annual
CH0109	kWh savings per year	kWh/year	X	X	X	X	X	R	Software	Modelling using collected data of CHO105	Numerical	2021/2022	Once	On-going calculations	2020	End of 2021	Twice
CH0110	t C/y savings per year	°C/year	X	X	X	X	X	R	Software	Modelling using collected data of CHO105	Numerical	2021/2022	Once	On-going calculations	2020	End of 2021	Twice
CH0112	Global Warming Potential (GWP; 100-year horizon)	ton CO2-eq ha-1 yr-1	X					R	GASERA ONE PULSE (Photoacoustic Analyzer for measurement of CH4, N2O and CO2)	The GHGs will be measured once a month during the experimental period.	Table values (csv, xlsx)	The measurements started in December 2020, with the beginning of the field experiment. It will end in June 2021 with the wheat harvest	Quarterly/annual	Not necessarry	May 2020	December 2020	Monthly
CH0213	RUNOFF ESTIMATION OF BIOSWALES IN BIOBOULEVARD	m3				x		?	KPI data is required using SCS Runoff Estimation Method by Autodesk Civil 3D Hydraflow Express Extensionx software.	Data collection frequency is twice through the project. The first one is for baseline calculations to assess the predevelopment data. The second one will be made after the construction is completed to measure the post-development effect.	xls, jpg, doc	2019/2021	Twice (before and after the implementation)	Completed (563.9 m3)	2021	2021	Once
CH0403	GREEN SPACE ACCESSIBILITY	%	X	X	X	X		C	Field calculator tool / spatial analysis software like QGIS tool includes Basic statistics for numeric fields	The measurement results will be given once a year.	%	Fixed and mobile sensors will be started in June-July 2019 and run for 3 years	every year	On-going calculations	12/07/1905	2020	Once
CH0406	RECREATIONAL VALUE	%			X			U	KPI data collected from user surveys and expert focus study groups can be	The measurement results will be given once a year.	%	Fixed and mobile sensors will be started in June-July 2019 and run for 3	every year	0			Once
CH0409	FOOD PRODUCTION	ton/Ha/yr					X		The KPI can be calculated by using a methodology defined by URBAN GreenUP Project: BACI (Before, After, Control, Impact)	The measurement results will be given once a year.	Numerical	two years	every 3 months	On-going calculations			Once
CH0410	POLLINATOR SPECIES INCREASE	number				X	X	S	observing and recording pollinating insects visiting the plants in demo sites	The measurement results will be given once a year in springtime.	xls/csv	2021/2022	Annually	10 taxons in Sasali/6 taxons in Peynircioglu	2020 May	2020 May	Once

			SCALE							DATA COLLECTION		REPORTING PERIOD		MONITORING RESULTS			
DB_Code	KPI	KPI Unit	R	M	U	S	B	ECOSYSTEM SERVICES	METERING SPECIFICATIONS	FRECUENCY	OUTPUT DATA	START/END	FRECUENCY OF REPORTING	BASELINE	Target to Start	Start	Frequency
CH0502	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	µg/m3			X			R	Sensors	during winter, every 30 min during peak pollution days (measured and reported by municipality), or else every hour every	Numerical Trend Graph overtime	2021/22	every month	On-going calculations	2020	2021	Monthly
CH0503	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	µg/m3			X			R	Sensors	during winter, every 30 min during peak pollution days (measured and reported by municipality), or else every hour every	Numerical Trend Graph overtime	2021/22	every month	On-going calculations	2020	2021	Monthly
CH0504	NOx TRENDS	µg/m3			X			R	Sensors	during winter, every 30 min during peak pollution days (measured and reported by municipality), or else every hour every	Numerical Trend Graph overtime	2021/22	every month	On-going calculations	2020	2021	Monthly
CH0505	Sox TRENDS	µg/m3			X			R	Sensors	during winter, every 30 min during peak pollution days (measured and reported by municipality), or else every hour every	Numerical Trend Graph overtime	2021/22	every month	On-going calculations	2020	2021	Monthly
CH0508	POLLUTANT REMOVED BY VEGETATION	kg/year				X	X	R	I-Tree Eco software	The measurement results will be given once a year.	xls/csv	2020/2021	Annually	28.98	2020	2020	Once
CH0601	GREEN SPACE QUANTITY	%			X	X	X	U, N, D	Field calculator tool / spatial analysis software like QGIS tool includes Basic statistics for numeric fields	The measurement results will be given once a year.	%	two years	every year	On-going calculations	2021	2021	Once
CH0702	CITIZEN PERCEPTION	(nº users) (% of satisfaction)							Spreadsheet software by Excel or SPSS and spatial analysis software like ARCGIS or QGIS.					On-going	2021	2021	Once
CH0704	URBAN FARMING EDUCATIVE/ participate activities, Learning for producers						X		The KPI can be calculated by using a methodology defined by URBAN GreenUP Project: BACI (Before, After, Control,	The measurement results will be given once a year.	Numerical	two years	every month	On-going calculations	2021	2021	Once
CH0706	URBAN FARMING ACTIVITIES- Energy saving kWh	Energy saving kWh					X		The KPI can be calculated by using a methodology defined by URBAN GreenUP Project: BACI (Before, After, Control, Impact)	The measurement results will be given once a year.	Numerical	two years	every month	On-going calculations	2021	2021	Once
CH0707	URBAN FARMING ACTIVITIES- Water savings	water saving(m3/ha/year)					X		The KPI can be calculated by using a methodology defined by URBAN GreenUP Project: BACI (Before, After, Control, Impact)	The measurement results will be given once a year.	Numerical	two years	every 3 months	On-going calculations	2021	2021	Once

			SCALE							DATA COLLECTION		REPORTING PERIOD		MONITORING RESULTS			
DB_Code	KPI	KPI Unit	R	M	U	S	B	ECOSYSTEM SERVICES	METERING SPECIFICATIONS	FRECUENCY	OUTPUT DATA	START/END	FRECUENCY OF REPORTING	BASELINE	Target to Start	Start	Frequency
CH0802	GREEN INTELLIGENCE AWARENESS (EDUCATIONAL ACTIONS)	nº educ. actions		X				C	Degree of awareness level can be processed by using spreadsheet software by Excel or SPSS.	The measurement results will be given at the end of project	Numerical			On-going	2021	2021	Once
CH0803	GREEN INTELLIGENCE AWARENESS (INHAB. ATTENDED)	inhab. attended		X				C	Degree of awareness level can be processed by using spreadsheet software by Excel or SPSS.	The measurement results will be given at the end of project	Numerical			On-going	2021	2021	Once
CH0902	WALKING AREA INCREASE	nº users and trips			X	X	X	C	KPI data are acquired by basic statistics in standard software by Excel or SPSS and GIS processing. Data collected via pedestrian and bicycle counter units has been sent to İzmir Transportation Centre called 'İZUM'.	The measurement results will be given once a year.	%	two years	every month	On-going	2021	2021	Once
CH0903	CYCLING AREA INCREASE	nº users and trips			X	X	X	C	KPI data are acquired by basic statistics in standard software by Excel or SPSS and GIS processing. Data collected via pedestrian and bicycle counter units has been sent to İzmir Transportation Centre called 'İZUM'.	The measurement results will be given once a year.	%	two years	every month	On-going	2021	2021	Once
CH1002	JOB CREATION	nº jobs €/m2	X	X				S	The KPI can be calculated by using a methodology defined by URBAN GreenUP Project: BACI (Before, After, Control, Impact)	The measurement results will be given at the end of project	Numerical			On-going	2021	2021	Once

4 Success Stories – Failures - Barriers and Boundaries on data collection - COVID Effect

4.1 Valladolid

Challenges

Decision-making process. The identification of monitoring indicators in Valladolid has evolved from the first selection of indicators to the present. In an initial phase on 2017, a series of indicators were identified from the list included in the Eklipse methodology which could be of interest for the Valladolid demo. However, with the development of the project, limitations have been identified in order to obtain reliable data to calculate these KPIs. This has meant that some KPIs have been changed for others more appropriate to real needs.

A specific case happens with the intervention of the Floodable Park (VAc11). This intervention will not be carried out in Valladolid, so the KPIs associated with flood risks will not be monitored by CENTA, from Challenge 2-Water management (*CH0202-Flood peak reduction*, *CH0203-Drought risk reduction*, *CH0208-Green areas in flood risk*, *CH0209-Area (ha) exposed to flood risk*, *CH0210-Population exposed to flood risk*).

Lack of information of the pre-NBS period. This situation occurs with several KPIS. As an example; energy efficiency KPIs, such as "*Energy and carbon savings from reduced building energy consumption*" will be calculated at the Green Roof and the Green Wall. They are expected to be calculated through several methodologies, some of the including direct measurement and some others considering its estimation from building energy consumptions. The second methodology is defined to compare energy consumptions before and after NBS implementation in buildings. However, data of the historical energy consumption of the market and the commercial building in which NBS are installed is not available and, when available, it is not detailed enough.

Other examples occur with the limited availability of economic data disaggregated at the building or street level of detail that URBAN GreenUP NBS monitoring requires. Economic data exists at the city level or at the macro level.

- The data is relative; it is highly complex to define the surface/ scale of the measurement.
- They are not defined with the level of complexity needed.
- There are more factors that influencing the economic KPIs, it makes it difficult to focus/extract only the NBS influence, it have to be considered in city growth scenarios.

Non-technical. COVID-19 has directly affected non-technical interventions in Valladolid. At the beginning of the pandemic in Spain, declared in March 2020, the population was confined to our homes and only those considered essential (health care, police, etc.) attended their jobs. Face-to-face meetings were prohibited at that time. They are now minimised, to avoid contact and community transmission of the virus.

Success stories

Air quality monitoring. In the ex-ante phase of intervention implementation, CARTIF technology centre has installed a network of equipment for air quality monitoring in the NBS environment. This network is composed of air quality equipment installed in the NBS environment and equipment installed in the vicinity to establish a baseline for comparison.

Figure 4-1: Mobile Air quality sensors installed close to the Green façade in Valladolid (CARTIF)

The data captured by these systems provided input information for the calculation of the Air Quality Challenge KPIs. Valladolid City Council also has an extensive network of air quality monitoring stations in the municipal Air Pollution Control Network (RCCAVA). The data provided by this network will complete the sensors installed specifically for the URBAN GreenUP project.

Mobile App. The partner GMV-S is programming an Android mobile application to take data of interest for monitoring URBAN GreenUP interventions. This mobile application has the following objectives:

- Gather KPI information leveraging smartphone sensor and user interaction.
- Raise awareness and increase Nature-Based Solutions engagement: The application will show information about the NBS associated with their location, which will allow the dissemination of information about the characteristics and benefits, contributing to the engagement.
- Monitor Green Corridor usage: Through a positioning API, the application will detect when the user is near an NBS. This contributes to know statistics of use or visit to the NBS. The App will detect also the mean of transport, by bike, on foot and others.
- Promote Green Corridor usage: The App has a generation of points per use, which allows establishing a ranking of users. This is an example of applied gamification (Serious games).

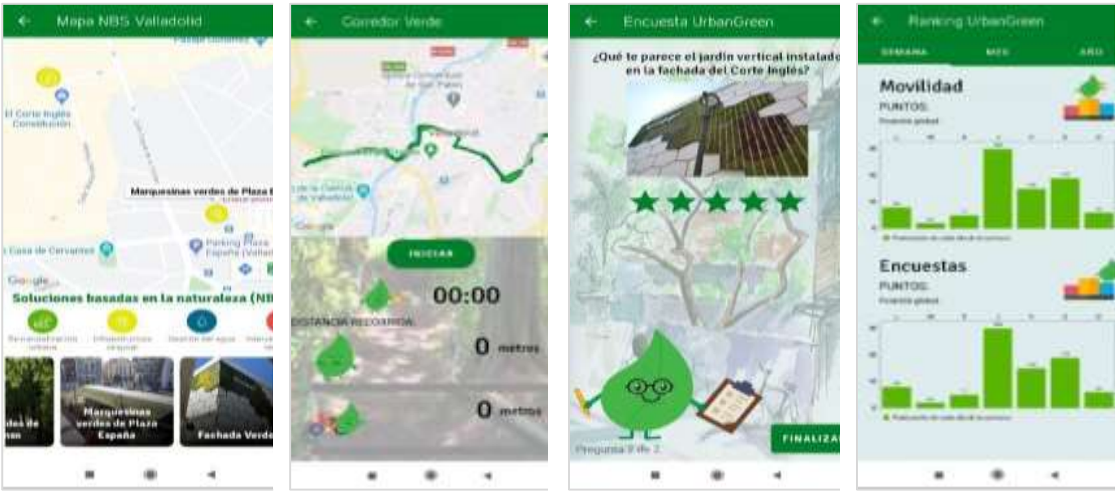


Figure 4-2: Screenshots of the Valladolid Demo mobile application (GMV-S)

Coordination between stakeholders for the water quality monitoring. Water quality parameters are measured from the laboratory analysis of water samples taken in-situ in the NBS during the treatment process. A successful collaboration between stakeholders has been necessary to acquire these data. Accordingly, AQUAVAL, the municipal company in charge of water and wastewater treatment in Valladolid, will be responsible for sampling and analysing at their laboratories. LEITAT, the project partner, will collect the given results and process them for publication.

4.2 Liverpool

To establish the parameters of the URBAN GreenUP delivery and monitoring protocols, the Liverpool project team drew upon the Eklipse documents in developing its KPIs. This has led to the development of set of KPIs that:

1) Were relevant to Liverpool interventions.

2) Could be robustly and consistently measured; and

3) Aligned with the human and financial resources available for the project.

In short, the key aim was to identify which KPIs best quantified the impacts of NBS which are hypothesised to have multiple benefits, so team wanted to measure multiple axes. Throughout the decision-making process and maintained the principles of identifying KPIs that could be monitored effectively and were repeatable and at reasonable cost.

The ideal and practical workarounds about when and where to monitor had to be balanced and allow time for slow-acting effects. Through discussion the Liverpool partners agreed the KPIs that were able to be evidenced at a frequency ideally tailored to natural range of variability and appropriate to the NBS installed. Socio-economic KPIs were designed with the complex nature of socio-economic data and its relationship to broader contextual factors in mind, to understand how NBS is addressing societal challenges beyond numerical improvements to the environment. For this reason, Liverpool adopted a range of KPIs that enabled the team to capture rich, detailed qualitative data alongside quantitative data.

Liverpool partners also worked with local experts to support data analysis and data collection.

Data collection

Data collection was supported in several ways that included direct data collection in the field, working with partners, student research projects, together with the award of direct contracts.

- Colleagues at Liverpool John Moores University supported some of the water quality heavy metal and nutrient analysis by permitting access to their labs and facilities.
- Other colleagues at Liverpool John Moores University supported data analyses through the use of new emerging tools to model and quantify project improvements.
- Liverpool John Moores University also worked alongside the Mersey Forest to develop a local, open access, user friendly data portal for the project data that can be shared and accessed once all data is complete and uploaded.
- University of Liverpool provided their weather station data; to enable more accurate precipitation, wind speeds and wind direction information to be compared and added to the data.
- A local sensor company (Sensor City) provided 4 continuous sensors to help us understand the detail behind some of our air quality monitoring and another 5 continuous NOx and PM air quality sensors.
- Contractors for the Ecosystem island (i.e. Biomatrix) provided underwater footage of the colonisation of the underwater reef structures;
- A postgraduate researcher in floating ecosystems also supported biodiversity surveys of vegetation and invertebrates.
- West Lancashire and Merseyside Bat Group helped with bat surveys and public bat walks.
- Water quality data was shared by the Canal and River Trust for Wapping Dock
- Liverpool city council assisted with the changing and analysis for local air quality diffusion tubes.
- Local community groups and Parks groups (e.g., Friends of Sefton Park) additionally supported citizen science projects and biodiversity monitoring
- The Landscape Architect for some of the pollinator projects additionally researched and tested several new innovative approaches that provided new data insights.
- Linking with the Lancashire Wildlife Trust and the Biobank to promote the use of the bioapp (iNaturalist) in the demo areas and across the city also involved many local people and helped to promote biodiversity recordings in the demo areas whilst adding to the city's biodiversity records and data sets.

Finally, data was also captured through third party contracts such as footfall, cyclist and vehicle movements along green corridor routes using the Vivacity sensors.

Data analyses

Data analyses were supported through contracted project staff at the University of Liverpool, University of Manchester, the Mersey Forest, and Liverpool city council officers. In addition, the project team was supported by several data experts as follows:

Water.

Data analysis support was provided by Dr Patrick Byrne at Liverpool John Moores University, Dr John Boyle at University of Liverpool, and Leo Philips from the Environmental Protection Group Ltd.

Air Quality

Data analyses support was provided by Dr James Levine at Birmingham University, Dr Johnny Higham at the University of Liverpool, and Keith Dooley from Liverpool City Council.

Thermal

Support in relation to the cooling properties of trees and soil moisture sensor data were provided by Dr Andrew Hirons at Myerscough College.

Biodiversity

Data analyses support was provided by Ben Deed at the Mersey Biobank, Seb Stroud from Leeds University, Elaine Cresswell (Landscape Architect at reShaped), several local community groups and individual experts, as well as the Tanyptera Trust and other Entomologists based at Liverpool World Museum.

In addition, several students and researchers also assisted with data analyses and data interpretation.

Data Modelling

- Colleagues at Liverpool John Moores University (Dr Sandra Angers-Blondin and Dr Colm Bowe) supported data analyses using new emerging tools (EcoservR) to model and quantify project improvements.
- Colleagues at the Mersey Forest (Mackenzie Russell) also provided GIVAL, Star and Condatis toolkit support to generate a range of benefit outcomes.

4.2.1 Changes in timeline – Covid 19

The timing of the Coronavirus and the subsequent lockdown affected project delivery and thus challenges around the monitoring. All interventions were halted in the run up to lockdown as it became uncertain if staff would be in work to progress works/accept deliveries etc. Some works already on site were left semi completed as contractors closed operational work, and all co-creation activities with communities were suspended which affected delivery of several initiatives. Where installation was delayed, this delayed the start of the post intervention monitoring.

The most significant delays relate to the socio-economic monitoring, as collection of social data in person was forbidden for most of 2020 and a large part of 2021 by the Human Ethics Research Committee at the University of Liverpool. All monitoring was shifted to an online format and much of it was undertaken slightly later than anticipated. All interviews were successfully conducted over the summer of 2020, which provided a rich source of qualitative data. Further online and postal surveys were also conducted in winter/spring 2021. All monitoring in person to evaluate public perceptions of the intervention was delayed and replaced with online alternatives. The funding was used judiciously to focus only on funding staff to undertake activities directly related to the KPIs as and when needed, in line with national, city-wide, and university-level restrictions.

UOL consulted its ethics committee to receive formal approval to modify the methodology. Following confirmation that all face-to-face data collection was prohibited for the foreseeable future, monitoring was moved online and targeted survey work via business, community and LCC supported networks. This was complemented by a dual approach to surveying including postal and online surveys, which allowed the project team to target specific communities as well as reach a broader population. The situation was monitored continually but return to face-to-face data collection was significantly delayed. Limited permission for face-to-face data collection was granted in November 2020, but soon after the UK went back into 'lockdown' and data collection was once again forbidden due to national orders to stay at home and not interact with others outside of their household. Specific changes to monitoring for both biophysical and socio-economic monitoring are summarised below.

The lockdown rules preventing face to face interaction for the surveys were lifted in the summer of 2021, after funding had finished for Liverpool's socio-economic monitoring programme which prevented any further activity. It was also notable that use of green spaces changed significantly over the course of the pandemic, as national and local restrictions often only allowed time spent outdoors and, at times, restricted both time and reasons for access to public spaces (e.g. permitting only 1 hour of exercise per day and forbidding recreational and social interactions in public spaces). This had an impact on the quality and reliability of the data, making it difficult to tease out from general data on perceptions, use, and access. To help address this, nationally representative datasets on use of green space will be used to help contextualise this data. Economic data will also be impacted by both the pandemic and Brexit and will need to be contextualised with national-level datasets as well.

For the biophysical monitoring:

Air Quality - NO2: diffusion tube monitoring was on hold during lockdown due to the closure of the labs, but restarted in June 2020, with just the loss of a few months data. However, continuous air quality monitors elsewhere in the city helped to plug some of the data gaps for background information during this period.

Temperature: Due to time for resetting camera and some distancing difficulties: data were not collected until June 2020 when guidelines relaxed, with the loss of data for a few months.

Water: March –July 2020: During this period there was no access to university laboratories for preservation and storage of water samples, nor was there opportunity to calibrate and clean equipment. Water sampling was limited to only abiotic measures with the water probe, but calibration checks of the probe were limited. No water samples were taken during April-July 2020 but sampling restarted in August 2020 and all the existing samples that had been collected had been filtered, frozen, or acidified to preserve them for future analyses. In total there was about a 4-month data gap when samples could not be collected, stored, and analysed. In the recent lockdown, access was again restricted, so no water sampling could take place in January and February 2021, but restarted in March 2021.

Pollinator & Floral (May – September 2020): No pollinator or floral data were obtained for May 2020, but monitoring restarted in June 2020. Monitoring had to accommodate several access restrictions from March 2020 (both temporary and permanent) to Parks and gardens, e.g., St Luke's Church Garden, Bluecoat Garden. In addition, it was not possible initially to access either the Royal Court Green Pollinator Roof, or St Johns Green Wall; although this has since been resolved. Similar access issues affected some Dragonfly Transects from May 2020 particularly at Otterspool SUDS as installation was in progress and taking longer due to covid restrictions. Bat transects restarted in July 2020 when distance guidelines relaxed, and parks were less full, and monitoring transects were shortened due to time restrictions on monitoring in the dark.

4.2.2 Success stories

A recent success story has been working with partners to further develop the models to demonstrate the impacts of the pollination capacity of NBS in a way that is accessible. The EcoservR model helps to tease out some of the benefits associated with the introduction of NBS. Using the example of pollination capacity, data can be inputted from pre NBS baseline data and compared with post intervention data to assess the pollinator capacity increase that is solely attributable to the additional NBS.

The first image below shows baseline data for demo B in an area that includes the site of the green wall at St Johns and the adjacent site of the Royal Court Pollinator roof. The second image shows the data post intervention once the NBS are in place. Comparison shows that a new bubble has been formed with a line of 100% capacity reflecting the location of the new wall. This very visual tool is also accompanied by a table which provides % capacity changes in a numerical format.

This model is still under development, but early results are promising.

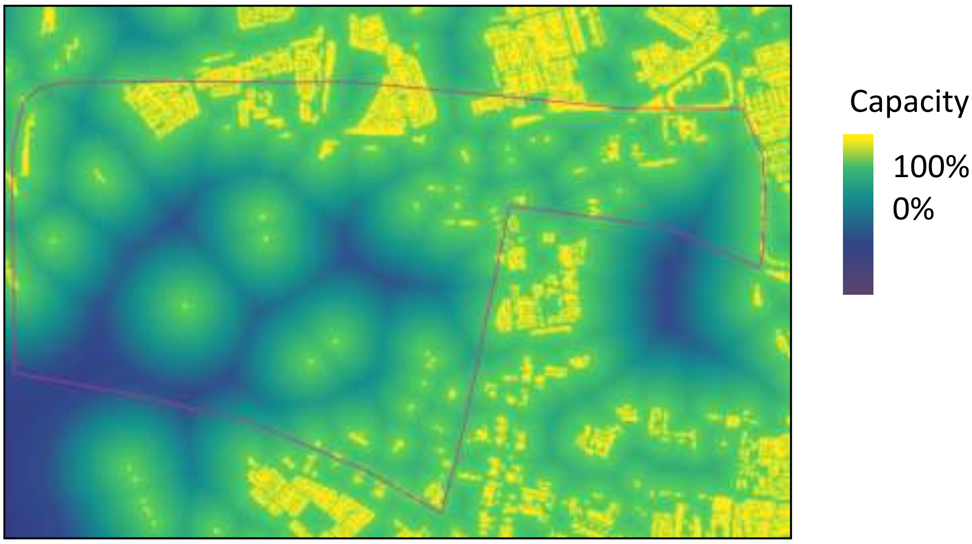


Figure 4-3: Pollination capacity increase baseline Sub Demo B

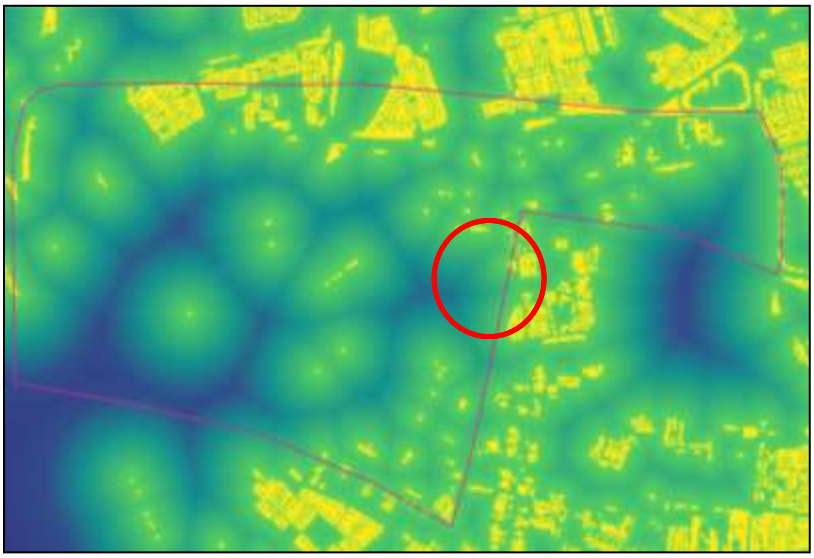


Figure 4-4: Pollination capacity increase baseline Sub Demo B following installation of green wall and pollinator roof (Royal Court)

It is also notable that all socio-economic KPIs have been monitored in some way, even if it was not in the same way as planned. Considering the covid crisis and its impact on conducting face-to-face interviews, engagement was shifted online. Interviews were conducted with individuals engaged with the urban greening agenda in Liverpool, many of whom were connected to the work of URBAN GreenUP. Interviewees ranged from business owners, SME and charity employees, members of 'Friends of' groups and local councillors. From this, we identified strong themes that contributed to monitoring of all socio-economic KPIs. Research by 6 masters students from the University of Liverpool in the summer of 2020 has also provided data on these KPIs, with researchers adapting methods to online alternatives to ensure alignment with government rules and ethical approval conditions. This is in addition to 8 prior masters research projects focused on Urban GreenUP and one MPhil research project, all of which provide data for the social and/or economic KPIs.

4.3 Izmir

Izmir monitoring teamhad studied the Eklipse documents for developing relevant KPIs, they evolved in the process. In other words, the identification of monitoring indicators has evolved from the first selection to the present phase based on some limitations and changes of the implementation sites (demo sites) in the process. Moreover, some of the initial calculation methods of KPIs that Ege Landscape Team is dealing with have been changed to new ways as well, such as getting involved I-Tree Eco software which was not the initial plan It was just included to have better and faster results for calculation of carbon, pollutant removal KPIs. In the cases of most of the KPI's, no substantial barrier or challenge has been observed in the monitoring process except slight delays of constructions or implementations.

The initial plan was to establish a green corridor between demo sites in different locations and assess the new green corridor's contribution to the connectivity. The planned initial 10 km green corridor or connectivity in the early stages of the project between Sasali and Peynircioğlu stream where baseline measurements had executed using some landscape metrics has not been implemented. Therefore, the KPI "green infrastructure connectivity" seems not possible to quantify now in the case of İzmir.

The initial locations of parklets have changed. Thus, baseline values had to be recalculated in the new locations of parklets to make a comparison with the monitored values.

In terms of Temperature Reduction and Human Comfort KPIs, air temperature, relative humidity and wind velocity measurements were planned to be performed for both baseline values and the monitoring process accordingly. Measurements have been made as planned in the Vilayetler Evi parking lot, one of the demo sites without any challenges by using a mobile device. However, in the Sasalı Wildlife Park car park, the installation of the measuring device (fixed one) was delayed due to the Covid-19 pandemic. The plan was to establish two fixed meteorological stations in two locations at the same time and start recoding accordingly. However, only one fixed station was able to be set up just before the COVID-19 pandemic (March 2020) and then the isolation period is started. In Sasali, only measurements taken by mobile device is available at for the beginning of the monitoring period.

Air quality monitoring for were also delayed because of the pandemic since a portable device was going to be used for measurements.

For the actions:

a) Smart soil production in climate-smart urban farming precinct
b) Development of smart soil from mud plant

The purchase of the two devices and laboratory equipment required for the planned measurements in the project was delayed due to the production processes that slowed down due to the pandemic period, as well as some bureaucratic problems. For this reason, maize field experiment that was planned to start in April 2020 for both subtasks of Subdemo B could not start as planned... However, as of December 2020, the experiments on both Subdemo A and B have started and are continuing clearly.

5 Conclusions

The current report set the basis and patterns to evaluate the data collection procedure of each frontrunner city during the monitoring period of the URBAN GreenUp project.

Although there have been changes in demo sites or delays on monitoring due to pandemic or other reasons most of the KPIs have been monitored by three front runner cities. The results of the KPIs for each NBS will be evaluated in another deliverable.

Six years is a long time and priorities, and many things can change as time passes. There have been many challenges faced by the cities' pandemic being the most obvious one. Some of the NBS actions could not be delivered due to unforeseen barriers and some KPIs became irrelevant. There has been management or personal changes which made it really challenging since there are not many qualified people working in the area. Support from other institutions, departments were crucial for all cities and made it possible to put together a lot of data.

This report aim to be a record of activities performed regarding data collection, what worked and what didn't, encouraging the reader that the knowledge gathered through these past years contribute on the understanding of this complex problem.