URBAN GreenUP

D5.5: Technical KPI Definition (INTERIM II)

WP 5, T 5.5

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Authors: 15 (GMV), 1 (CAR), 2 (VAL), 7 (LIV), 8 (CFT), 9 (UOL), 10 (IZM), 11 (DEM), 12 (EGE), 13 (IZT), 14 (BIT)

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Project Coordinator	Raúl Sánchez Fundación CARTIF rausan@cartif.es
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[1] PU = Public

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

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Versions

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REFERENCE DOCUMENTS

Deliverable	Name of the Deliverable
D5.1	Technical KPI definition (Interim I)
D5.3	Monitoring Procedures
D2.4	Valladolid City Diagnosis and Monitoring Procedures
D3.4	Monitoring Protocol for Liverpool
D4.4	Monitoring Program to Izmir

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1 Introduction

1.1 Deliverable Rationale

Aims to upgrade the definition of the Key Performance Indicators selected for the project URBAN GreenUP. It shall define the set of KPIs (Key Performance Indicators) selected, that will be used to assess the methodology defined in Work Package 1 (WP1): renaturing city methodology and also in each demonstration city diagnosis and baselines being developed (WP2, Valladolid; WP3, Liverpool; WP4, Izmir), where the projected NBS (Nature Based Solutions) are related to both a challenge (below) and to KPIs.

In this document the methodology for the monitoring of different NBS and a global perspective shall be approached by outlining the main challenges and focused on goals that have been drawn directly from the Eklipse Mechanism; a self-sustained mechanism under the umbrella of the European Union's Horizon 2020.

The KPIs are based on the Eklipse mechanism framework, where a robust set of KPIs shall be selected and established by challenges that relate to NBS. These challenges are:

- Climate mitigation & adaptation
- Water Management
- Coastal Resilience
- Green Space Management
- Air Quality
- Urban Regeneration
- Participatory Planning and Governance
- Social Justice and Social Cohesion
- Public Health and Well-being
- Potential of economic opportunities and green jobs
- Other challenge/s

1.2 Scope of the deliverable

In Task 5.1: Technical KPIs definition provided a detailed definition of calculation formulas and indices in order to measure and evaluate the accuracy and quality of the Key Performance Indicators. Deliverable D5.1 Technical KPIs definition was a first version of a *living document* that aims to fully achieve one of the main purposes of WP5, which is that by the end of the URBAN GreeenUP project a final have a robust set of KPIs building upon the knowledge of the three very different demo cities and this will be delivered in a final version of the document: D5.8 Technical KPI definition (Final), to be summited by the end of the project.

Deliverable D5.5. Technical KPIs definition (Interim II) was planned to be delivered following the kick off the two years of monitoring expected. Due to covid-19 global crisis and the direct impact to monitoring programme this document will be summited as expected (May 2020).

1.3 Aims and principles of a green infrastructure monitoring program

The key aim is to quantify the impacts of having GI. GI is hypothesised to have multiple benefits, so we want to measure multiple axes. Principles: effective, repeatable and reasonable cost.

1.4 Issues in when and where to monitor - the ideal and practical workarounds

When: ideally before and after and allowing time for slow-acting effects. Frequency ideally tailored to natural range of variability (e.g. no need to monitor every day if change slow; no need to monitor in winter if summer is when effects occur. However, monitoring before and after intervention should use the same time schedule). Workarounds might include using different baseline data sources.

Where: at relevant NBS and/or close to relevant NBS where effects are hypothesised to reach; Sampling and representativeness; ideally sample control sites in BACI design. Workarounds might include taking an arbitrary sample instead of a random sample (e.g. a bus route).

1.5 Protocols for measuring key performance indicators

Each KPI requires a clear and simple protocol, in order to arrive at an effective and comparable monitoring program. By protocol, we mean every step from recording raw data (or obtaining it from publicly available sources), through any data processing and modelling that may be necessary, to the final KPI which can be reported. In the rest of this section, each KPI will have its entry either under its *Eklipse Challenges* (for Core KPIs) or under the city adopting it (for city specific KPIs).

Each protocol will typically include:

- Whether the KPI is directly measured or modelled based on e.g. A map
- The choice of sensor or measuring instrument and why that was chosen (if needed)
- Which NBS the KPI is relevant to (although in some cases some KPIs are best measured across a whole demo area or whole city and not attributable to individual NBS interventions)
- When (frequency and duration) and where (extent and placement relative to NBS) measurements are made
- Method to be followed by the measurer, if not automated
- Method for data post-processing and modelling if relevant, including GIS methods

For core KPIs, we will also contrast *minimum* standards for the protocol and *desirable* standards which would lead to better data if time and resources allow.

1.6 New coding system

URBAN GreenUP consortium involved in Monitoring and Evaluation Working Package (WP5) decided to change the old coding system inherited from the early stages of the project to a new one more friendly.

Where CH means Challenge, followed by two round numbers according to the challenge that tackles and two more numbers for numerical order. Being:

2 Core KPIs

A set of Key Performance Indicators (KPI) were selected based on the Eklipse mechanism that shows how the proposed actions and NBS will tackle the challenges that the project and each demonstration city is facing. These challenges and KPIs are specified in a summary below. Each epigraph is named after a challenge where the 29 related KPIs are fitted in.

The Core KPI are divided by challenges: Challenge 1, climate mitigation & adaptation; Challenge 2, water management; Challenge 3, coastal resilience – there are no NBS planned to face this challenge in city demos, therefore it is not considered to be Core–; Challenge 4, green space management; Challenge 5, air quality; Challenge 6, urban regeneration; Challenge 7, participatory planning and governance; Challenge 8, social justice and social; Challenge 9: public health and well-being; Challenge 10, potential of economic opportunities and green jobs.

DB_Code	KPI_Standard
CH0101	Ton C02 CARBON REMOVED per Ha
CH0102	Ton C02 CARBON REMOVED per year
CH0103	CARBON STORED
CH0105	TEMPERATURE DECREASE
CH0106	TEMPERATURE REDUCTION (PROJECTION)
CH0108	HEATWAVE RISK
CH0201	RUN-OFF COEFFICIENT
CH0204	ABSORPTION CAPACITY (m3/m2)
CH0205	ABSORPTION CAPACITY (m3/tree)
CH0206	TEMPERATURE REDUCTION
CH0214	DRINKING WATER PROVISION
CH0216	WATER REMOVED FROM THE WATER TREATMENT
CH0217	WATER SLOWED DOWN FROM ENTERING SEWER SYSTEM
CH0401	GREEN SPACE DISTRIBUTION (m2/capita)
CH0402	GREEN SPACE DISTRIBUTION (km cycle lane/capita)
CH0403	PEOPLE LIVING WITHIN 300M TO GREEN AREAS
CH0405	GREEN SPACE ACCESSIBILITY
CH0409	RECREATIONAL OPPORTUNITIES
CH0411	CONNECTIVITY PERCEPTION
CH0412	FOOD PRODUCTION
CH0413	POLLINATOR SPECIES INCREASE
CH0501	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES
CH0502	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES
CH0503	EMMISIONS TRENDS of NOx
CH0504	EMMISIONS TRENDS of SOx
CH0507	AIR QUALITY MONETARY VALUES
CH0601	ACCESSIBILITY / DIVERSITY NBS
CH0602	BENEFITS FROM INTERVENTIONS
CH0703	CITIZEN PERCEPTION
CH0802	GREEN INTELLIGENCE AWARENESS (Educational actions)
CH0803	GREEN INTELLIGENCE AWARENESS (Communication activities)
CH0901	NOISE REDUCTION
CH0902	WALKING AREA INCREASE
CH0903	CYCLING AREA INCREASE
CH1002	JOB CREATION

Table 2.1. Second version of the core KPI table (2020)

3 KEY PERFORMANCE INDICATOR BY CHALLENGE

CHALLENGES	TYPE OF INDICATORS	DB_Code	KPI_Standard	VALLADOLID	LIVERPOOL	IZMIR
CHALLENGE 1: Climate mitigation & adaptation	Chemical	CH0101	Ton C02 CARBON REMOVED per Ha	X		X
		CH0102	Ton C02 CARBON REMOVED per year	X		X
		CH0103	CARBON STORED		X	X
		CH0104	CARBON SEQUESTRATION		X	
	Physical	CH0105	TEMPERATURE DECREASE	X	X	
		CH0106	TEMPERATURE REDUCTION (PROJECTION)		X	
		CH0107	HUMAN COMFORT			X
		CH0108	HEATWAVE RISK	X	X	X
	Biological	CH0109	SPECIES MOVEMENT		X	
	Economic	CH0110	kWh SAVINGS PER YEAR	X	X	X
		CH0111	t C/y SAVINGS PER YEAR	X		X
		CH0112	SAVINGS IN ENERGY USE DUE TO IMPROVED GI	X		
CHALLENGE 2: Water Management	Physical indicators	CH0201	RUN-OFF COEFFICIENT	X	X	X
		CH0202	FLOOD PEAK REDUCTION	X		X
		CH0203	ABSORPTION CAPACITY (m3/m2)	X		X
		CH0204	ABSORPTION CAPACITY (m3/tree)	X		
		CH0205	TEMPERATURE REDUCTION	X		
		CH0206	INTERCEPTED RAINFALL	X		
	Chemical	CH0207	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)	X	X	
		CH0208	NUTRIENT ABATEMENT (Biochemical Oxygen Demand, BOD)	X		
		CH0209	NUTRIENT ABATEMENT (Total Solids, SST)	X		
	Socioeconomic indicators	CH0210	DRINKING WATER PROVISION			X
		CH0211	IRRIGATION WATER PROVISION	X		
		CH0212	WATER REMOVED FROM THE SEWAGE WATER SYSTEM	X	X	X
		CH0213	WATER SLOWED DOWN FROM ENTERING SEWER SYSTEM		X	
	Economic	CH0214	SAVINGS IN TREATMENT OF STORMWATER	X	X	
CHALLENGE 4: Green Space Management	Spatial	CH0401	GREEN SPACE DISTRIBUTION (m2/capita)	X		X
		CH0402	GREEN SPACE DISTRIBUTION (km cycle lane/capita)	X		
		CH0403	PEOPLE LIVING WITHIN 300M TO GREEN AREAS			X
		CH0404	PEOPLE LIVING WITHIN 10KM TO GREEN AREAS			X
		CH0405	GREEN SPACE ACCESSIBILITY	X	X	X
		CH0406	GREEN INFRASTRUCTURE CONNECTIVITY	X	X	X
	Social	CH0407	GREEN INFRASTRUCTURE FUNCTIONALITY		X	
		CH0408	RECREATIONAL VALUE	X		
		CH0409	RECREATIONAL OPPORTUNITIES			X
		CH0410	ELDERLY PEOPLE LIFE QUALITY	X		
		CH0411	CONNECTIVITY PERCEPTION	X		
		CH0412	FOOD PRODUCTION	X		X
	Biological	CH0413	POLLINATOR SPECIES INCREASE	X	X	X
		CH0414	FLORAL RESOURCES INCREASE		X	
		CH0415	PLANT SPECIES INCREASE		X	
		CH0416	INSECTIVORE INCREASE		X	
		CH0417	GREEN AREAS SUSTAINABILITY	X		
CHALLENGE 5: Air Quality	Physical indicators	CH0501	ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES	X	X	X
		CH0502	ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES	X	X	X
		CH0503	EMMISIONS TRENDS of NOx		X	X
		CH0504	EMMISIONS TRENDS of SOx		X	
		CH0505	ANNUAL MEAN LEVELS OF O3	X		
		CH0506	POLLUTANTS REMOVED BY VEGETATION			X
	Economic	CH0507	AIR QUALITY MONETARY VALUES	X	X	
CHALLENGE 6: Urban	Social	CH0601	ACCESSIBILITY / DIVERSITY NBS		X	X
		CH0602	BENEFITS FROM INTERVENTIONS	X	X	
CHALLENGE 7: Participatory Planning and Governance	Social	CH0701	OPENNESS	X		
		CH0702	SOCIAL LEARNING		X	
		CH0703	CITIZEN PERCEPTION	X	X	X
		CH0704	URBAN FARMING PARTICIPATION			X
CHALLENGE 8: Social Justice and Social Cohesion	Social justice	CH0801	CRIME REDUCTION	X	X	
	Social cohesion	CH0802	GREEN INTELLIGENCE AWARENESS (Educational actions)	X		X
		CH0803	GREEN INTELLIGENCE AWARENESS (Communication activities)	X		
CHALLENGE 9: Public Health and Well-being	Psychological	CH0901	NOISE REDUCTION	X		X
	Health	CH0902	WALKING AREA INCREASE	X		X
		CH0903	CYCLING AREA INCREASE	X	X	
		CH0904	HEALTH QUALITY PERCEPTION		X	
CHALLENGE 10: Potential of economic opportunities and green jobs	Economic	CH1001	TAX REDUCTION	X		
		CH1002	JOB CREATION	X	X	X
		CH1003	BUSINESS REVENUE	X	X	
		CH1004	PROPERTY VALUE CHANGE		X	
		CH1005	CONSUMPTION BENEFITS	X		
	TOTAL NUMBER OF KPIs	68		46	34	31

Table 3.1. KPI Full list (2020)

CHALLENGE 1: CLIMATE MITIGATION & ADAPTATION MONITORING PROCEDURE

Code	**CH0101**
NAME	**Ton $C0_2$ CARBON REMOVED per Ha**
KPI DEFINITION	Defined as the process of increasing the carbon content of a reservoir or pool other than the atmosphere
RELATED NBS	This KPI is related to NBS involving green shady structure, urban carbon sink, green parklets and new green corridor.
Measured method	Following the same methods and formulas employed by Rowntree and Nowak, 1991; Vleeshouwers and Verhagen, 2002; Bandarnayake et al., 2003; Tratalos et al., 2007; Townsend-Small and Czimczik, 2010; Davies et al., 2011; Beaumont et al., 2014
KPI Unit	Tons CO_2/ha
Output	Results can be displayed throughout maps and/or tables. In Izmir, ICT platform results will be shown in KPI flashcards.

Code	**CH0102**
NAME	**Ton $C0_2$ CARBON REMOVED per year**
KPI DEFINITION	Defined as the process of increasing the carbon content of a reservoir or pool other than the atmosphere
RELATED NBS	This KPI is related to NBS involving green shady structure, urban carbon sink, green parklets and new green corridor.
Measured method	Following the same methods and formulas employed by Rowntree and Nowak, 1991; Vleeshouwers and Verhagen, 2002; Bandarnayake et al., 2003; Tratalos et al., 2007; Townsend-Small and Czimczik, 2010; Davies et al., 2011; Beaumont et al., 2014
KPI Unit	Tons CO_2/year
Output	Results can be displayed throughout maps and/or tables. In Izmir, ICT platform results will be shown in KPI flashcards.

Code	CH0103
NAME	CARBON STORED
KPI DEFINITION	Total amount of carbon stored in vegetation
RELATED NBS	This KPI is related to NBS involving green shady structure, urban carbon sink, green parklets and new green corridor.
Measured method	GI- Val Tool 1.7 is based upon the Forestry Commission's Woodland Carbon Code Calculators and Lookup Tables (West, 2018).
KPI Unit	tCO_2e
Output	Database

Code	CH0104
NAME	CARBON SEQUESTRATION
KPI DEFINITION	Total amount of carbon sequestered in vegetation
RELATED NBS	This KPI is related to NBS involving green shady structure, urban carbon sink, green parklets and new green corridor.
Measured method	GI- Val Tool 1.8 is based upon De Deyn et al (2010) and Dawson & Smith (2007). It estimates the carbon sequestration resulting from three types of land cover change. The areas of each type of new vegetation planted will be entered into GI-Val.
KPI Unit	tCO_2e year
Output	Database

Code	CH0105
NAME	TEMPERATURE DECREASE
KPI DEFINITION	Decrease in mean or peak daytime local temperatures
RELATED NBS	Green shady structures, Shade Trees, Cooling trees, Green Façade, Green parking pavements.
Measured method	Measure air temperature and relative humidity at sampling points at a range of radii from NBS locations both pre- and post-intervention
KPI Unit	ºC
Output	Database

Code	**CH0106**
NAME	**TEMPERATURE REDUCTION (PROJECTION)**
KPI DEFINITION	Estimation of the maximum surface temperature expected in a neighbourhood, taking into account the evaporative cooling effect of the vegetation.
RELATED NBS	Green shady structures, green covering shelters, cool pavements, shade and cooling trees, parklets.
Measured method	The sub-demo areas will be divided into study areas where groups of interventions have been made, and for each study area the pre- and post-intervention land cover will be calculated.
KPI Unit	ºC
Output	Database

Code	**CH0107**
NAME	**HUMAN COMFORT**
KPI DEFINITION	The main goal of this KPI is to calculate outdoor thermal comfort after measuring micro-climate conditions in Demo Sites before and after implementation of the NBS.
RELATED NBS	Green shady structures, green covering shelters, shade and cooling trees, cool and green pavements.
Measured method	RayMan model (Matzarakis et al., 2007; 2010) in order to calculate outdoor thermal comfort indexes such as the Predicted Mean Vote (PMV), the Physiological Equivalent Temperature (PET) and the new Standard Effective Temperature (SET*). The PET is derived from the human energy balance and is preferable to other thermal comfort indexes such as Predicted Mean Vote (PMV)
KPI Unit	ºC
Output	Database

Code	**CH0108**
NAME	**HEATWAVE RISK**
KPI DEFINITION	Decrease in mean or peak daytime local temperatures
RELATED NBS	Green shady structures, green covering shelters, cool pavements, shade and cooling trees, parklets.
Measured method	Air temperature and relative humidity will be measured and recorded hourly.
KPI Unit	Number of days
Output	Map

Code	**CH0109**
NAME	**SPECIES MOVEMENT**
KPI DEFINITION	Increased opportunity for species movement in response to climate change
RELATED NBS	Source and target locations were selected to represent species movement from south to north through the Liverpool area [Appendix D3.2 Mersey Forest].
Measured method	The Condatis model will be used to test whether the new NBS GI habitat patches have increased the connectivity value of existing habitat networks across the Liverpool area
KPI Unit	% change in long-distance range-shift potential pre- and post-intervention
Output	Database

Code	**CH0110**
NAME	**Energy savings from reduced building energy consumption**
KPI DEFINITION	Energy savings in building energy consumption due to the integration of green infrastructure on building envelope
RELATED NBS	Green Wall and the Green Roof
Measured method	Three options are considered: estimation from previous studies, direct estimation from building energy consumption or estimation from wall thermal transmittance and internal and external temperature measurement.
KPI Unit	kWh per year
Output	Database

Code	**CH0111**
NAME	**Carbon savings from reduced building energy consumption**
KPI DEFINITION	Carbon savings resulting from the reduction in building energy consumption due to the integration of green infrastructure in building's envelope
RELATED NBS	Green Wall and the Green Roof
Measured method	Estimated through a conversion factor from the "Energy savings from reduced building energy consumption"
KPI Unit	t C/y per year
Output	Database

Code	**CH0112**
NAME	**SAVINGS IN ENERGY USE DUE TO IMPROVED GI**
KPI DEFINITION	It quantifies both the energy savings and the bioenergy generated by all the NBS implemented.
RELATED NBS	All NBS (Energy issues)
Measured method	It will be calculated by converting other KPIS into their associated energy savings by means of conversion factors (For example energy savings due to water removed from the sewage system; energy consumption per m^3 of sewage water treated in centralized treatment plants).
KPI Unit	kWh per year
Output	Database

CHALLENGE 2: WATER MANAGEMENT MONITORING PROCEDURES

Code	**CH0201**
NAME	**RUN-OFF COEFFICIENT**
KPI DEFINITION	Run-off coefficient in relation to precipitation quantities
RELATED NBS	SUDs, Natural Wastewater Treatment Plant, Rain Gardens, Green Parking pavements
Measured method	Data are acquired by statistic and rainfall and soil available information in each intervention. Three parameters are used to calculate surface runoff: rainfall depth, initial abstraction of the rainfall, and the potential maximum storage of the soil (Boughton, 1989).
KPI Unit	Numeric
Output	Database

Code	**CH0202**
NAME	**FLOOD PEAK REDUCTION**
KPI DEFINITION	Flood peak reduction. Increase in time to peak (%)
RELATED NBS	SUDs, Natural Wastewater Treatment Plant, Rain Gardens, Green Parking pavements
Measured method	Calculation of hydrograph for a given rainfall event will be calculated and then compared quantitatively in two scenarios (before and after the installation of the NBS) for each intervention.
KPI Unit	%
Output	Database

Code	**CH0203**
NAME	**ABSORPTION CAPACITY m^3/m^2**
KPI DEFINITION	Absorption capacity of green surfaces, bio-retention structures and single trees
RELATED NBS	Natural wastewater treatment, Tree related actions, Green filter area, Rain Garden, SUDs, green parking pavements, electro-wetland.
Measured method	The SCS-CN method is used to estimate the absorption capacity of green surfaces.
KPI Unit	**(m^3/m^2)**
Output	Database

Code	**CH0204**
NAME	**ABSORPTION CAPACITY m^3/tree**
KPI DEFINITION	Absorption capacity of green surfaces, bio-retention structures and single trees
RELATED NBS	Natural wastewater treatment, Tree related actions, Green filter area, Rain Garden, SUDs, green parking pavements, electro-wetland.
Measured method	The SCS-CN method is used to estimate the absorption capacity of trees
KPI Unit	**(m3/tree)**
Output	Database

Code	**CH0205**
NAME	**TEMPERATURE REDUCTION**
KPI DEFINITION	Mean and peak daytime local temperatures will be calculated and used to assess the impact of the NBS related to water interventions.
RELATED NBS	Natural wastewater treatment, Urban catchment forestry, Green filter area
Measured method	Measure air temperature and relative humidity at sampling points at a range of radii from NBS locations both pre- and post-intervention.
KPI Unit	ºC
Output	Database

Code	CH0206
NAME	INTERCEPTED RAINFALL
KPI DEFINITION	Intercepted gross rainfall by the canopy and evaporated directly back into the atmosphere.
RELATED NBS	Tree related actions
Measured method	Direct measures, which requires de use of rain gauges.
KPI Unit	m^3/year
Output	Database

Code	CH0207
NAME	NUTRIENT ABATEMENT (Chemical Oxygen Demand, COD)
KPI DEFINITION	Calculation of the removal of organic compounds from municipal wastewater by means of the analysis of the Chemical Oxygen Demand (COD).
RELATED NBS	Natural wastewater treatment plant, Electro-wetland, SUDS, Rain Garden
Measured method	Laboratory analysis of inflow and outflow wastewater samples from each NBS monitored.
KPI Unit	*mg O_2 L^{-1}; Kg O_2/year*
Output	Database

Code	CH0208
NAME	NUTRIENT ABATEMENT (Biochemical Oxygen Demand, BOD)
KPI DEFINITION	Calculation of the removal of organic compounds from municipal wastewater by means of the analysis of the Biochemical Oxygen Demand (COD).
RELATED NBS	Natural wastewater treatment plant, Electro-wetland, SUDS, Rain Garden
Measured method	Laboratory analysis of inflow and outflow wastewater samples from each NBS monitored.
KPI Unit	*mg O_2 L^{-1}; Kg O_2/year*
Output	Database

Code	CH0209
NAME	NUTRIENT ABATEMENT (Total Solids, TSS)
KPI DEFINITION	Calculation of the removal of Total solids (TSS) from municipal wastewater.
RELATED NBS	Natural wastewater treatment, Electro-wetland, SUDS, Rain Garden
Measured method	Laboratory analysis of inflow and outflow wastewater samples from each NBS monitored.
KPI Unit	*mg TSS L^{-1}; Kg TSS/year*
Output	Database

Code	CH0210
NAME	DRINKING WATER PROVISION
KPI DEFINITION	Drinking water used in NBSs with plantation
RELATED NBS	Tree related actions; SUDs; Bio-swale; Green pavements
Measured method	Measurement method for the drinking water supplied to the consumers is direct measurement with the help of water meters.
KPI Unit	m^3, m^3/time, m^3/ha/year
Output	Database

Code	CH0211
NAME	IRRIGATION WATER PROVISION
KPI DEFINITION	Volume of the water used for irrigation purpose is measured
RELATED NBS	Greenhouse related NBSs
Measured method	Amount of water
KPI Unit	m^3
Output	Database

Code	**CH0212**
NAME	**WATER REMOVED FROM THE SEWAGE WATER SYSTEM**
KPI DEFINITION	Green infrastructure prevent rainfall from entering the water treatment system by allowing it to soak into the soil or to evaporate back into the air.
RELATED NBS	GI
Measured method	V-notch gauging station, infrared height sensors, and Ultrasonic Flow Meters. Valladolid demo site will estimate this KPI using previous calculated KPI's runoff coefficient and absorption capacity of green surfaces.
KPI Unit	$m^3\ sec^{-1}$
Output	Database

Code	**CH0213**
NAME	**WATER SLOWED DOWN FROM ENTERING SEWER SYSTEM**
KPI DEFINITION	Green infrastructure prevent rainfall from entering the water treatment system by allowing it to soak into the soil or to evaporate back into the air.
RELATED NBS	GI
Measured method	V-notch gauging station, infrared height sensors, and Ultrasonic Flow Meters
KPI Unit	$m\ sec^{-1}$
Output	Database

Code	**CH0214**
NAME	**SAVINGS IN TREATMENT OF STORMWATER**
KPI DEFINITION	Reduction in the surface runoff by the implementation of the different NBS will reduce the total volume of wastewater collected though the sewers system and, therefore, the volume of water to be treated. Reducing storage and treatment that will suppose economic savings.
RELATED NBS	Rain Garden, SUDs, Green Parking pavements.
Measured method	Estimation of annual cost before and after the implementation of the NBS.
KPI Unit	€/m^3
Output	Database

CHALLENGE 4: GREEN SPACE MANAGEMENT MONITORING PROCEDURES

Code	**CH0401**
NAME	**GREEN SPACE DISTRIBUTION (m2/capita)**
KPI DEFINITION	Accessibility of urban green spaces for population in terms of m2 per inhabitant.
RELATED NBS	NBS involving horizontal green infrastructures, such as green corridor, urban carbon sink
Measured method	Geographical information systems processing
KPI Unit	**m^2/capita**
Output	Geodatabase

Code	**CH0402**
NAME	**GREEN SPACE DISTRIBUTION (km cycle lane/capita)**
KPI DEFINITION	Accessibility of urban green spaces for population in terms of km of cycle lane per inhabitant.
RELATED NBS	NBS involving horizontal green infrastructures, such as green corridor, urban carbon sink
Measured method	Geographical information systems processing
KPI Unit	**km cycle lane/capita**
Output	Geodatabase

Code	**CH0403**
NAME	**PEOPLE LIVING WITHIN 300M TO GREEN AREAS**
KPI DEFINITION	Accessibility of urban green spaces for population within 300 m.
RELATED NBS	NBS involving horizontal green infrastructures, such as green corridor, urban carbon sink
Measured method	Geographical information systems processing
KPI Unit	**m**
Output	Geodatabase

Code	**CH0404**
NAME	**PEOPLE LIVING WITHIN 10KM TO GREEN AREAS**
KPI DEFINITION	Accessibility of urban green spaces for population within 10 km.
RELATED NBS	NBS involving horizontal green infrastructures, such as green corridor, urban carbon sink
Measured method	Geographical information systems processing
KPI Unit	**Km**
Output	Geodatabase

Code	**CH0405**
NAME	**GREEN SPACE ACCESSIBILITY**
KPI DEFINITION	Accessibility of urban green spaces for population in terms of distance and time.
RELATED NBS	NBS involving horizontal green infrastructures, such as green corridor, urban carbon sink
Measured method	Geographical information systems processing
KPI Unit	m
Output	Geodatabase

Code	**CH0406**
NAME	**GREEN INFRASTRUCTURE CONNECTIVITY**
KPI DEFINITION	Increased connectivity to existing GI
RELATED NBS	NBS GI interventions
Measured method	Use of GIS to calculate % change
KPI Unit	% change
Output	Geodatabase

Code	CH0407
NAME	GREEN INFRASTRUCTURE FUNCTIONALITY
KPI DEFINITION	NBS can be found (a typology map), where each function is performed, and where each benefit is felt
RELATED NBS	All NBS
Measured method	The method makes use of a wide variety of input data and local authority open space data, to map green infrastructure typology, function and benefit.
KPI Unit	Features classes
Output	Map

Code	CH0408
NAME	RECREATIONAL VALUE
KPI DEFINITION	The number of recreational and educational activities related to a NBS
RELATED NBS	Non-technical interventions: Educational activities: Educational paths (A, C); Urban farming educational activities.
Measured method	Quantify the visitors and the number of people participating in the recreational activities per year. URBAN GreenUP Mobile App (geofencing).
KPI Unit	Number of people per year
Output	Database

Code	CH0409
NAME	RECREATIONAL OPPORTUNITIES
KPI DEFINITION	Increase of opportunities related to green infrastructures
RELATED NBS	Tree related actions; Green cycle lane/pedestrian route/road traffic junction improvements. Urban farming promotion.
Measured method	A score or weight (in the 0–5 range Likert-scale) assigned to these factors standing for their relative importance or impact in terms of recreation potential
KPI Unit	(nº factors) (focus group attended)
Output	Database

Code	CH0410
NAME	ELDERLY PEOPLE LIFE QUALITY
KPI DEFINITION	Nature based solutions contribute to improving the quality of life of elderly people both by reducing the pollution and providing new spaces for social interaction and recreational/physical activity development.
RELATED NBS	Green cycle lane; Tree related actions; Vertical and horizontal green infrastructure; tree related actions, Green resting areas; Cycle-pedestrian green paths.
Measured method	The smartphone application includes a generic survey engine that will allow defining different surveys and gathering the responses from the users.
KPI Unit	% of survey responses above a certain threshold.
Output	Database

Code	CH0411
NAME	CONNECTIVITY PERCEPTION
KPI DEFINITION	Increases of connectivity related to existing green infrastructures.
RELATED NBS	Green infrastructures, either horizontal or vertical, such as green corridor, urban carbon sink, etc.
Measured method	GIS software and spreadsheet software
KPI Unit	%
Output	Map

Code	CH0412
NAME	FOOD PRODUCTION
KPI DEFINITION	Production of food resulting from urban farming
RELATED NBS	Urban farming promotion: Urban orchard; Community composting; Small-scale urban livestock
Measured method	The production of food resulting from urban farming activities will be measured by tones/ha per year based on fieldworks.
KPI Unit	(Tonnes per year)
Output	Database

Code	**CH0413**
NAME	**POLLINATOR SPECIES INCREASE**
KPI DEFINITION	Increased habitat for pollinators in NBS GI may contribute to increased abundance of pollinators in the wider urban area.
RELATED NBS	Monitoring of pollinator increase will be carried out in all NBS which have herbaceous or shrub vegetation, including floral resources.
Measured method	Observation of pollinator visits to NBS within 1x1m quadrats (at sampling locations selected at random) is proposed as a suitable method to obtain representative sampling of the study site. The monitoring period should be carried out during the flowering period and at specific conditions to carry out the sampling will be: temperature ≥ 15 ° C, low wind, no rain and dry vegetation. Each period will consist of different flowering plants and different pollinators, depending on the area. Annual mean abundances and species-richness of pollinators recorded pre-intervention with those recorded post-intervention.
KPI Unit	%
Output	Database

Code	**CH0414**
NAME	**FLORAL RESOURCES INCREASE**
KPI DEFINITION	Increased habitat for floral pollinators in NBS GI may contribute to increased abundance of pollinators in the wider urban area.
RELATED NBS	NBS sites with herbaceous or shrub vegetation including floral resources, but not including trees.
Measured method	1x1m sampling method
KPI Unit	%
Output	Database

Code	**CH0415**
NAME	**PLANT SPECIES INCREASE**
KPI DEFINITION	Increased habitat for plant pollinators in NBS GI may contribute to increased abundance of pollinators in the wider urban area.
RELATED NBS	NBS sites with herbaceous or shrub vegetation including floral resources, but not including trees.
Measured method	1x1m sampling method
KPI Unit	%
Output	Database

Code	**CH0416**
NAME	**INSECTIVORE INCREASE**
KPI DEFINITION	Increased habitat for insectivore pollinators in NBS GI may contribute to increased abundance of pollinators in the wider urban area.
RELATED NBS	NBS sites with herbaceous or shrub vegetation including floral resources, but not including trees.
Measured method	Surveys made by an automated bat detector, walking at a constant speed along a pre-determined route. And walking at a constant speed along a pre-determined route with fixed point (3 minute) stops at each of several pre-determined locations with a clear view of open water habitats for the survey of Dragonflies.
KPI Unit	%
Output	Database

Code	**CH0417**
NAME	**GREEN AREAS SUSTAINABILITY**
KPI DEFINITION	Urban green system can achieve self-stability. Urban green and blue solutions contribute to sustainability, which integrates social, economic, cultural and environmental aspects
RELATED NBS	Green corridor; Tree related actions; Urban carbon sink; Vertical and horizontal interventions; Floodable park, NWTP/Detention pond; SUDs (include Rain garden, SUDs, Green parking pavement); Pollinator's modules.
Measured method	Simplified method based on a score table, has been defined to have an evaluation approach of the impact of the different Nature Based Solutions (NBS)
KPI Unit	Score (0%-100%)
Output	Database

CHALLENGE 5: AIR QUALITY MONITORING PROCEDURES

Code	**CH0501**
NAME	**ANNUAL MEAN LEVELS OF FINE PM2.5 PARTICULES**
KPI DEFINITION	Annual mean levels of fine particulate (PM2.5) matter in cities concentration recorded ug/m3
RELATED NBS	Urban Garden BioFilter, Urban Trees including: Planting and renewal of urban trees; Shade Trees; Cooling trees; Trees re-naturing parking and Arboreal areas around urban areas, Green Façade, Green shady structures, Green fences
Measured method	A portable photometric sampler designed to measure ambient PM2.5 and PM10 concentrations. This KPI requires a portable monitor because of the quite big measurement points.
KPI Unit	PM2.5 µg/m^3
Output	Database

Code	**CH0502**
NAME	**ANNUAL MEAN LEVELS OF FINE PM10 PARTICULES**
KPI DEFINITION	Annual mean levels of fine (PM10) particulate matter in cities concentration recorded ug/m3
RELATED NBS	Urban Garden BioFilter, Urban Trees including: Planting and renewal of urban trees; Shade Trees; Cooling trees; Trees re-naturing parking and Arboreal areas around urban areas, Green Façade, Green shady structures, Green fences
Measured method	A portable photometric sampler designed to measure ambient PM2.5 and PM10 concentrations. This KPI requires a portable monitor because the quite big measurement points.
KPI Unit	PM10 µg/m^3
Output	Database

Code	**CH0503**
NAME	**EMISSIONS TRENDS of NOx**
KPI DEFINITION	Trends in levels of NOx
RELATED NBS	Citywide will be carried out by the same laboratory to provide consistency in the comparability of data collected historically and elsewhere across the city
Measured method	Concentrations of NOx (units) will be provided following laboratory analysis.
KPI Unit	NOx µg/m^3
Output	Database

Code	**CH0504**
NAME	**EMISSIONS TRENDS of SOx**
KPI DEFINITION	Trends in levels of SOx
RELATED NBS	Citywide will be carried out by the same laboratory to provide consistency in the comparability of data collected historically and elsewhere across the city
Measured method	Concentrations of SOx (units) will be provided following laboratory analysis.
KPI Unit	SOx µg/m^3
Output	Database

Code	**CH0505**
NAME	**ANNUAL MEAN LEVELS OF** O_3
KPI DEFINITION	Annual mean levels of
RELATED NBS	Citywide, will be carried out by the same laboratory to provide consistency in the comparability of data collected historically and elsewhere across the city
Measured method	Concentrations of O_3
KPI Unit	O_3 µg/m^3.
Output	Database

Code	**CH0506**
NAME	**POLLUTANTS REMOVED BY VEGETATION**
KPI DEFINITION	Pollutant's removed by vegetation (in leaves, stems and roots)
RELATED NBS	Green parklets, urban carbon sink: planting new trees, green fences/green walls, shade and cooling trees.
Measured method	The trees capacity to removal air pollutant is calculated based on Baldocchi and Camara, 1987.
KPI Unit	kg ha -1 year -1
Output	Database

Code	**CH0507**
NAME	**AIR QUALITY MONETARY VALUES**
KPI DEFINITION	Value of air pollution reduction
RELATED NBS	Urban Garden BioFilter; Urban Trees including: Planting and renewal of urban trees; Shade Trees; Cooling trees; Trees re-naturing parking and Arboreal areas around urban areas, Green Façade; Green shady structures; Green fences
Measured method	City official data plus city platforms and surveys by questionnaires and small-medium enterprise accounts.
KPI Unit	€
Output	Database

CHALLENGE 6: URBAN REGENERATION MONITORING PROCEDURES

Code	**CH0601**
NAME	**ASSESSMENT OF ACCESSIBILITY / DIVERSITY NBS**
KPI DEFINITION	Assessment of the NBS and the ways in which individuals, communities and local business may attribute value and/or function to the landscape.
RELATED NBS	All
Measured method	Social survey taking into account a Green infrastructure mapping and a typology map together with other datasets to identify where each of the functions performed by the green infrastructure
KPI Unit	N/A
Output	Report

Code	**CH0602**
NAME	**ASSESSMENT OF THE BENEFITS FROM INTERVENTIONS**
KPI DEFINITION	Assessment of typology, functionality and benefits provided
RELATED NBS	All
Measured method	Taking into account a group of parameters that are the criteria to calculate the global indicator. These criteria are defined as single parameters, which are calculated departing from technical and statistical data collected or provided from other indicators.
KPI Unit	%
Output	Report

CHALLENGE 7: PARTICIPATORY PLANNING AND GOVERNANCE

Code	**CH0701**
NAME	**OPENNESS**
KPI DEFINITION	Openness of participatory processes
RELATED NBS	This KPI apply to all technical interventions
Measured method	There is used an Excel sheet and statistics software. This KPI is based on the participation actions delivered in the city. The methodology defines two steps, (1) data collection and characterization (Participation techniques, Degrees of participation, Co-creation & Co-production agent); and (2) Data evaluation (quantitative-qualitative).
KPI Unit	(#Participatory actions/year) (# attendees) (qualitative evaluation score)
Output	Report

Code	**CH0702**
NAME	**SOCIAL LEARNING**
KPI DEFINITION	Social learning has long been established as essential to policy change and thus is essential to mainstreaming NBS.
RELATED NBS	All
Measured method	Data from all methods will be analysed using standard qualitative data analysis software, using a combination of deduction and induction, using a priori codes from theory (Creswell 2013).
KPI Unit	N/A
Output	Report

Code	**CH0703**
NAME	**CITIZEN PERCEPTION**
KPI DEFINITION	Perceptions of citizens on urban nature
RELATED NBS	Green corridor (green cycle lane, resting areas, cycle-pedestrian green paths); Vertical and horizontal green infrastructure; Tree related actions; Natural Wastewater Treatment Plant, Rain gardens; Green Parking Pavements; Electro wetland. Non-technical interventions: Promotion of ecological reasoning and intelligence.
Measured method	Measurements for the social survey will be done in person (in situ surveys), via online platforms (online surveys) and via the smartphone applications provided by the URBAN GreenUP Consortium.
KPI Unit	Likert scale (1-5) (% of satisfaction) (nº users)
Output	Database

Code	**CH0704**
NAME	**URBAN FARMING PARTICIPATION**
KPI DEFINITION	Urban Farming Educative and participate activities plus learning for producers
RELATED NBS	Urban Farms
Measured method	Survey
KPI Unit	N/A
Output	Report

CHALLENGE 8: SOCIAL JUSTICE AND SOCIAL MONITORING PROCEDURES Social indicators

Code	**CH0801**
NAME	**CRIME REDUCTION**
KPI DEFINITION	Crime Reduction related to green infrastructure
RELATED NBS	All
Measured method	This will be mapped along with the police data on GIS to show the locations and frequency of criminal activity at each of the demo sites.
KPI Unit	Nº or %
Output	Map

Code	**CH0802**
NAME	**GREEN INTELLIGENCE AWARENESS (Educational actions)**
KPI DEFINITION	Green Infrastructure awareness will lead to a change in behaviour and human attitudes. This KPI aims to reflect on how the intervention is used for educational purposes and enhancement of public awareness. There are two different categories: Educational activities (CH0802) and Communication activities (CH0803)
RELATED NBS	Non-technical interventions: Educational activities: Educational paths (A, C); Urban farming educational activities; VAc39- Promotion of ecological reasoning and intelligent.
Measured method	Quantify the number of activities, publications or campaigns focused on the enhancement of green intelligence awareness per year, related to a NBS.
KPI Unit	Number of educational activities. Number of people reached.
Output	Database

Code	**CH0803**
NAME	**GREEN INTELLIGENCE AWARENESS (Communication activities)**
KPI DEFINITION	Green Infrastructure awareness will lead to a change in behaviour and human attitudes. This KPI aims to reflect on how the intervention is used for educational purposes and enhancement of public awareness. There are two different categories: Educational activities (CH0802) and Communication activities (CH0803)
RELATED NBS	Non-technical interventions: Educational activities: Educational paths (A, C); Urban farming educational activities; VAc39- Promotion of ecological reasoning and intelligent.
Measured method	Quantify the number of publications or campaigns focused on the enhancement of green intelligence awareness per year, related to a NBS ((editorial, communication actions)).
KPI Unit	Number of publications
Output	Database

CHALLENGE 9: PUBLIC HEALTH AND WELL-BEING MONITORING PROCEDURES

Code	**CH0901**
NAME	**NOISE REDUCTION**
KPI DEFINITION	Noise reduction rates applied to UGI within a defined road buffer per square meter of vegetation unit
RELATED NBS	Green Noise Barriers, Green Façade, Green shady structures, Green fences, Urban Trees including: Planting and renewal of urban trees; Shade Trees; Cooling trees; Trees re-naturing parking and Arboreal areas around urban areas, Green roof, Green covering shelters
Measured method	In situ measurements and modelled values by software assistance
KPI Unit	dB (A) m^2 vegetation unit
Output	Database

Code	CH0902
NAME	WALKING AREA INCREASE
KPI DEFINITION	Increase in walking in and around areas of interventions
RELATED NBS	This KPI is related to NBS interventions, such as green corridor, new green cycle lane, horizontal green interventions etc.
Measured method	Measured throughout pedestrian counter units
KPI Unit	%
Output	Database

Code	CH0903
NAME	CYCLING AREA INCREASE
KPI DEFINITION	Increase in cycling in and around areas of interventions
RELATED NBS	This KPI is related to NBS interventions, such as green corridor, new green cycle lane, horizontal green interventions etc.
Measured method	Measured throughout pedestrian and bicycle counter units
KPI Unit	Number of users.
Output	Database

Code	CH0904
NAME	HEALTH QUALITY PERCEPTION
KPI DEFINITION	Perceptions of health and quality of life
RELATED NBS	NBS interventions
Measured method	Social survey of local residents will be conducted to understand perceptions of general, physical, and mental health, as well as general, individual, and communal well-being
KPI Unit	N/A
Output	Report

CHALLENGE 10: POTENTIAL OF ECONOMIC OPPORTUNITIES AND GREEN JOBS MONITORING PROCEDURES

Code	**CH1001**
NAME	**HEALTH QUALITY TAX REDUCTION**
KPI DEFINITION	Number of subsidies or tax reductions applied for (private) NBS measures
RELATED NBS	Vertical green interventions, Horizontal green interventions, Urban farming promotion: Urban orchard; Community composting; Small-scale urban livestock, Sponsoring activities; Support to citizen project of NBS, Non-technical actions, Natural wastewater treatment.
Measured method	Application of subsidies and reduction of fees by the NBS
KPI Unit	€
Output	Database

Code	**CH1002**
NAME	**JOB CREATION**
KPI DEFINITION	Number of jobs created; gross value added
RELATED NBS	Vertical green interventions, Horizontal green interventions, Urban farming promotion: Urban orchard; Community composting; Small-scale urban livestock, Sponsoring activities; Support to citizen project of NBS, Non-technical actions, Natural wastewater treatment.
Measured method	City official data, city platforms, questionnaires, small-medium enterprise accounts.
KPI Unit	Nº of jobs
Output	Database

Code	**CH1003**
NAME	**BUSINESSES REVENUE**
KPI DEFINITION	Increased returns of business rates with NBS
RELATED NBS	All
Measured method	Self-reported via questionnaires administered in business owners and representatives in person and online.
KPI Unit	Nº
Output	Database

Code	**CH1004**
NAME	**PROPERTY VALUE CHANGE**
KPI DEFINITION	Changes in mean house prices/rental markets
RELATED NBS	100 meter radius of the NBS
Measured method	Database analysis pre and post interventions
KPI Unit	%€
Output	Database

Code	**CH1005**
NAME	**CONSUMPTION BENEFITS**
KPI DEFINITION	Consumption benefits: property betterment and visual amenity enhancement
RELATED NBS	Vertical green interventions, Horizontal green interventions, Urban farming promotion: Urban orchard; Community composting; Small-scale urban livestock, Sponsoring activities; Support to citizen project of NBS, Non-technical actions, Natural waste water treatment.
Measured method	City official data, city platforms, questionnaires, small-medium enterprise accounts
KPI Unit	(nº improvements) (€/m2)
Output	Database

4 How to use KPIs once they have been calculated

4.1 Using KPIs within cities for reporting

4.1.1 Monitoring responsibilities (partners/third parties …)

GMV is working intensively in the different front runners 'demonstrations (WP2, WP3 and WP4) with the delivery of their monitoring programs, ensuring technological harmonization among the different front-runners cities. Front-runners cities (Valladolid, Liverpool and Izmir) are supported by several local partners creating a group of stakeholders to lead the city transition that assures the solutions implementation and monitoring success.

The following diagram shows the relation between the global Monitoring and Evaluation Plan, between the corresponding local monitoring programs of the front-runner cities. Local partners of each city have defined the evaluation protocols and KPIs for monitoring the NBS that they are implementing, according to their knowledge and experience.

Local partners' responsibility will be data capture of and KPIs calculation. The data sources will be provided by the municipal entities (Valladolid, Liverpool and Izmir city councils), from external sources or from the URBAN GreenUP monitoring systems such as sensors, drones, satellite image or others.

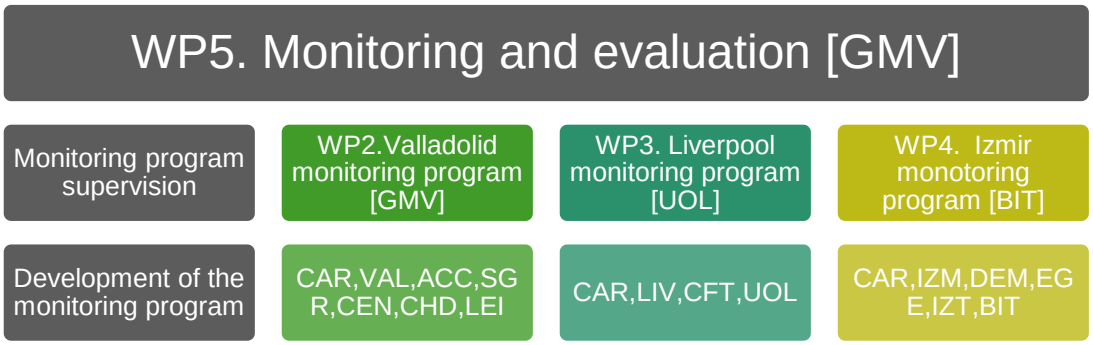

Figure 4.1: Relationship between monitoring programs and responsible partners.

4.1.2 Reporting periods

URBAN GreenUP will launch a two year monitoring period to collect a complete set of data and achieve maximum accuracy in the evaluation process. Data collection periodicity will be variable according to the KPI nature and its data source. Thus, there are daily data, such as air quality, regular data or punctual data.

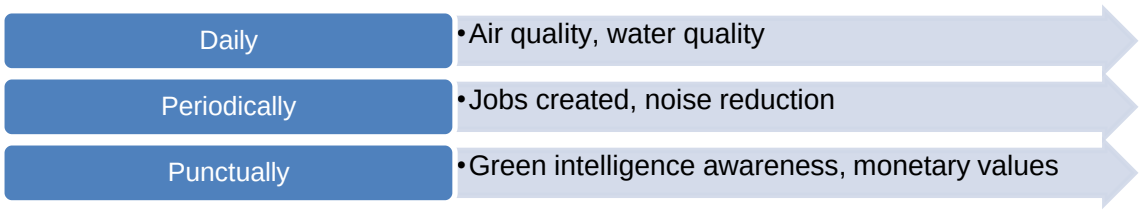

Figure 4.2: Different data collection periods and some examples.

However, the following reporting periodicity is proposed for the KPIs calculation:

- **Quarterly reporting**: The values of the KPIs calculated/measured should be uploaded to the monitoring platform quarterly. It is noted that some indicators will not show quarterly variations. Leader: Monitoring program supervisor (GMV for Valladolid, UOL for Liverpool and BIT for Izmir).
- **Annual reporting**: Grouped global KPI calculation will be submitted annually. Leader: Monitoring program supervisor (GMV for Valladolid, UOL for Liverpool and BIT for Izmir) with the supervision of local entities, WP2, WP3 and WP4 leaders.

Figure 4.3: Reporting periods' proposal.

4.1.3 Report format (reporting tables)

The calculated indicators should be presented in a homologated table format consistent with the database language. The final format will be provided by the URBAN GreenUP database manager, GMV, as part of the WP5.

The table will have a standard format that will match with the current KPI definition table for each city/area. The Core KPIs will be identified, as well as if the indicator is specific for each city/area.

Database field	Description	Example
Eklipse challenge	Classification of the indicator in 10 Challenges of the Eklipse project.	CHALLENGE 5:Air Quality
Type of indicator	Sub-classification.	Environmental (chemical)
KPI Definition	Indicator description according to the metric.	Air quality parameters NOx and PM
KPI unit	Unit of measurement for the indicator value.	µg/m^3
Core / DemoSite	Identify with an 'X' if it is a Core KPI. Identify the city which is calculating this KPI. This field allows identifying if the KPI is Core or is calculated specifically by a city.	ESA core KPIs (X) Valladolid (X) Liverpool () Izmir ()
NBS	Contains the intervention to which the indicator applies to monitor its effectiveness	Urban Garden BioFilter
Value	Value of the indicator for the corresponding quarter. There will be four quarterly values and an annual value.	XX % of reduction in PM or NOX concentration in the area after the intervention.

Table 4.1: Content of the indicator monitoring standard reporting table

4.2 Intended use of KPIs within the URBANGreenUp global ICT platform

The global URBAN GreenUP ICT platform is based on the city KPI calculation platform or local storage that will be enabled and or developed for the different types of KPIs received from the respective partner cities' data and or model of systems and platforms. By intending use of KPIs, the global platform serves as a scientific tool for developers of climate solutions for urban cities and provides a model that enable smart usage of data for “green” status.

This means that there isn’t a platform that will calculate or process data but there is an ICT solution that will fulfil the needs to make the data accessible, interoperable and open in order to be compliance with the research purpose of the project.

The global platform provides an effective and sustainable framework and architecture to produce the necessary visualization of the KPIs. The KPIs are basically reported and collected

from a combination of guidelines provided for raw data, KPI calculation processes and user's engagement at different cities of concerns. The platform is just for raw data collection and calculated KPI input and output but also for visualization of the already calculated indicators. To serve scientific storage, scientific decision making processes, and additionally provides an engagement platform for users from scientific communities, and, municipalities to interact and make proactive "green" solutions for cities at large.

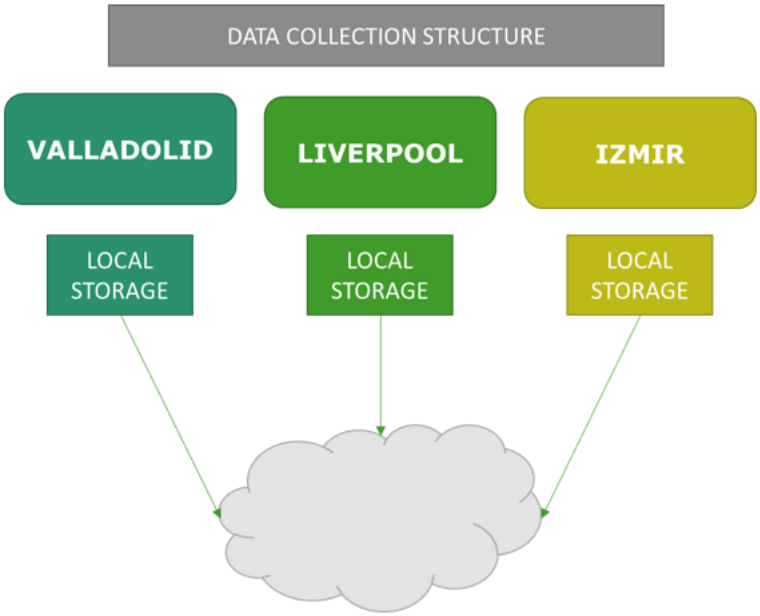

Figure 4.4: ICT platform diagram I

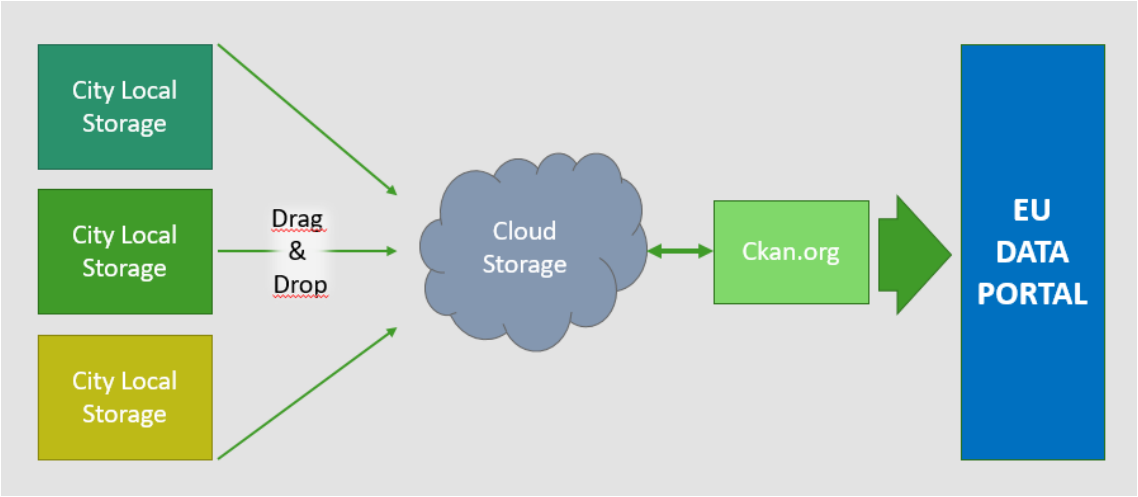

Figure 4.5: KPI delivery procedures

KPIs are quantities that depict the condition of a NBS model and are utilized as input or output to condense data about the state of URBAN GreenUP system. They lessen dimensionality of information, disentangle understandings, and encourage correspondence amongst specialists

and non-specialists. In this way, KPIs could be utilized as measurements for key data concerning community-based solution structure, and administrations.

The KPIs to the URBAN GreenUp is to do visualized data about conditions and may demonstrate drifts and give a superior comprehension of the reasonability of cities' framework. The KPIs used are generally describing:

- Which ecosystem/environment function is providing a service and how much
- How much of that service or input can be used in a sustainable way

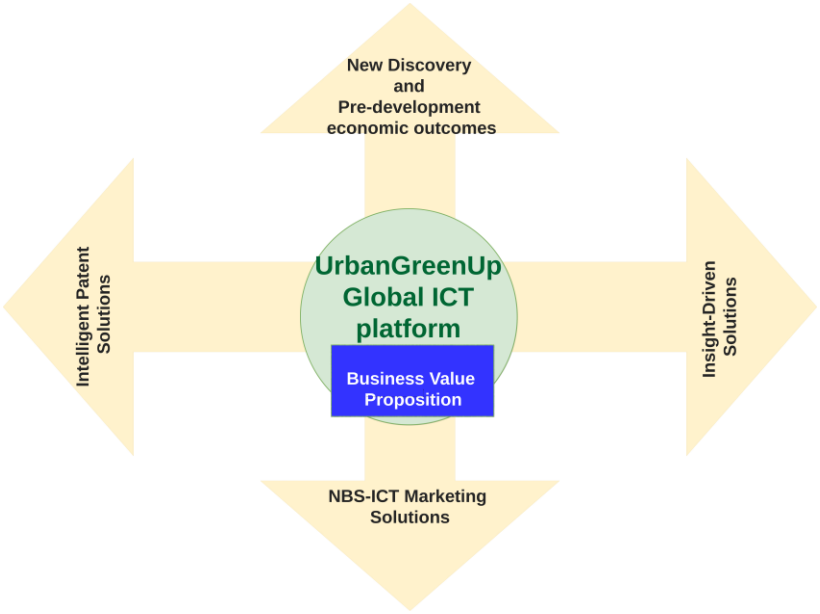

Figure 4.6: KPI-enabled Global ICT Platform: Business model, actions and future

The KPIs will be a substantial function of parameter to present a model of visualization that can be used in urban ecosystem. It enables the visualization of functions to provide services that increases the "green" capacities of our environment. The URBAN GreenUP ICT platform will enable services that use the KPIs to do performance analysis for various "green" environment solutions in steps as:

- Evaluate the weight as related to other corresponding parameters such as KPI input data
- Do benchmarking, certification with respect to other cities and projects
- Do replication development for other "green-enabled" citizens' related project

4.3 Combining KPIs to give aggregated indicators

According to Eklipse 2017 report, in many cases, the measurement of impacts may not be reasonable or even feasible at an urban scale because the change caused by a single measure is too small. While the amount of pollutants captured by vegetation may be important at the micro scale, a single project will hardly affect the quantity of pollutants at the meso level. The same holds for water quality, the urban heat island effect and the carbon storage capacity, as the impacts of spatially limited individual NBS projects (or actions) may be very small, but in aggregate they can make a difference.

Examples of the possible range of co-benefits and costs as identified in the challenges taken for URBAN GreenUP team are given in table below. For example, temperature reduction actions are likely to have co-benefits for air quality and green space management, but also for public health and wellbeing. Increasing the ground water quality, will benefit green space. There are also opportunities for urban regeneration and social justice and social cohesion from actions aimed at increasing the water quality. In contrast, increases in property prices stemming from actions to improve economic opportunities and green jobs in urban areas may adversely affect social justice and social cohesion by displacing groups of socioeconomically disadvantaged residents. Nevertheless, as potential costs, benefits and trade-offs need to be assessed in the specific local context, this table can only indicate some of the interactions between the challenges, including opportunities to build synergies.

In order to compare, and evaluate different options for NBS or alternative investments, Net Present Value (NPV) of each option needs to be evaluated. So most common form of aggregation of KPIs can be based on economic (monetary) assessment methods which aggregate all monetary costs and expected benefits of the investment. This is called Cost and Benefit Approach (CBA) either considers costs and benefits directly connected to single (or a group of) investors (e.g. a local authority or utility), the Social Costs and Benefits Approach (SCBA) includes wider societal costs and benefits in the assessment, such as tax revenues, subsidies, increased real estate values, etc.

Many of the environmental and social benefits and costs connected to the impacts of NBS actions are measured in terms of physical parameters or qualitative judgements of individual and aggregated preferences, which can only partly be translated into monetary terms (e.g. pollution-related health effects) and are thus difficult to aggregate. Therefore, researchers need to take in to account different types of qualification, quantification, aggregation and standardisation. Multi-criteria analysis allows for the representation of different outcomes of the assessment process according to different group (or individual) preferences. Rather than producing a single result indicating the “optimal” solution, these approaches allow for visualising the impact of different preferences on the assessment results.

4.4 General remote sensing indexes

Another of key elements that are researching and will be a major output for the URBAN GreenUP project will be the Earth Observation Indicators that will sum to the KPI to gather further knowledge about the demo cities.

As said, some of the data that is being acquired and is being process to monitoring the demonstration cities come from the space.

Thanks to the Copernicus Programme we are able to use and process data from the Sentinel constellation in order to have insight and expand the information about the urban ecology for the whole city. Some of this data will be merged with the information that KPI will be providing, as could be the accessibility to green areas or green infrastructure per capita.

We have process data from Sentinel-2 from 2017 to 2019 and will continue the processes until the end of the project. We will have valuable information.

So far we have initiated the calculation of eleven indexes. Some of them are proved to be useful others are yet to be tested and validated.

These are the Earth Observation Indicators that are being in process:

1. **Normalized Difference Vegetation Index (NDVI)**

   NDVI, is an indicator of the greenness of the biomes which use the near-infrared band and the red band of the spectrum.

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

2. **Green Normalized Difference Vegetation Index (GNDVI):**

$$GNDVI = \frac{(NIR - Green)}{(NIR + Green)}$$

3. **Enhanced Vegetation Index (EVI):**

$$EVI = G * \frac{(NIR - Red)}{(NIR + C1 * Red - C2 * Blue + L)}$$

   The standard EVI used by NASA in MODIS sensor: G=2.5, L=1, C1=6 and C2=7.5
   We've initiated tests with same parameters for Sentinel -2, we need to validate these.
   Further research is needed.

4. **Advance Vegetation Index (AVI):**

$$AVI = \sqrt[3]{(NIR + 1) * (256 - Red) * (NIR - Red)}$$

5. **Advance Vegetation Index (SAVI):**

$$SAVI = \frac{(NIR - Red)}{(NIR + Red + L)} * (1 + L)$$

An "L" value of 0.5 is typically used for intermediate vegetation cover.

6. **Normalized Difference Moisture Index (NDMI):**

$$NDMI = \frac{(NIR - SWIR_1)}{(NIR + SWIR_1)}$$

7. **Moisture Stress Index (MSI):**

$$MSI = \frac{SWIR_1}{NIR}$$

8. **Green Coverage Index (GCI):**

$$GCI = \frac{NIR}{Green} - 1$$

9. **Normalized Burn Ratio (NBR):**

$$NBR = \frac{(NIR - SWIR_2)}{(NIR + SWIR_2)}$$

10. **Bare Soil Index (BSI):**

$$BSI = \frac{(SWIR_1 + Red) - (NIR + Blue)}{(SWIR_1 + Red) + (NIR + Blue)}$$

11. **Normalized Difference Water Index (NDWI):**

$$NDVI = \frac{(Green - NIR)}{(Green + NIR)}$$

4.5 Results analysis

Results will be collected and analysed in WP5 framework during Task 5.4 (*Data collection and ICT platforms implementation supervision*) and Task 5.5. (*Global Evaluation and conclusions/recommendations*). Task 5.4 will supervise remotely the raw data collection and the implementation of the monitoring procedures on each city to ensure compliance with the given guidelines and established schedule. On time and right. In Task 5.5 an overall performance of the KPIs weights shall be defined. These weights will depend on social, meteorological or other local aspects to any NBS. Each city will obtain a global evaluation as a function of the KPIs with their associated weights after its NBS implementation is finished. The overall conclusion and the data analysis will be derived into recommendations for the follower cities, guidelines and also knowledge that may be marketable for both front-runner and follower cities.

5 Covid19 Risk Assessment

In March 2020 the outbreak of the virus SARS-CoV-2 impacted our project as the cities and countries involved were highly infected and governments started taking actions.

Before the month was over from the WP5 it was collected the following information regarding open task and in order to have a first sight the impact on the WP5 of the pandemic.

The information collected is in the table below. All the information was shared in an urgent call occurred in March 2020.

covid19 - WP5 IMPACT	***Teleworking Y/N***	***Impact on the performance in the WP***	***Impact on the established deadlines (Deliverable D5.5)***	***Would you be able to produce KPI data in given circumstances? Impact on the established deadlines (monitoring)***	***Comments***
GMV	Y	GMV is fully operative, working on a regular basis aiming to provide the same quality of services and solutions. We'll be coordinating WP5, producing RS data and collaborating with the rest of the WPs.	*We missed the deadline for the deliverable (we will be sharing the ToC for the D5.5 in the following weeks) Asking from inputs from the 30th of March to 30th of April*	Yes, as in normal circumstances	GMV is keen to support with any problem related to technical issues always and especially during this crisis. Our aim is to provide our best performance during URBANGREENUP project and if any partner is experiencing issues that we can help to palliate please don't hesitate to contact us.
CAR	Y	We are working as normal.	We can work in the required inputs as normally	We can manage to calculate KPIs, however, some data collection is pending due to alarm state (those data which require a physical visit to the city: i.e. pollinators control, temperature and humidity data collection, etc.)	
VAL	Y	Valladolid City Council has stopped the regular administrative activities. We provide basic services. There cannot be started new contracts. Open contracts still ongoing, unless the contractors ask for a temporal suspension (every procedure according to new laws).	We can work from home and calculate VAL KPIs. We might find difficulties on finding the basic data (we do not have access to municipal databases) We can contribute to Deliverable D5.5. during April.	Yes, we can produce KPI. We might find difficulties on finding and providing the basic data (meteorological data, economic data, etc.)	VAL are focused on the WP2 implementation phase, even with the operational difficulties during the Alarm Period. We are dealing with open contracts, new contracts, according to new laws (COVID-19)

ACC		ACC is operative working remotely, we hope not to be affected by the situation in reference to the WP5 and URBANGreenUP Project.	Currently working on it, hope to be able to deliver the results in the coming days.	In our case, we gather the data from Valladolid Municipality, we have to establish connections with them, still not done, to be updated next week.	Economic KPIs assigned is complex issue, depending on the data that in some cases may be confidential, and where possible new factors should be taken into account, we do our best to present the valuable contents soon.
SGR	Y	Fully operative	Available for inputs	Normal	We are available, for any question don't hesitate to contact us.
CEN	Y	CENTA holds the operational resources and is able to develop all the required tasks of the WP		Yes, if data can be gathered and provided by VAL	
LIV	Y	The baseline data has been collected and is currently being analysed, calculated and collated. Some data has yet to be analysed in labs and some data still needs to be calculated using on line tools (possible remotely). Liverpool is in lockdown for 3 weeks and data collection and monitoring has been suspended. Going forward, there will be gaps in data collection except for some of the continuous data loggers. The current situation has also delayed the implementation of some NBS and due to the seasonal nature for some of these NBS, they may now need to be delayed until the autumn. The monitoring of the NBS already installed will commence as soon as they become accessible to us again.	We will support the deliverable to the best of our ability based on the current limitations imposed on the project.	Yes in normal circumstances, but for the next few weeks data collection will not be possible, and there are delays on water quality data as samples are analysed in batches. The university labs are now inaccessible due to lockdown. Some KPIs require further calculations/use of online tools. Continuous data loggers require the data to be treated to create manageable files for uploading and this needs to be carried out by a third party and it may not be possible to complete this remotely. For socio-economic data - see UoL	Liverpool has a good set of baseline data. Some NBS have been installed and others are now on hold due to the circumstances. Monitoring following the introduction of NBS will commence as soon as movement restrictions are lifted. The city will need to review its monitoring programme given the staggered introduction of NBS, which will now span many months.
CFT	Y	As Liverpool	As Liverpool	As Liverpool	As Liverpool

UOL	Y	UOL is leading on the monitoring, and no monitoring can take place until further notice. The baseline is there, but there is an open question about when follow up monitoring can occur until we know 1) the interventions are in, and 2) field work is allowed again.	Once the deliverable is shared, we can contribute.	A good baseline already exists, but many KPIs will be impacted. We cannot collect some KPIs face-to-face and the university has cancelled all field work until further notice. We will be meeting as a whole Liverpool partner team to discuss this soon.	We will be able to revise some methods for socio-economic data collection to be remote (e.g. phone interviews, online surveys), but some data cannot be collected remotely until the UK is no longer on lockdown, the interventions are all in place and the university authorises field work once again. The extent of the impact is contingent on the length of the crisis.
IZM	Y	Working remotely. Almost fully operative. There might be some missing data due to operational problems on demosites.	No negative impact	There might be some missing data due to operational problems on demosites. Implementations have not finished yet. So there is no data to monitor for some NBSs.	
DEM	Y	DEM is also fully operative and working on a regular basis. We are working remotely but we are able to continue our studies in the same way for every WP of course including WP5	We will follow the deadlines and continue our studies on T5.4 in cooperation with GMV and BIT	Yes, we are able to produce data for the KPIs we responsible.	
EGE	Y	Y	Y	N	Climate smart greenhouse construction, plant production compatible with changing climate condition, biochar production and testing on agricultural fields and Work on the improvement of soil properties and use of waste sludge for agricultural purposes has started. But there are disruptions in labouring and tender processes due to covid19.There are significant delays due to Covid19.
BIT	Y	BitNet is also fully operational.	We will support GMV to make the deadlines	business as usual	We are willing to support any partners and GMV in these difficult times

LEI	Y	LEITAT is fully operative regarding its participation in WP5, as long as other partners provide the required information and the intervention of which LEI is responsible can be constructed in Valladolid, LEI will be able to calculate their KPIs with no delays and send the results to Valladolid City Council.	LEITAT is fully operative to provide the corresponding contributions to the D 5.5.	Regarding the KPI of which LEI is in charge of their calculation: as long as other partners provide the required information, LEI will be able to calculate their KPIs with no delays and send the results to Valladolid City Council. Regarding the data generated in LEI's intervention (Electrowetland), as long as it can be constructed in Valladolid, LEI will coordinate the record of the data and provide it to Valladolid City Council and other responsible partners for KPI calculation. However, as a consequence of the COVID19, the Electrowetland construction may be delayed and therefore, LEITAT will not be able to generate the data for the corresponding KPI calculation.	LEITAT is also waiting for the approval of the amendment in preparation to elucidate if all changes in subcontracting costs are accepted by the EC.

Table 5.1. WP5 status on March 2020 after covid19 impact

During the urgent call we focused mainly in the covid19 impact to our partners and especially on how the data will be affected. We knew that some of the KPIs won't be showing proper results and the monitoring in some cases where stopped. At that moment the clearest output was that there was no answer and we needed to flexible and adapt to the situation that was (still is) ahead of us.

During the Second Project Review it was asked to include a risk assessment inside this document. The methodology followed to collect the risk was the following one.

GMV, as leader coordinator of the working package, based on practises held in the company and well established for risk management created a YES/NO answer risk questionnaire to be distributed to the rest of the cities, that could extend to other partners involved, to address how the Monitoring and the Data Collection and Data Storage could be affected and identify risks, mishaps and the affection of those to the working package and the project itself.

The questionnaire shared is in the table below.

Risk Assessment Questionnaire:

Source of risk	Yes	No	Explanation if the answer is in the negative
Personnel			
Will they be available in case of extension?			
Sensors Installed			
Will they be available on time for use?			
Will they be stable when used?			
Will they be mature when used?			
Will they be suitable when used?			
Will they be error-free when used?			
Sensors to be installed			
Will they be available on time for use?			
Will they be stable when used?			
Will they be mature when used?			
Will they be suitable when used?			
Will they be error-free when used?			
Indicators			
Will they be affected when collect?			
Will they be collect on time?			
Will they be collect in case of extension?			
Will they be compromise when collected?			
Will they be suitable for purpose if compromised?			
Tools to be used in the project			
Will they be available on time for use?			
Will they be stable when used?			
Will they be mature when used?			
Will they be suitable when used?			
Will they be error-free when used?			
EC deliverables			
Will they be on time schedule based?			
Will they be in line with the cost estimation?			
Will they be correct after COVID19? [submitted ones]			
Will they be error-free when uploaded?			
Local Data Storage			
Will they be available on time for use?			

Source of risk	Yes	No	Explanation if the answer is in the negative
Will they be stable when used?			
Will they be mature when used?			
Will they be suitable when used?			
Will they be error-free when used?			
Data Storage Maintenance			
Will they be available on time for use?			
Will they be stable when used?			
Will they be mature when used?			
Will they be suitable when used?			
Will they be error-free when used?			
Equipment and materials (internal and external) to be used			
Has the obsolescence of the equipment and materials been taken into account in the planning of the project?			
Has the End of life of the equipment and materials been taken into account in the planning of the project?			
Project plan			
Are the resources contemplated in the GA enough?			
Are the deadlines agreed with the EC achievable?			
Project Team			
Does the project team have enough knowledge and experience?			
Will the project team be available as required by the project plan?			
Review meetings			
Have the objectives of the review meetings been defined and they are clear?			
EC			
Will the EC meet their commitments?			
Consortium members			
Will the consortium members meet their commitments?			

Source of risk	Yes	No	Explanation if the answer is in the negative
Subcontractors			
Will the subcontractor meet their commitments?			
Other sources of risk (to be detailed)			

Definitions:

- Availability: ready for use
- Stability: not changing
- Maturity: with a final state
- Suitability: fit for purpose
- Quality: absence of defects

RESULTS

In the case of IZMIR

Source of risk	Yes	No	Explanation if the answer is in the negative
Personnel			
Will they be available in case of extension?	Y		
Sensors Installed			
Will they be available on time for use?		N	We need to change some sensor heads for extended times Also for some sensors we cannot travel due to restrictions of covid
Will they be stable when used?	Y		
Will they be mature when used?	Y		
Will they be suitable when used?	Y		
Will they be error-free when used?	Y		
Sensors to be installed			
Will they be available on time for use?	Y		
Will they be stable when used?	Y		
Will they be mature when used?	Y		
Will they be suitable when used?	Y		
Will they be error-free when used?	Y		
Indicators			
Will they be affect when collect?	Y		
Will they be collect on time?		N	Due to the effects of COVID19. There are delays in the implementation. Due to these delays, data collection on indicators will be delayed
Will they be collect in case of extension?	Y		
Will they be compromise when collected?	Y		
Will they be suitable for purpose if compromised?	Y		
Tools to be used in the project			
Will they be available on time for use?	Y		
Will they be stable when used?	Y		
Will they be mature when used?	Y		
Will they be suitable when used?	Y		
Will they be error-free when used?	Y		
EC deliverables			
Will they be on time schedule based?	Y		
Will they be in line with the cost estimation?	Y		
Will they be correct after COVID19? [submitted ones]	Y		
Will they be error-free when uploaded?	Y		

Source of risk	Yes	No	Explanation if the answer is in the negative
Local Data Storage			
Will they be available on time for use?	Y		
Will they be stable when used?	Y		
Will they be mature when used?	Y		
Will they be suitable when used?	Y		
Will they be error-free when used?	Y		
Data Storage Maintenance			
Will they be available on time for use?	Y		
Will they be stable when used?	Y		
Will they be mature when used?	Y		
Will they be suitable when used?	Y		
Will they be error-free when used?	Y		
Equipment and materials (internal and external) to be used			
Has the obsolescence of the equipment and materials been taken into account in the planning of the project?		N	Yes but if the project extends beyond estimated time, then we need to take into consideration of SLAs and sensors time limits
Has the End of life of the equipment and materials been taken into account in the planning of the project?		N	Yes but if the project extends beyond estimated time, then we need to take into consideration of SLAs and sensors time limits
Project plan			
Are the resources contemplated in the GA enough?	Y		
Are the deadlines agreed with the EC achievable?	Y		
Project Team			
Does the project team have enough knowledge and experience?	Y		
Will the project team be available as required by the project plan?	Y		
Review meetings			
Have the objectives of the review meetings been defined and they are clear?	Y		
EC			
Will the EC meet their commitments?	Y		
Consortium membersy			
Will the consortium members meet their commitments?	Y		

Source of risk	Yes	No	Explanation if the answer is in the negative
Subcontractors			
Will the subcontractor meet their commitments?	Y		
Other sources of risk (to be detailed)			

Risk identified:

- [Risk IZM-01]: Data collection of some sensors have been delayed and if the project extends beyond time some of the sensors could be inoperative.

In the case of LIVERPOOL

Source of risk	Yes	No	Explanation if the answer is in the negative
Personnel			
Will they be available in case of extension?		x	Contract for UGUP officer expires at end of project
Sensors Installed			
Will they be available on time for use?	x		Sensors are already installed and working
Will they be stable when used?	X		Most will – some may be upgraded
Will they be mature when used?	X		Some are being improved and updated
Will they be suitable when used?	X		
Will they be error-free when used?	x		
Sensors to be installed			
Will they be available on time for use?			N/A sensors are already in
Will they be stable when used?			
Will they be mature when used?			
Will they be suitable when used?			
Will they be error-free when used?			
Indicators			
Will they be affected when collected?	X		We can provide information for most (all?) of the agreed indicators, but the timing of collection has been slightly affected due to COVID. We have not been allowed to undertake face-to-face data collection for most of 2020 due to human research ethics approvals at the university.
Will they be collected on time?	X		We can provide information for most (all?) of the agreed indicators on time
Will they be collected in case of extension?		X	Unlikely as no paid resource to support this
Will they be compromise when collected?	X		Covid will compromise some of the anticipated data. y will be affected by the circumstances of COVID, e.g. some months are missing, fewer surveys than expected, pollution levels affected by lockdowns, use of public spaces affected by COVID.
Will they be suitable for purpose if compromised?	X		Covid will compromise some of the anticipated data, but much of this can be contextualised and/or adjusted to reflect the unique circumstances.
Tools to be used in the project			
Will they be available on time for use?	X		
Will they be stable when used?	X		
Will they be mature when used?	X		
Will they be suitable when used?	X		
Will they be error-free when used?	x		
EC deliverables			
Will they be on time schedule based?	X		Delays due to covid and technical issues
Will they be in line with the cost estimation?	X		Mostly but some variances

Source of risk	Yes	No	Explanation if the answer is in the negative
Will they be correct after COVID19? [submitted ones]	X		Some variances can still be expected until all completed
Will they be error-free when uploaded?	x		When completed - yes
Local Data Storage			
Will they be available on time for use?	X		We have shared internal data storage systems and processes in place to collect this.
Will they be stable when used?	X		
Will they be mature when used?	X		
Will they be suitable when used?	X		
Will they be error-free when used?	X		
Data Storage Maintenance			
Will they be available on time for use?	X		N/A as UoL are leading on this aspect
Will they be stable when used?	X		
Will they be mature when used?	X		
Will they be suitable when used?	X		
Will they be error-free when used?	X		
Equipment and materials (internal and external) to be used			
Has the obsolescence of the equipment and materials been taken into account in the planning of the project?	X		
Has the End of life of the equipment and materials been taken into account in the planning of the project?	x		
Project plan			
Are the resources contemplated in the GA enough?	X		
Are the deadlines agreed with the EC achievable?		x	Unable to complete 2 years post intervention monitoring for all NBS
Project Team			
Does the project team have enough knowledge and experience?	X		
Will the project team be available as required by the project plan?	X		
Review meetings			
Have the objectives of the review meetings been defined and they are clear?	X		

Source of risk	Yes	No	Explanation if the answer is in the negative
EC			
Will the EC meet their commitments?			N/A as unsure what the EC commitments are. If it means that the EC will have data to test the impact of the interventions and information about how to implement NBS in the real world, then they will have plenty of very useful data.
Consortium members			
Will the consortium members meet their commitments?	x		For Liverpool - yes
Subcontractors			
Will the subcontractor meet their commitments?	X		To the best of our current knowledge
Other sources of risk (to be detailed)			

Risks identified:

- [Risk LIV-01]: Losing key partners due to contract expiration.
- [Risk LIV-02]: Indicators won't be sustainable after project life.
- [Risk LIV-03]: Unable to complete 2 years post intervention monitoring for all NBS

In the case of Valladolid

Source of risk	Yes	No	Explanation if the answer is in the negative
Personnel			
Will they be available in case of extension?	X		
Sensors Installed			
Will they be available on time for use?		X	Some sensors are not installed yet
Will they be stable when used?		X	Some sensors are not installed yet
Will they be mature when used?		X	Some sensors are not installed yet
Will they be suitable when used?		X	Some sensors are not installed yet
Will they be error-free when used?		X	Some sensors are not installed yet
Sensors to be installed			
Will they be available on time for use?		X	Due to the delays in the implementation, the temperature and humidity sensors are not still installed and were due to be installed on May 2020.
Will they be stable when used?	X		
Will they be mature when used?	X		
Will they be suitable when used?	X		
Will they be error-free when used?	X		
Indicators			
Will they be affect when collect?	X		Activity on the green corridor may be negatively affected by the pandemic. Also, welfare and perception of the interventions may be negatively affected due to the general situation.
Will they be collect on time?		X	They were foreseen to be collected from May 2020 but there are delays in the implementation
Will they be collect in case of extension?			TBD. Some will.
Will they be compromise when collected?	X	X	Some responses to the surveys may be affected (mostly related to elderly people welfare). Activity on the green corridor may be limited/hindered by the activity restrictions due to the pandemic. At the moment, although the delays there would be enough data to generate relevant indicators
Will they be suitable for purpose if compromised?	X	X	Although some responses may be negatively affected, we expect the data to be mostly useful and to be able to observe the evolution of the survey responses and citizen activity as the situation becomes more normal. At the moment, although the delays there would be enough data to generate relevant indicators
Tools to be used in the project			
Will they be available on time for use?	X		The APP is about to begin testing phase. We are scheduling to be released to the general public by the end of the year.
Will they be stable when used?	X		
Will they be mature when used?	X		
Will they be suitable when used?	X		

Source of risk	Yes	No	Explanation if the answer is in the negative
Will they be error-free when used?	X		
EC deliverables			
Will they be on time schedule based?	X		
Will they be in line with the cost estimation?	X		
Will they be correct after COVID19? [submitted ones]	X		
Will they be error-free when uploaded?	X		
Local Data Storage			
Will they be available on time for use?	X		
Will they be stable when used?	X		
Will they be mature when used?	X		
Will they be suitable when used?	X		
Will they be error-free when used?	X		
Data Storage Maintenance			
Will they be available on time for use?	X		
Will they be stable when used?	X		
Will they be mature when used?	X		
Will they be suitable when used?	X		
Will they be error-free when used?	X		
Equipment and materials (internal and external) to be used			
Has the obsolescence of the equipment and materials been taken into account in the planning of the project?	X		The APP should not require significant changes during the project extension
Has the End of life of the equipment and materials been taken into account in the planning of the project?	X		Again, there are no expected changes due to the project extension
Project plan			
Are the resources contemplated in the GA enough?	X	X	In the case of the APP, No additional resources (except maybe management) are foreseen to keep the APP running for the additional duration. For the rest, Valladolid partners are open to be flexible concerning the circumstances.
Are the deadlines agreed with the EC achievable?		X	If there is no project extension we will not be able to monitor the Electrowetland during the 2 years compliance.
Project Team			
Does the project team have enough knowledge and experience?	X		
Will the project team be available as required by the project plan?	X		

Source of risk	Yes	No	Explanation if the answer is in the negative
Review meetings			
Have the objectives of the review meetings been defined and they are clear?	X		
EC			
Will the EC meet their commitments?			
Consortium members			
Will the consortium members meet their commitments?	X		If there is no project extension we will not be able to monitor the Electrowetland during 2 years.

Risks identified:

- [Risk VAL-01]: Not comply with the two years of monitoring.
- [Risk VAL-02]: The NBS interventions are perceived negative by the citizens due to the current situation.

Summary of risks:

Risk CODE	Definition
[Risk IZM-01]	Data collection of some sensors have been delayed and if the project extend beyond time some of the sensors could be inoperative.
[Risk LIV-01]	Losing key partners due to contract expiration
[Risk LIV-02]	Indicators won't be sustainable after project life.
[Risk LIV-03]	Unable to complete 2 years post intervention monitoring for all NBS
[Risk VAL-01]	Not comply with the two years of monitoring.
[Risk VAL-02]	The NBS interventions are perceived negative by the citizens due to the current situation.

Table 5.2. Summary of the risks

Palliative actions:

Risk CODE	Palliative Action
[Risk IZM-01]	Account those that will be inoperative and those that will continue and estimate the real impact on the data to see further actions.
[Risk LIV-01]	Account the participation and the actions of the key partners that will be gone and anticipate their actions to impact the lesser to the project and WP.
[Risk LIV-02]	Take an action to establish a dialogue between the cities that will continue the monitoring and share information to see and incorporate if suitable potential good practises.
[Risk LIV-03]	Focus on the data that will be monitored along the timespan of the project and ask for flexibility to the EC with this milestone.
[Risk VAL-01]	Focus on the data that will be monitored along the timespan of the project and ask for flexibility to the EC with this milestone.
[Risk VAL-02]	Account this possible output and learn. Considerate an action about this topic and add a section on it in the last deliverable of the WP regarding global conclusions of the project.

Table 5.3. Palliative actions

6 Quality assurance

The aim of this section is to describe the methodology that will be followed in the URBAN GreenUP project to assess the validity of the set of indicators selected for each of the intervention sites in order to evaluate the performance of the Nature Based Solutions deployed in the scope of the project.

If the previous sections of the document work on top of the impact assessment framework of the EKLIPSE Expert Working Group Report of the EC to select a set of indicators and describe the implementation of the indicators themselves, this section aims to define a set of tests to study the relevance, cross interference and sensitivity of the indicators as defined in previous sections, trying to provide insight on the usefulness of these indicators both to measure the cost-effectiveness of NBS individually, but also to compare across different NBS projects.

Different tests will be carried out to understand if the indexes are well designed and respond to changes as expected and also to compare the proposed methodologies for the construction of the indexes (particularly where the implementation between different sites is different). These tests should lead to the selection of the most suitable calculation and aggregation methods and also highlight areas for improvement in the selected indicators.

6.1 Validation of the evaluation strategy

Given that NBS seek to address societal challenges, they need, by definition, to address economic, environmental and social challenges. There is a range of potential actions that can be taken and indicators are an important means of assessing the potential performance and the actual effectiveness of particular NBS actions (European Commission, 2016).

Each climate resilience challenge area can be addressed by multiple individual actions, and indicators can be used to assess the effectiveness of individual actions in addressing each climate resilience challenge. However, there is potential for interactions between NBS actions which require consideration in NBS assessments.

Indicators for assessing specific types of NBS impacts can be relevant to multiple climate resilience challenges. It is, therefore, important to assess the impacts of NBS across aspects of multiple systems, including socio-economic, socio-cultural and ecosystems, although geographic and temporal scale may be relevant to the interactions.

The selection of appropriate indicator(s) will depend on a number of factors including:

- Objective of the action — which challenge(s) it is seeking to address;
- Type of action — all NBS will involve some element of biodiversity, but will differ in their attributes and thus appropriate methods for measurement;
- Potential expected impacts, both direct and indirect, and both positive (synergies) and negative (trade-offs or disservices);
- Resources and skills available for measurement of the impacts;
- Scale of analysis, which influences the availability and relevance of data for specific indicators

The objective of the evaluation strategy is to determine the robustness and sensitivity of the selected indicators to changes and assure that the impact of the Nature Based Solutions adopted in the scope of the project is correctly reflected in the changes of the different KPIs.

The evaluation strategy should assess the methodology selected to calculate the different indicators: aggregation (or single impacts), thresholds, baseline definition, stipulations, models, calculation formulas, statistical data sources, robustness against missing data, etc.

Finally, the evaluation strategy will try to provide insight on the cross-effects between NBS actions, synergies and interactions among the different indicators (although issues of scale, implementation and local context may hide said synergies or trade-offs).

6.2 Indicators tests

The purpose of the indicators tests is to check if the calculated indicators respond to changes as it is expected to happen with the variations introduced in the value of the actual measurements and to compare the methodologies proposed. Thus, the following indicators tests are defined:

- Extreme values. Minimum and maximum values.
- Variation of values. Minimum and significant variations.
- Missing values. Minimum, maximum and mean values.

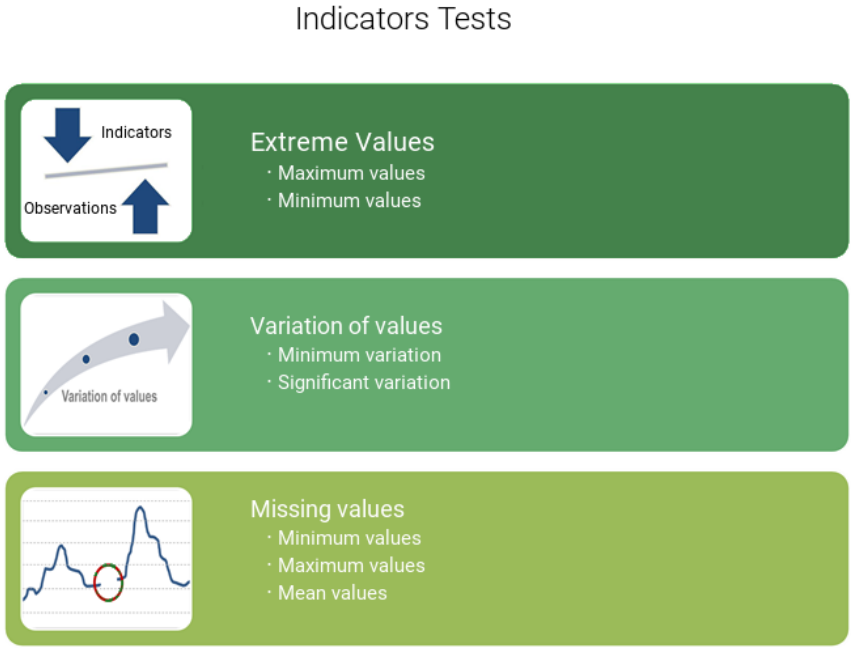

Figure 6.1: Indicators examples

6.2.1 Reference scenarios

6.2.2 Behaviour under extreme values. Minimum and maximum values

The purpose of these tests is to check that the indicators can reach the expected minimum and maximum values, that is, if the KPI is calculated by transforming an observation of a physical magnitude (in time or multiple locations) or a combination of observations of multiple magnitudes, or replies to surveys, when all the observations take the minimum value or all the observations take the maximum value (limited by the sensitivity of the measurement equipment /sample limitations).

This means that the indicators can reach their maximum value when all the observations have maximum values, and likewise will reach the lowest possible value when the observations have minimum values. This means that the calculation formulas will be evaluated when:

- All the observations take the maximum value.
- All the observations take the minimum value.

Inability to reach said values may indicate that it is necessary to normalize the indicator or modify the calculation procedure so that it reaches the expected values.

6.2.3 Variation of values. Minimum and significant values

The purpose of these tests is to understand the sensitivity of the indicators to a minimum and significant variations of the value of the measured observations in the final value of the indicators. Since there are different proposed methodologies for weighting and aggregation, these tests are also defined to compare the sensitivities of the different methods to these variations in the final indicator values. Thus, the following variations are defined to test the indicator behaviour:

- Variation of 5% of the value of all the observations (multiple spatial/time samples or multiple observations if they are combined for a single indicator) at the same time.
- Variation of 50% of the value of all the observation at the same time.
- Variation of 5% of the value of all the magnitudes, one at the time.

Variation of 50% of the value of all the magnitudes one at the time.

6.2.4 Resilience to missing values, minimum and mean values

Due to multiple reasons, such as malfunction of a sensor, impossibility to perform a field survey, lack of samples in a particular area, or lack of statistical information from a particular source, it is likely to have missing values for some of the observations used for the indicator calculation.

The purpose of these tests is to determinate the sensitivity of the indicators to missing observations in order to compare which method is the most appropriate to use in the final configuration of the indicators. Thus, the following tests are defined:

- Variation of the value of each magnitude to the mean value of the interval

- Variation of the value of each magnitude to the minimum value of the interval
- Variation of the value of each observation to the maximum of the interval

This should allow determining which the most suitable substitution value is for each of the indicators.

6.3 Data sources validation

The basis for all observational studies is the availability of appropriate data of high quality. Data may be collected specifically for the research purpose in question (what is often referred as "primary data"), but data collected for other purposes (so-called "secondary data") is also useful in research. Data validation is intended to provide certain well-defined guarantees for fitness, accuracy, and consistency for any of various kinds of input data.

Although high accuracy and precision are desirable, a high degree of trust and knowledge about their maximum and minimum level and additional metadata of the data sources (collection method, availability, transformations, etc.) is often as much or even more valuable to achieve correct and unbiased results.

Primary data is mostly validated through proper screening, by using various descriptive statistical methods. Secondary data validation is more complex and often relies on trust in the sources, combining data from multiple sources, two-stage sampling and aggregated methods.

6.4 Reference data sets

Reference datasets provide statistically accurate data that can be used to evaluate the measurements (primary source data) performed on the NBS sites and other datasets used for the calculation of the KPI. Such data may come from statistics institutes, public administrations, or previous similar studies. In any case, it is necessary to validate the data to a degree according to the rest of the project (usually by comparing to real data or previous publications).

It may also be necessary to convert the data source information due to differences in representation, sampling, units or accuracy. Thus, not only the reference data source needs to be validated but also the transformation applied to the reference data.

All data sources used for the calculation of the indicators need to be listed and validated, on one hand, to verify that the data is applicable, and also to prepare a dataset for further studies that will allow to evaluate the methodology and as a future reference for additional research and to compare between different NBS and demonstration sites.

Reference datasets can also be used to evaluate the calculation methods for the indicators. By entering the reference dataset in the KPI calculation algorithms, we should obtain the range of typical values for the indicator, to compare the results with the expected scenarios.

Finally, having a reference data set to compare with allows detecting deviation or malfunction in primary data collection during operation (e.g. a sensor malfunctioning or an error in data transmission/encoding) by comparison with the expected range of values.

7 Data management and data privacy

7.1 Introduction

Data Management Plans (DMPs) have been introduced in the Horizon2020 Work Programme for 2014-15. Since the main purpose of the DMP is to provide an analysis of the main elements of the data management policy that will be used in the scope of the project with regard to all the datasets that will be managed to carry out the related activities. The scope of the DMP is not only the development of the project but also after it is completed.

A DMP has to describe the data management life cycle for the data sets that will be collected, processed and/or generated in the scope of the project, and even after it is completed. Processes regarding data collection, processing and generation should be outlined, including methodologies, standards, data access and how this data will be curated and preserved.

According to the EC guideline, the DMP needs to be updated at least by the mid-term and final review of the project, it is not a fixed document; it evolves and will be updated during the lifespan of the project. In this case, updates of the DMP will be developed in M24 and at the end of the project.

7.2 Data Management Plan in the scope of the URBAN GreenUP project

Once the purpose of a DMP has been described, the main elements of the DMP of the URBAN GreenUP project have to be detailed.

Confidentiality issues must be taken into account, but also the dissemination ones, because it is in the interest of some partners to disseminate the results achieved in the scope of the project. As a result, it is important to take into account that the DMP is closely related to the Dissemination Plan, so a compromise must be found between confidentiality and dissemination of the achieved results.

As detailed in the picture below, two different types of datasets will be created: the ones containing gathered data and the ones containing the Key Performance Indicators (KPIs) calculated using the aforementioned data. Restricted access will be given to raw data sets, and the calculated KPIs will be free to access and use. The data gathered will be available by ftp (secured using login/password), and the KPIs will be published on the project website[2].

[2] http://www.urbangreenup.eu/

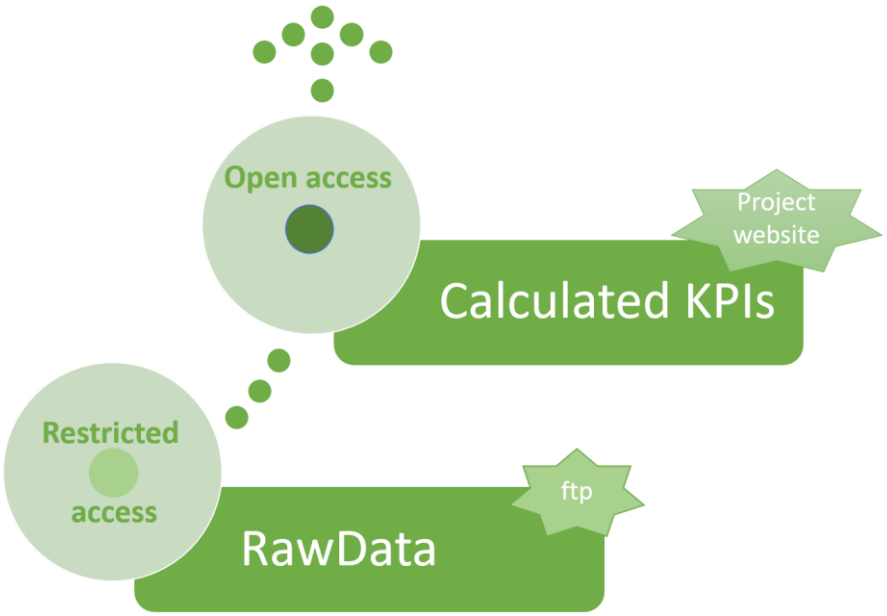

Figure 7.1: Data relation

Concerning the data gathering, and if needed (if personal data will be gathered/processed), all the issues related to the GDPR (General Data Protection Regulation) will be implemented.

As the GDPR is a new regulation, the main differences with the previous directive 95/46/EC regarding the data subject rights are pointed below:

- The conditions for consent have been reinforced for the sake of clarity and intelligibility of the legal terms and conditions, and also making easy the processes of withdrawing.
- Breach notification that should be done within 72 hours after the notification.
- Right to access. The data subjects now have the right to get, from the data controller, confirmation that the data is being processed and the purpose of that process.
- Right to be forgotten. The data subject has de right to oblige the data controller to erase the data, cease dissemination and halt processing of the data from third parties.
- Data portability. The data user, once he has received its personal data in a legible digital format from one controller, can send them to another one.
- The territorial scope has been increased, and now the regulation applies to all companies processing data of subjects residing in the EU, independently from the location of the company.