URBAN GreenUP

D4.4: MONITORING PROGRAM TO IZMIR

WP 4 , T 4.6

Date of document

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0 Executive summary

The URBAN GreenUP project is a 5-year project combining practical implementation of nature-based solutions (NBS) with social, ecological, and economic research. NBS have been presented as an innovative way to address the many challenges facing urban areas. This project tests whether – and to what extent – NBS can contribute to solving biophysical, social, and economic challenges in urban areas by first undertaking 1 year of baseline research, then implementing targeted NBS interventions, followed by a 2-year post-intervention monitoring period.

This document outlines the monitoring protocols proposed for the City of Izmir URBAN GreenUP interventions, following Task 4.6: Development of the monitoring programme, and in line with the higher order principles outlined in D5.3: City Diagnosis and Monitoring Procedures (URBAN GreenUP 2018). This monitoring protocol focuses on the principles and procedures of the biophysical and social monitoring, as structured by the EKLIPSE framework (Raymond et al. 2017) and KPIs selected in the City of Izmir.

City of Izmir has some 21 core KPIs but also has 4 ADDON KPIs that is customized for the Izmir use cases. Summary of the KPIs is given with a simple Table 1-1 with KPI name, Indicators type, Measure Method/Data Processing/NBS Type, Core KPI number or ADDON and Owner. For each KPI. 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 own entry either under its *EKLIPSE Challenges* (for Core KPIs), or Izmir 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, software, 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 Introduction

1.1 Project Overview

URBAN GreenUP does Urban sustainability through a complex process where a combination of parameters, baselines, KPIs, and data come together to play a big role and provide an advantageous interaction. A smart solution for this process is the use of advanced monitoring system with data quality in its various modes of infrastructure, data analysis and service-oriented architecture to achieve development of the sustainability goals. This report aims to provide an overview monitoring models for URBAN GreenUP with respect to KPIs, raw data and calculated outputs. This also highlight the benefits of “green” processing for our environments. In line with the goal of the URBAN GreenUP project that is a 5-year project, this task does use the monitoring process and KPIs to do the combination of nature-based solutions (NBS). The NBS have assigned parameters that are of social, ecological, and economic research models of data.

Basically, it has NBS with monitored KPIs that are presented as an innovative way to address the many challenges facing urban areas. As directed by the European Commission and in line with URBAN GreenUP objectives, Izmir has a set of Key Performance Indicators (KPI) based on the Eklipse framework (Raymond et al., 2017).

To apply the framework the Eklipse expert panel established ten areas in which cities face urgent challenges, and for which NBS can be used as a partial solution:

- Challenge 1: climate mitigation & adaptation;
- Challenge 2: water management;
- Challenge 3: coastal resilience
- 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 cohesion;
- Challenge 9: public health and well-being; and
- Challenge 10: potential of economic opportunities and green jobs.

Indicators are classified as either measurable or empirical, so data to be measured quantitative or qualitative, empirical or based on calculation, and by period of measurement. If data is based on calculation, method of formula needs to be provided. For example, for an environmental chemical indicator to be measured by modelled KPIs' and related data parameters. The data is quantitative or can be used to get aggregated statistical indicators (min, max, average). Period of measurement can be hourly, daily, weekly or monthly.

Finally, ICT Method column will provide all methods, starting from how this KPI will be acquired all the way, to how it will be presented. For example, for an environmental chemical indicator to be measured by modelled KPIs' and related to data parameters. The data is quantitative or can be used to get aggregated statistical indicators (min, max, average). Period of measurement can be hourly, daily, weekly or monthly.

KPI input and output type(s) can be quantitative, or qualitative. Both of these types can be singular or time series based or spatial (based on location) based. They can be stored in databank or database or layered on top of MAP files generated by drones or satellites. Similarly, calculated KPIs can be similar types as well. The following figures below illustrate all NBS challenges, type of indicators, KPIs, owner of tasks for Izmir, KPI input types and output types.

1.2 Scope of the task

The scope of the task is to present the related **Izmir** KPIs for the URBAN GreenUP project, as they will be used for monitoring. The URBAN GreenUP project is monitored through the KPIs (robust set of indicators) and the capacity to gather the necessary data is of high importance. The data and respective use serve the requirement-based analysis for existing tasks and future use of URBAN GreenUP models and system. The proposition and data-based proposition are viable solutions for future alternatives and systems.

The scope follows the model such that:

- Data and respective KPIs for specific parameters can be utilized to analyse the level of efficiency. This also shall show where improvement is needed regarding to collaborating partners (Demo Cities and municipal administrations) and researchers.
- The resulting analysis of the KPIs will help in the information dissemination to local partners and government officials that are related to URBAN GreenUp. This will in turn create a productive communication and change effect in the application of the NBS, as proposed by URBAN GreenUP objectives.
- The monitoring activities and system described here is to serve as an asset. The monitoring does comparative analysis to produce estimation models as described in other tasks.
- The related data and information from other URBAN GreenUP-related-project (e.g. EKLIPSE) shall be utilized as a basis for calculation especially in the NBS.Based on KPI and data estimation derived from Demo Cities interventions, respective recommendations will be formed.

1.3 KPI Lists for Izmir and Measurement Summary

CHALLENGES	TYPE OF INDICATORS	KPI	Measurement Method/ Data Processing	Core KPI Number or ADDON	NBS	Owner
CHALLENGE 1: Climate mitigation & adaptation	Carbon savings per unit area Carbon storage and sequestration Landscape, Vegetation	Tonnes of carbon removed or stored per unit area per unit time / Total amount of carbon stored in vegetation (ton CO_2/Ha) (ton CO_2/year).	The areas of each type of new vegetation planted will be entered to formulas (GIS Data) The land use-land cover map will be derived from WorldView2 satellite images using screen digitalizing in ArcGIS 10. The percentage of tree cover is calculated for each Demo Site separately in ArcGIS 10.	1-2	This KPI is related to NBS involving green shady structure, urban carbon sink, green parklets and new green corridor	EGE University Landscape
	Temperature reduction (environmental, physical)	Decrease in mean or peak daytime local temperatures (°C)	Air-Surface Temperature Analysis, Optris Thermal Camera, Various Sensors, Pix Connect software , QGIS GIS Software Periodic measurement before and after the intervention	7	Green shady structure, urban carbon sink, green parklets and new green corridor.	ZT EGE University BIT - Anadolu
		Heatwave risks (nº of combined tropical nights (>18 °C) and hot days (>20 °C)	Air-Surface Tempe. Analysis, Optris Thermal Camera, Various Sensors, Pix Connect software, QGIS GIS Software. Baseline from Satellite and Drone where applicable	9		IZT EGE University BIT - Anadolu

CHALLENGES	TYPE OF INDICATORS	KPI	Measurement Method/ Data Processing	Core KPI Number or ADDON	NBS	Owner
			Periodic measurement before and after the intervention Sensors + Cameras + GIS Software			
	Measures of human comfort	Measures of human comfort e.g. ENVIMET PET — Personal Equivalent Temperature, or PMV — Predicted Mean Vote	Calculated using formulas	8	Green shady structures, green covering shelters, shade and cooling trees, cool and green pavements.	IZT
	Energy Carbon Savings	Energy and carbon savings from reduced building energy consumption	Formula with meteorological data, satellite-derived and surface temperature (LST) retrievals will also be used as in-situ estimations of the urban temperature fields at each Demo Site. Sensors + Cameras + GIS Software	10	Green shady structures, green covering shelters, shade and cooling trees, cool and green pavements.	IZT DEM
	Carbon stored on soil	Tonnes of stored per unit area per unit time (ton CO_2/ha) (ton CO_2/year). Total amount of carbon stored in soil (smart soil)	The greenhouse gases measurements which can be released depending on the field applications during the two-year field experiments will be carried out	ADDON	Tree related actions; pollinator verges and spaces; Urban Carbon sink; horizontal and vertical GI	EGE University Soil

CHALLENGES	TYPE OF INDICATORS	KPI	Measurement Method/ Data Processing	Core KPI Number or ADDON	NBS	Owner
	Energy Carbon Reduction	Energy, water and carbon reduction via urban farming (Climate-smart Greenhouse)	Rain water harvest measurement Measurement of heat energy from solar energy; Measurement of agricultural product from vertical agriculture; Measurement of agricultural production from high ridge soil preparing system;	ADDON	Agricultural product from vertical agriculture. Agricultural production from high ridge soil preparing system.	EGE University Soil
Challenge 2 Water Management		Run-off coefficient in relation to precipitation quantities (mm/%)	A GIS based analysis will be made to predict runoff by using the most common method called The Runoff Curve Number (CN), developed for ungauged basins to calculate runoff from rainfall data by USDA NRCS	ADDON	NBS involving bio-boulevard and grassed swales and water retention pounds around bio-boulevard.	EGE University Landscape
		Drinking Water provision (m^3/ha/yr)	Measurement method for the drinking water supplied to the consumers is direct measurement with the help of water meters.	33	*Tree related actions; SUDs; Bioswale; Green pavements*	DEM
		Water for irrigations purposes (m^3/ha/yr)	The measurement equipment and method will be the same with KPI33.	34	Greenhouse related NBSs	DEM

CHALLENGES	TYPE OF INDICATORS	KPI	Measurement Method/ Data Processing	Core KPI Number or ADDON	NBS	Owner
Challenge 4: Green Space Management	SocioEconomical	Accessibility (measured as distance or time) of urban green spaces for population and total green space m²/distribution (Tamosiunas et al., 2014).	GIS Data mainly. Spatial analysis and spreadsheet software. Data are acquired by statistic and GIS processing, so none sensor is required. İzmir Metropolitan Municipality uses ARCGIS that can be converted to open software platforms like QGIS in order to enhance its usability.	53	Horizontal green infrastructures such as green corridor, urban carbon sink, green resting areas, etc.	IZT DEM IZM
	SocioEconomical	Weighted recreation opportunities provided by urban green infrastructure	Recreation opportunities including naturalness, aesthetics-scenic beauty etc. can be conducted via user questionnaire through standard spreadsheet software (Excel or SPSS).	60	Tree related actions; Green cycle lane/pedestrian route/road traffic junction improvements. Urban farming promotion: Urban orchard; Community composting; Small-scale urban livestock. Educational activities: Educational paths (A, C); urban farming educational activities.	IZT DEM IZM
	Environmental (biological)	Production of food (ton/Ha/year)	Measurements from the figures from inventory	73	Urban farming activities	EGE University Soil
		Increased connectivity to existing GI	GIS based analysis will be made again at	76	Green Corridor	

CHALLENGES	TYPE OF INDICATORS	KPI	Measurement Method/ Data Processing	Core KPI Number or ADDON	NBS	Owner
			the city level using recent data and information to identify recent land use-land cover, and above-mentioned landscape metrics will be computed			EGE University Landscape
		Urban green spaces per capita	Green spaces/total surface per capita is calculated by dividing the sum of all green spaces in the urban development zones by the total urban population in ArcGIS10	ADDON	Green covering shelter, Shade and cooling trees, new green cycle lane and re-naturing existing bike lane, urban carbon sink: planting trees.	EGE University Landscape
		Pollinator species increase (number)	Base on observation and study	77	Vertical green interventions, such as fruit wall and green fences, pollinator (houses) modules and bio-swales around bio-boulevard.	EGE University Landscape
		Distribution of public green spaces/total surface per capita	GIS Based Green spaces/total surface per capita is calculated by dividing the sum of all green spaces in the urban development zones by the total urban population in ArcGIS10	52	Grassed swales and water retentions ponds, green covering shelter, shade and cooling trees, new green cycle lane and re-naturing existing bike lane, Urban Carbon Sink: Planting Trees.	EGE University Landscape

CHALLENGES	TYPE OF INDICATORS	KPI	Measurement Method/ Data Processing	Core KPI Number or ADDON	NBS	Owner
CHALLENGE 5: Air Quality	Environmental (chemical)	Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted) concentration	Monitoring equipment: A portable photometric sampler designed to measure ambient $PM_{2.5}$ and PM_{10} concentrations and QGIS software	83	Green shady structures, green covering shelter, parklets, shade and cooling trees, grassed swales, new green corridor, green fences	IZT
		Air quality parameters Trends in emissions NO_X, SO_X , PM10	PM_{10}, SO_x and NO_x will be measured by stationary Air Quality Measurement Stations located in Çiğli, Bayrakli and Karsiyaka (MEU, 2018), and a mobile station belongs to Izmir Metropolitan Municipality (IMM, 2017) pre-and post-interventions	84		IZT
	Environmental (chemical)	Pollutants Removed by Vegetation in Leaves, stems and Roots	Based on Formulas in ICT Tool	87	Green parklets, urban carbon sink: planting new trees, green fences/green walls, shade and cooling trees	EGE Landscape
CH6 Urban Regeneration	Socio-cultural indicators	Accessibility: distribution, distance, spatial configuration to NBS and green spaces. Diversity of NBS (land use and functionality).	GIS based analysis will be made again at the city level using recent data and information to identify recent land use-land cover	95	NBS involving new green cycle lane and re-naturing existing bike lane.	IZT
CH7 Participatory planning and governance	Social	Perceptions of citizens on urban nature- green spaces quality (Buchel and Frantzeskaki, 2015; Colding and Barthel, 2013; Gerstenberg and Hofmann, 2016; Scholte et	Spatial analysis and spreadsheet software. Data are acquired by statistic and QGIS processing, so none sensor is required.	117	Horizontal green infrastructures such as green corridor, urban carbon sink, green resting areas etc.	IZT

CHALLENGES	TYPE OF INDICATORS	KPI	Measurement Method/ Data Processing	Core KPI Number or ADDON	NBS	Owner
		al., 2015; Vierikko and Niemelä, 2016).				
	Social	Urban Farming Educative/ participate activities, Learning for producers.	Trainings , seminars	ADDON	Climate sensitive greenhouse and its garden	Ege University Soil
CH 8: Social Justice and social cohesion	Social cohesion	Green intelligence awareness	Surveys for measuring qualitative impacts of cycling and walking activities in selected areas	127	NBS involving green infrastructures, such as green corridor, new green cycle lane, horizontal green interventions etc.	IZT
CHALLENGE 9: Public Health and Well-being	Health indicators	Increase in walking and cycling in and around areas of interventions	This KPI can be measured throughout pedestrian and bicycle counter units. Surveys may be done as well, in order to know the qualitative impacts of cycling and walking activities in selected areas.	139	Green cycle lane; Vertical green interventions; Horizontal green interventions; raingarden	IZT
CHALLENGE 10: Economic opportunities and green jobs	Economic	Number of jobs created; gross value added	Measurement instruments such as city official data, city platforms, questionnaires, small-medium enterprise accounts	141	Vertical green interventions, Horizontal green interventions, Urban farming promotion: Urban orchard; Community composting; Small-scale urban livestock, Sponsoring activities; Support to	IZT

CHALLENGES	TYPE OF INDICATORS	KPI	Measurement Method/ Data Processing	Core KPI Number or ADDON	NBS	Owner
					citizen project of NBS, related non-technical actions	
	TOTAL NUMBER OF KPIs		26	22/4		

Table 1-1 List of KPIs for Izmir, Indicators type, Measure Method/Data Processing/NBS Type and Owner

1.4 About this Document

This document outlines the monitoring protocols proposed for the City of Izmir URBAN GreenUP interventions, following Task 4.6: Development of the monitoring programme, and in line with the higher order principles outlined in D5.3: City Diagnosis and Monitoring Procedures. Key information about the City of Izmir, the rationale for developing the interventions and their locations are provided in the diagnosis and baseline reports (i.e. D4.1: Report on the Diagnosis of Izmir and D3.2: Baseline Document for Izmir). These provide an important contextual basis for this monitoring protocol, which focuses only on the principles and procedures of the biophysical and social monitoring.

This document addresses nine challenges covered in EKLIPSE methodology in corresponding nine sections between Section 2 and Section 10. Only coastal resilience is not addressed. Each challenge is divided into two parts: biophysical monitoring and socio-economic monitoring, reflecting what Bryman (2006) described as multi-strategy research. The rationale for taking a multi-strategy approach follows what Greene et al. (1989) described as 'expansion', that is, using multiple research methods to increase the breadth of the research. To organise this multi-strategy and multi-method research we are drawing on the typology created by Leech and Onwuegbuzie (2009) and specifically following a 'partially mixed, concurrent, equal status' design. The biophysical and socio-economic research methods are considered partially mixed because of the distinct research questions they respond to and because mixing is predominantly designed to occur in later stages of analysis. The data are collected generally concurrently through baseline and monitoring phases, and carry equal status in the research design. To communicate this complex design with clarity the two parts of this document are organised differently to align with disciplinary and methodological differences.

2 CHALLENGE 1: CLIMATE MITIGATION & ADAPTATION MONITORING PROCEDURE

2.1 Biophysical KPIs

2.1.1 Tonnes of carbon removed or stored per unit area per unit time (ton CO_2/Ha) (ton CO_2/year).

2.1.2 Total amount of carbon stored in vegetation (ton CO_2/Ha) (tonCO_2/year). -- Combined in Same Monitoring Methods

INTRODUCTION

Urban vegetation has an important role in offsetting CO_2 concentration by acting as a sink for atmospheric CO_2 via photosynthesis and by storing carbon through the growth process (Davies et al., 2011).

This KPI can be estimated as carbon sequestration and it is defined as the process of increasing the carbon content of a reservoir or pool other than the atmosphere. When plants grow, they capture CO_2 from the atmosphere therefore the choice of plant species for urban areas may be set out considering their own air amelioration capability. Maximizing the net sequestration of carbon through species selection and management practices will be the aim (City Diagnosis and Monitoring Procedures WP5 document T5.3).

NBS TYPES

This KPI is related to NBS involving green shady structure, urban carbon sink, green parklets and new green corridor.

METHOD

Although URBAN GreenUP requires two-year monitoring period after the implementations of the NBS to collect a complete data set and achieve a maximum accuracy in the evaluation process, in monitoring calculations for carbon storage will be done only once for each NBS separately 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 as used in baseline estimations (Please see baseline document WP4 T4.2). In this way, a comparison is going to be made between baseline and monitored values after the implementation period.

MEASUREMENTS

In terms of monitoring, all calculations for carbon storage capacity of the implemented NBS will be executed at the level of the related Demo Sites.

UNIT OF MEASUREMENT

Tons/ha

CALIBRATION / VERIFICATION

It was calculated in Demo Sites before the interventions and will be executed again after NBSs are implemented in order to make a before and after comparison.

STUDY SITES

In İzmir, study sites will be focused in and around the areas of the NBS interventions such as new green corridor, green parklets in Girne Avenue and green fences along Peynircioğlu Stream where new trees are planted.

DATA PROCESSING

The land use-land cover map will be derived from WorldView2 satellite images using screen digitalizing in ArcGIS 10. The percentage of tree cover is calculated for each Demo Site separately in ArcGIS 10. Izmir Municipality currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS.

RESULTS, Report Format

Results can be displayed throughout maps and/or tables. In Izmir ICT platform results will be shown in KPI flashcards.

2.1.3 Decrease in mean or peak daytime local temperatures (°C)

RATIONALE/INTRODUCTION

Increasing urban density and lack of vegetation have resulted in the increase of temperatures in urban areas and high pollution levels in most of the cities over the last couple of years (Katayama et al. 1993). According to the report of UN-Habitat 2009, a comprehensive set of green policies and strategies must be used for filling the gap between urban and green development toward a higher resilience and adaptability to climate change.

Green urban infrastructure can play a role in climate change adaptation through reducing air and surface temperature by providing shading and enhancing evapo-transpiration, which leads to two benefits: improved thermal comfort and reduced energy use. The thermal comfort and reduced energy benefits via physical indicators such as ambient temperature, turbulent fluxes and energy savings will be addressed

This KPI will be measured/calculated at Sub-Demo A.

Sub Demo A: Abatement of Heat Island Effect in Urban-Nature Continuum

Sub Demo A is designed to exhibit the heat island effect in the city with two locations: 1) A parking lot and 4 parklets at highly-urbanised Karşıyaka Metropolitan District and a rural area where Sasalı Natural Life Park located in Figure 2.1. The main purpose of the interventions on Sub Demo A is to compare heat island effect in highly-urbanised area and rural area, and to show the effect of NBSs on mitigation of heat island effect in both areas. The NBSs in both areas will reduce maximum/average surface temperatures and air pollution while outdoor thermal comfort will increase.

In this KPI, local air temperature and relative humidity values will be measured. Then, mean and peak daytime local air temperatures and relative humidity values will be calculated and be used to assess the impact of the NBSs. In one or two locations. Likewise, wind speed and velocity values will be measured to use it different KPIs.

Figure 2-1 Location of Demo Sites (A, B, C)

NBS TYPES

Green shady structures, green covering shelters, cool pavements, shade and cooling trees, parklets.

METHOD

BACI (Before, After, Control, Impact)

Measure air temperature and relative humidity at sampling points at a range of radii from NBS locations both pre- and post-intervention. Compare these data with measurements taken at equivalent locations on equivalent stretches of NBS locations without those NBS at a similar time of day on the same dates or continuously.

Field measurements will be done at two parking lots in Sub Demo A by two different methods: 1) using fixed sensors placed on site in representative locations and regularly measuring air temperature and relative humidity values, 2) using satellite and aerial drone measurements of surface temperatures. 3) If drone surface measurements cannot be deployed due to flight restrictions, then surface measurements will be completed by a specific surface camera as described below from land and over the 6-8 m heights (from roof of the apartment)

The data gathered from Demo Sites before and after the interventions will be compared and the impacts of the NBSs on Demo Sites will be evaluated.

As a previous work, temporal series of temperature and relative humidity will be studied in order to define peak times and values, and mean values of historical data (at night and daytime) taken from the closest meteorological stations to the NBS locations. This study will serve to establish a general baseline for the city. On the other hand, the meteorological data will be used as additional references of non-intervention areas.

Monitoring Methods, Sensors, Software and Analysis

There will be two types of temperature measurements and associated methods, software and analysis. These are 1) Land Surface Measurement with Thermal camera with IR analysis software Optris PIX Connect 2) Air Temperature measurements accompanied with other in-stu sensors such as humidity, wind direction, speed etc.

1. **Land Surface Measurements and Analysis**

The surface measurements are planned to be taken with thermal camera, Optris PI-450 (Optris Infrared Thermometars. Operator's Manual) which has a spectral range from 7.5 to 13.5 µm. The infrared cameras Optris PI 400 / PI 450 are the smallest thermographic cameras in their class. Being equipped with a measurement speed of 80 Hz and an optical resolution of 382 x 288 pixels they provide real-time thermographic images in high speed. The IR camera PI 450 is, due to its thermal sensitivity of 40 mK, specifically suited for detection of slightest temperature differences, making it indispensable in quality control of products and in medical prevention. The compact and high-performance infrared cameras offer a temperature range of -20°C up to 900°C, being optionally upgradeable up to 1500 °C [14] Figure 2.2

Figure 2-2 Optris PI 450 Infrared Camera

The IR analysis software Optris PIX Connect sets benchmarks within the thermography branch by offering its users extensive recording and real-time analysis options. In addition, moving measuring objects can be monitored via line scan function.

A real-time data transfer to external software programs, including radiometric video sequences and snap shots, text files for the analysis in Excel as well as files containing color information for standard programs such as Adobe Photoshop or the Windows Media Player, is supported by the software PIX connect.

Furthermore, several functions for automatic process and quality control procedures, such as the individual setup of process related alarm levels, are supported by the thermographic software, enabling one to immediately react to temperature fluctuations and thus, optimize your processes.

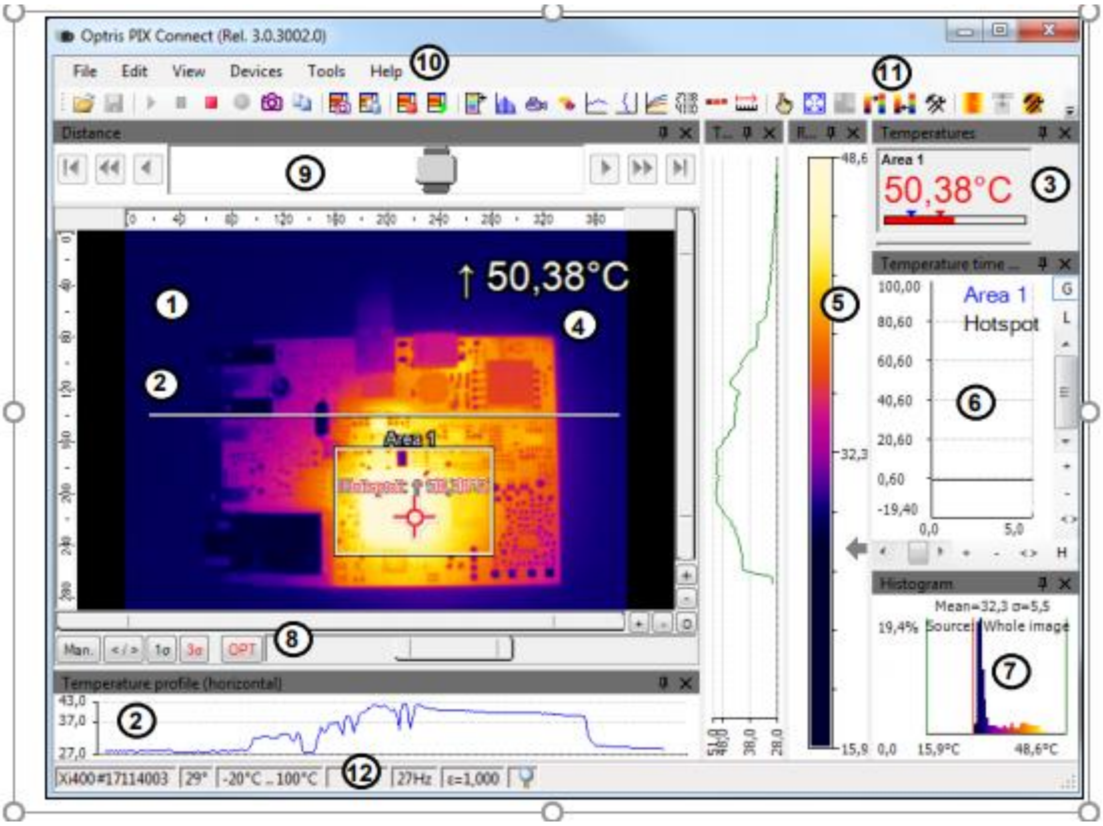


Figure 2-3 Surface Temperatures

Study Area

In order to determine the temperature differences before and after building a green roof, two different study areas have been selected in this study. Both of the study area are located in the surroundings of the city of Izmir (Figure 2-4).

Figure 2-4 Study area

The first study area is a parking space with approximately 40x60 m dimensions, while the second area is a parking place with approximately 30x40 meters dimensions.

Landsat-8 - Land Surface Temperature Analysis

Land surface temperature (LST) is a fundamental variable controlling the surface energy balance, and it is involved in physical, chemical, and biological processes of the Earth surface. In urban areas, LST allows the assessment of the surface urban heat island (SUHI) effect. Earth observation data have been widely exploited to retrieve LST: spaceborne sensors have the advantages of covering large areas at the same time, while temperature observations registered in situ are unevenly distributed in space. Different spaceborne platforms, such as ASTER, AVHRR, MODIS and Landsat, were used to retrieve the different factors need to be quantified to retrieve LST from satellite thermal infrared data, including sensor radiometric calibration, atmospheric correction and surface emissivity selection. These factors greatly influence the final result, thus estimation of uncertainties in the retrieval process and validation procedures are important tasks especially for operational datasets. Moreover, the satellite sensor spatial resolution may be a limiting factor in representing the fine scale spatial variability of LST, especially in the presence of impervious surfaces and sharp transitions (e.g., buildings, roads, parking lots, sidewalks, and other built surfaces), such as in urban areas. Data from middle-spatial resolution (10-100 meters) are usually used for macro-analysis.

Taken into consideration the study areas presented in Figure 2-5, a spatial comparison was made in order to investigate the possibility to observe the temperature changes over the mentioned areas using Landsat-8 satellite images.

For this purpose, one satellite image from 17 July, 2017 over the city of Izmir was downloaded from the USGS webpage. Afterwards, Land Surface Temperature was retrieved using the LST tool in Erdas IMAGINE developed by (Avdan and Jovanovska, et al. 2016). (Figure 2-6)

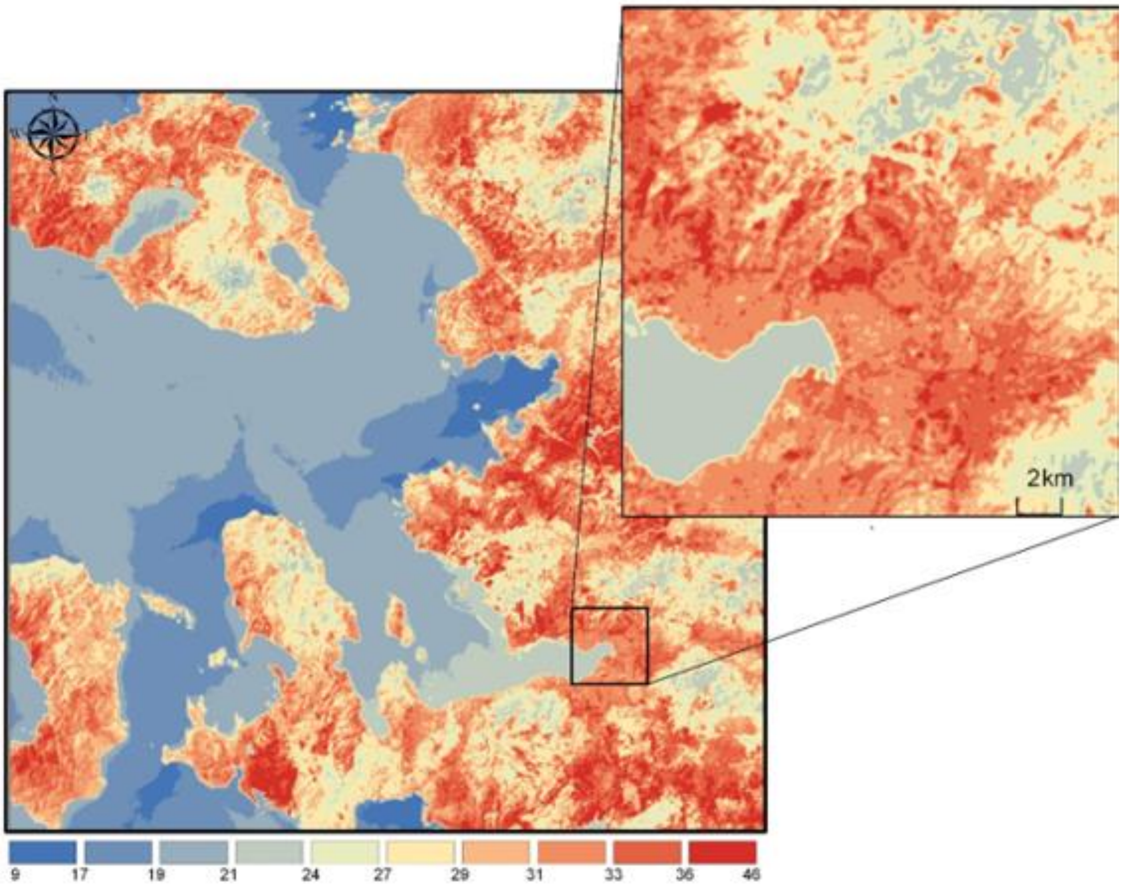


Figure 2-5 17 July, 2017, LST – Izmir

Taking into consideration the dimensions of the both study areas in this study, using Landsat-8 satellite imagery for observing the temperature differences before and after the building of the green roof over the parking spaces would not be very convenient. For such small areas, higher resolution remote sensing sensor is more appropriate.

In Figure 2-6 and Figure 2-7 are presented the results of a LST in Izmir, 17 July, 2017, overlapped with high resolution imagery. As seen from the figures, the first study area covers one whole Landsat-8 30 meters pixel, and several parts of the surrounding pixels. The second study area cover small parts of five different pixels.

In this study, the Urban Heat Island of a bigger area in Izmir will be made.

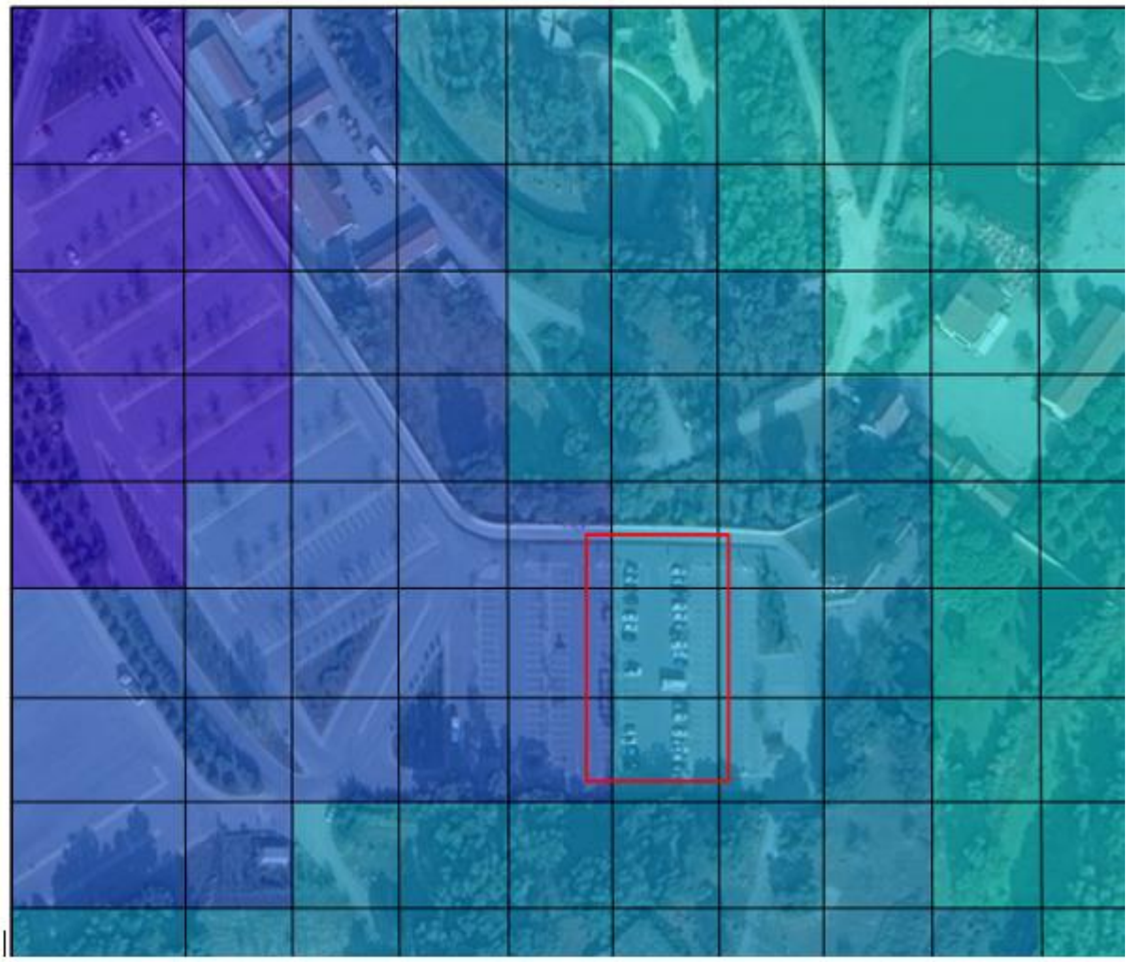


Figure 2-6 Landsat-8 LST 30 m grid overlapped with high resolution image – Study area 1

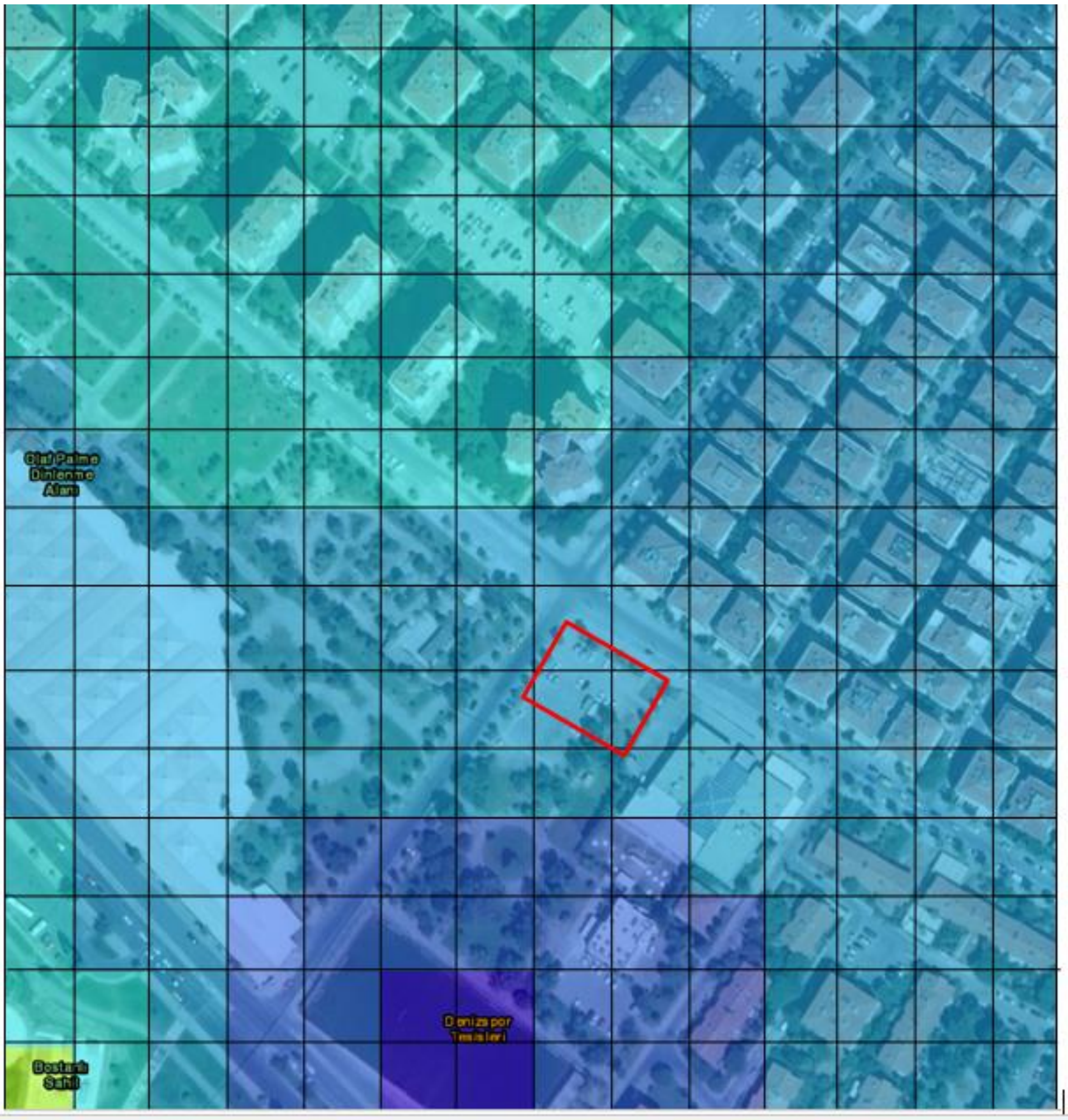


Figure 2-7 Landsat-8 LST 30 m grid overlapped with high resolution image – Study area 2

Thermal Camera

All matter radiates energy at thermal IR wavelengths (3 to 15 µm) both day and night. The ability to detect and record this thermal radiation as images have obvious reconnaissance application. Thermal IR images generally record broad spectral bands, typically 8.0 to 14.0 µm for images from satellites by (Sabins at al. 2007). The thermal camera technology can be used as a nondestructive diagnostic technique used in different applications (Malone et al. 2005, and Pascucci at al. 2005). The advantage of thermal imagery to detect the temperature can be of great use in many application and study areas. It is being widely used in the monitoring of animals (Jerem P. et al. 2015, Zheng at al. 2016), agriculture (Vadivambal R, et al. 2011), industrial applications, gas detection (Lewis AW et al. 2003), fire detection and military, detection and tracking of humans (MA YL et al. 2016), medical analysis (Jones BF 1998, Jones BF, Plassmann P. 2002), building inspection, and etc. Thermal cameras have been used for years for inspecting heat loss from building. Besides heat loss detection, thermal imaging has been used to detect problems behind the surface and, for some ancient buildings, it is of interest to monitor wall's hidden structure that can be done with thermal camera. (Gade R, Moeslund TB. 2014). An attempt for material classification and material characterization of a concrete material and its surrounding will be made.

Methods

The ideal way to observe the changes from the green roof would be using high resolution Unnamed Areal Vehicle (UAV) with a thermal camera. With such UAV very high-resolution imagery can be obtained. However, since there have been several complications and both of the study area are in restricted area, we would not be able to fly over the mentioned study areas. According to Directorate General of Civil Aviation (DGCA), the location of the area where the thermal aerial photographs are planned to be carried out with UAV is in the restricted area (Figure 2-8). Also, according to 5 (b) of the Judgement on the Use of Civil Unmanned Aerial Vehicles (UAV or Drones) on Izmir Province; UAV flights are banned that is 15 km from the center of the Meydan reference point of Çiğli Air Base Command without being dependent on altitude, half-width area and 22 km long area in both directions. parking garage is approximately 8.40 km from the air base command and the natural habitat parking is approximately 5 km from air base command. Due to these limitations, the UAV flight has been removed from the project.

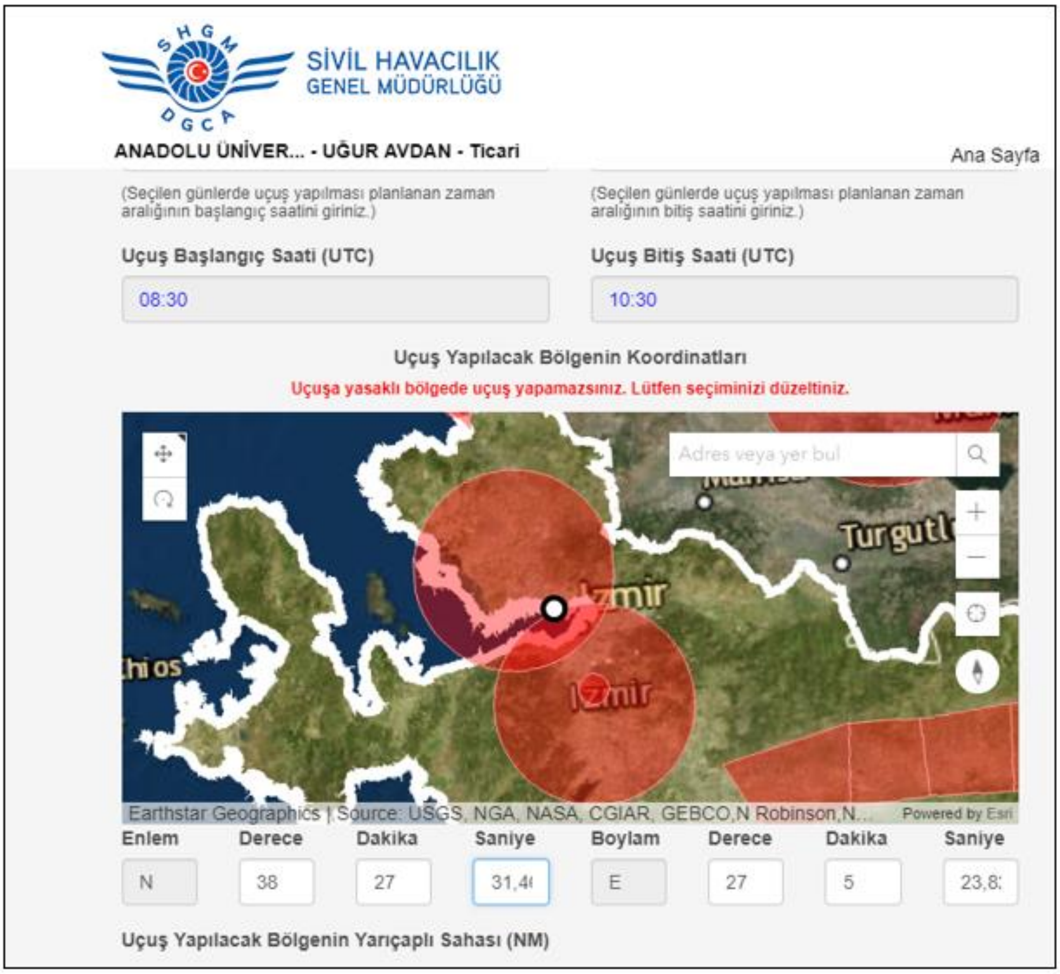


Figure 2-8 UAV Flight permit request web-page of Directorate General of Civil Aviation

Black – White dot indicates the location of study area. Red circles show restricted zones on the UAV flight. As an alternative method, manual measurements with Optris thermal camera will be performed. The methodology of this study contains few steps:

Closing the parking area for 24 hours

Measuring for 24 hours – 1-hour interval

Measuring different land covers (concrete, green areas, buildings, water etc.)

Zonal statistics

Results

The first step of the methodology will be applied to the second study area and it requires closing of the parking area for 24 hours. Regarding that, the best time would be starting from 24:00. In order to be able to compare the results, it is required to also close the parking area (Figure 7-B) next to the study area (Figure 2-10 – A and B)

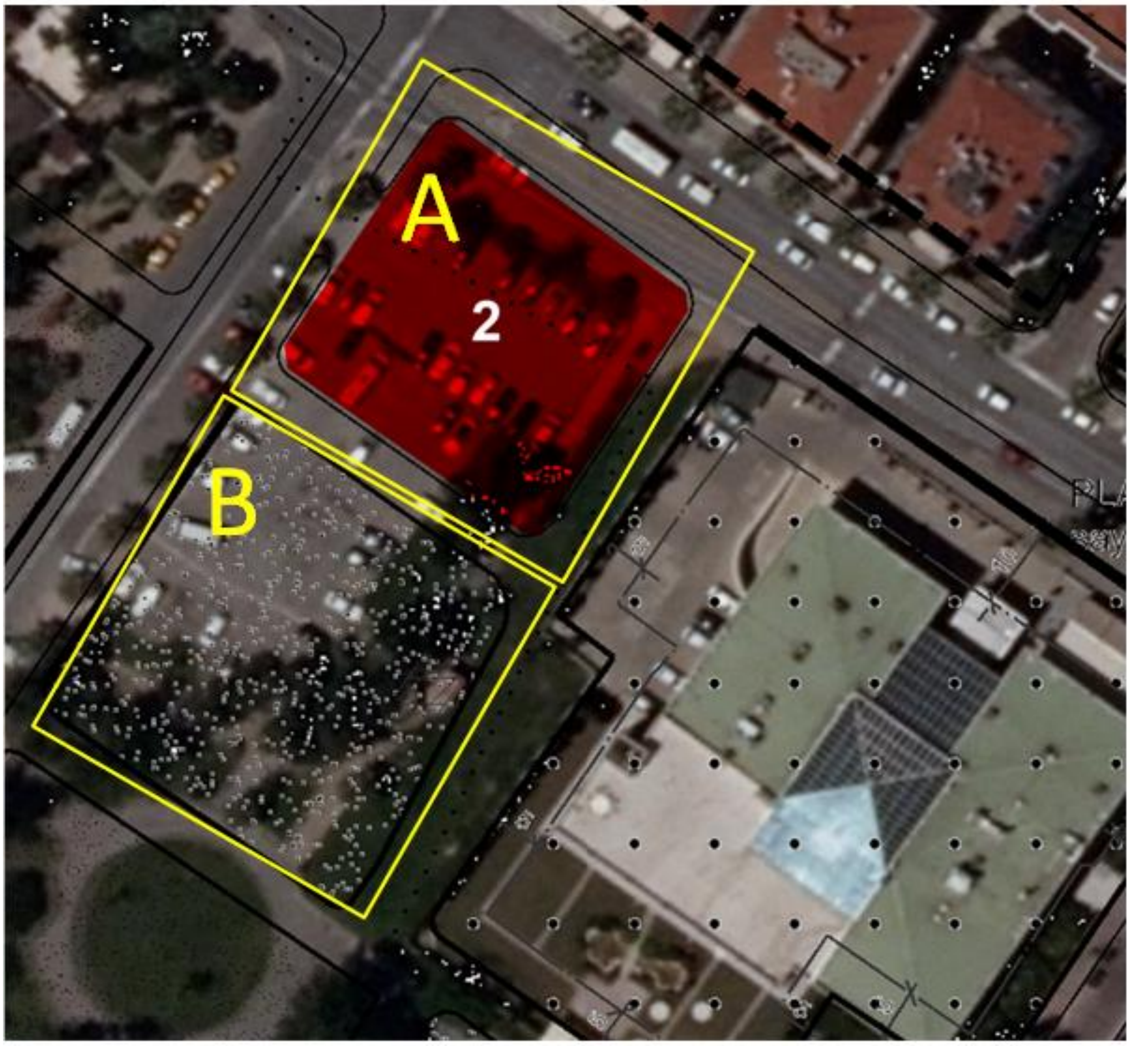


Figure 2-9 A-B Area that needs to be closed for 24 hours

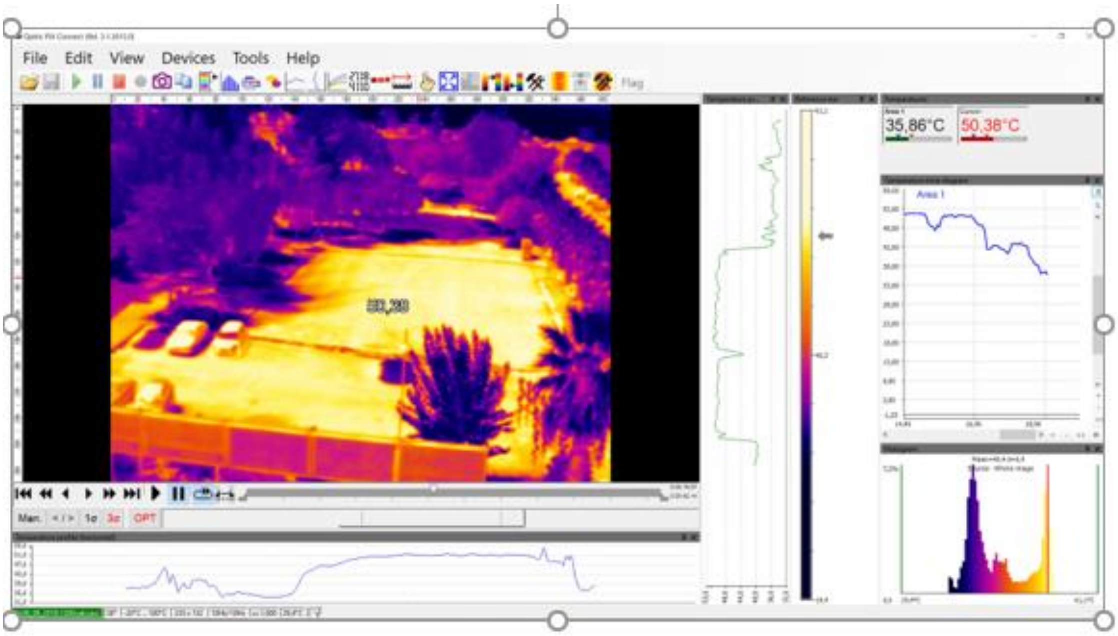
The observation of the temperatures are planned to be made in the summer period when the temperatures in the study area are significantly high. Using Optris IP-450 thermal camera, it is planned to measure the temperatures within the study area and its surroundings every hour in order to be able to get 24-hour temperature behavior of the different land covers. The measurements will be taken over the parking area, surrounding green area, trees, buildings, roads etc.

Using zonal statistic, the temperature difference before and after the construction of the green roof will be calculated. Since area A and area B (Figure 2-9 A-B) have similar characteristics, the temperature difference will be easy to detect.

During the write-up of this report, first 24 hour measurement is completed at Area A and B. The following figure shows some figures from this measurement.






File Edit View Devices Tools Help
35,86°C
50,38°C
Area 1

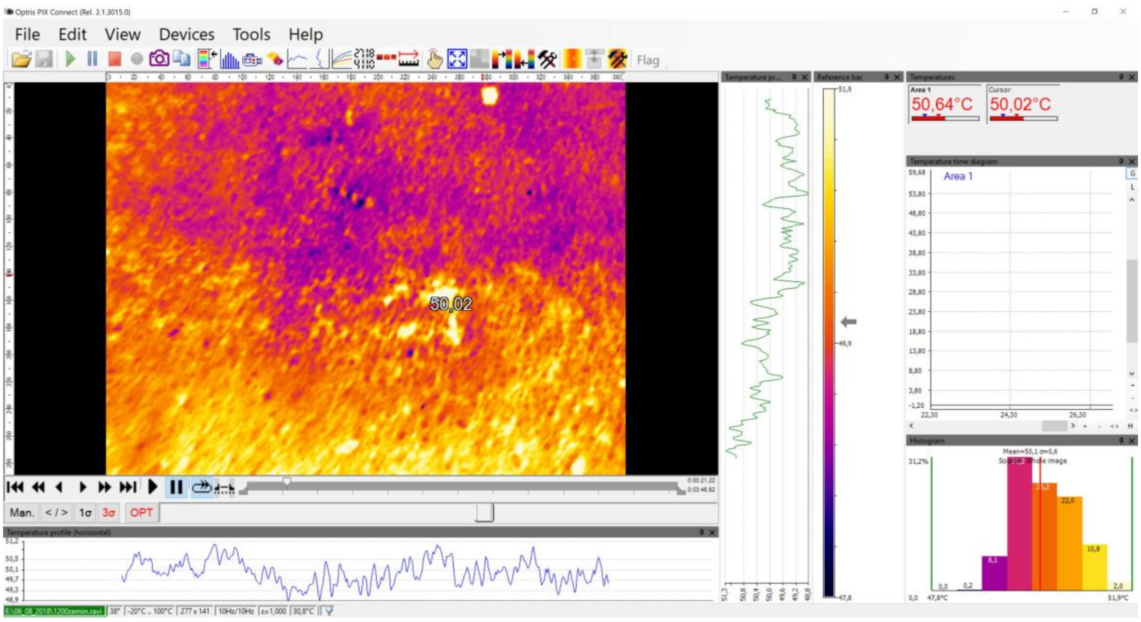


Figure 2-10 Various figures from the first 24-hour measurement

2. Air Temperatures, humidity, wind speed and direction measurements and Analysis

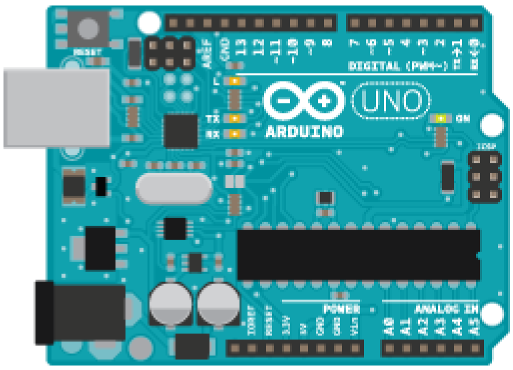
Air temperature, humidity wind speed, direction, rainfall will be measured by in-stu and mobile equipment below in Figure 2-11.

The My weatherbox's models allow to monitor multiple environmental parameters involving a wide range of applications. It has been provided with sensors for air and soil temperature and humidity, solar visible radiation, wind speed and direction, rainfall, atmospheric pressure, etc.

Data stored on the device can be downloaded later to a PC using the USB cable and software provided with the monitor.

Mobile Elitech RC-5 USB Temperature Data Logger LCD Display Temperature Recorder 32000 Points High Accuracy Reusable.

https://www.elitechonline.co.uk/RC-5



Low cost Arduino based sensors equipment with multiple environmental sensors for air temperature and humidity, atmospheric pressure will be used.

Data stored on the device can be downloaded later to a PC using the USB cable and software provided with the monitor.

Figure 2-11 Various Sensors (My Weatherbox, Elitech, Arduino based low cost sensors)

MEASUREMENTS

Surface temperature, air temperature, relative humidity, wind velocity and direction (at selected locations) will be measured and recorded hourly (at least) of the five days on which temperatures are forecast to be highest during that month.

If there is safety or working environment restrictions exist for study sites, then these measurements will be taken once every four weeks over the summer months (May- September) at multiple pre-determined (fixed) points at each NBS study site selected for this type of monitoring and at paired control study sites. Temperature measurements at each study site will be taken between 1200 and 17.00 hours and few night hour measurements on one of the five days on which temperatures are forecast to be highest during that month.

UNIT OF MEASUREMENT

Temperature in °C, relative humidity in % and wind velocity m/s.

CALIBRATION / VERIFICATION

Calibration/verification at laboratory.

STUDY SITES

a) Measurements under the shelters and unsheltered parking lots in-situ (sensors and thermal cameras) and aerial sensors by drone and/or satellite if/when possible.
b) A matching number of locations along equivalent stretches of NBS locations where without any intervention (**control study sites**). Control sites should be a sufficient distance away from intervention sites for the observations made to be considered independent from the effects of NBS.

NUMBER OF STUDY SITES

Two parking lots one in highly-urbanised area, the other one in a sub-urban area are selected as study sites as shown in Figure 2-4.

NUMBER OF SAMPLES

At each study site and control site, a set of sensors will be installed at fixed height (between 1.5m, human height, and 3.5m, height to avoid vandalism) in different locations.

DATA SAMPLING

Both intervention and matched control study sites will be monitored with the same schema during the same time (although with a lower number of sensor points). Each fixed sampling location at a study site will be sampled hourly (at least) for a year pre-intervention (September 2018 to August 2019), and for two years post-intervention (spring 2020 to spring 2022).

DATA PROCESSING

Calculation of daily, weekly, monthly and annual mean levels (day and night) of temperature and relative humidity at each stretch. Comparison of mean values for NBS intervention and control sample locations will be done at each study site before and after the interventions.

SPATIAL ANALYSIS SOFTWARE

QGIS is the GIS software proposed to be used, due to it is an open source and multiplatform software and it is distributed under Creative Commons Attribution-Share Alike 3.0 licence (CC BY-SA). We recommend using the last long-term release repository, most stable (QGIS 2.18 is currently the last one). Data processing involved in this KPI can be done with the standard version and the standard toolbox.

Surface Analysis Optrix Pix Connect will be used.

RESULTS

The calculated values will be compared qualitatively and quantitatively for the periods before and after the interventions in the NBS and reference sections. Quantitative assessment will be done by using the following expression:

$$\textbf{Temperature impact} = \left(\frac{NBS\ Temp.average\ after\ intervent. - NBS\ Expected\ Temp.average\ after\ intervent.}{NBS\ Expected\ Temp.average\ after\ intervent.}\right) \times 100$$

Where *temperatures average after intervention.* is the average value of measurements after interventions and *Expected temperature value after intervention.* (but supposing that interventions had not been done) is:

$$\textbf{Temperature Expected average after intervent.} = \left(\frac{Ref.Temp.average\ after\ intervent.}{Ref.Temp.average\ before\ intervent.}\right) \times NBS\ Temp.average\ before\ intervent.$$

Positive or null temperature impact values indicate negative or no impact of the NBS on average temperatures for that implementation. A negative value indicates a positive impact of that NBS on temperatures (and/or humidity, same procedure).

2.1.4 Measures of human comfort e.g. ENVIMET PET — Personal Equivalent Temperature, or PMV — Predicted Mean Vote

RATIONALE/INTRODUCTION

Climate change is often discussed in terms of changes in air temperature, cloud, wind, etc. However, in order to evaluate its impact on people's thermal perception and wellbeing, it is definitely necessary to analyse their combined effect (Mayer, H. and Höppe, P., 1987). Human thermal comfort can be defined as a condition of mind that shows satisfaction with the surrounding environment. High temperatures and humidity naturally result in discomfort sensations and dissatisfaction (Abdel-Ghany et al., 2013).

The degree of human or thermal comfort that people experience in open and green spaces is one of the key factors, especially in areas with extreme climatic conditions. There is a wide range of indexes in the literature on this matter, such as THI, PE, TS, PMV, PET, mPET and COMFA (Matzarakis et al., 1999, Ruiz & Correa, 2014, Xuea and Xiao, 2016).

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.

NBS TYPES

Green shady structures, green covering shelters, shade and cooling trees, cool and green pavements.

METHOD

BACI (Before, After, Control, Impact)

A common adaptation measure to decrease radiation fluxes and outdoor temperatures is to increase shadow surfaces by plantations and/or shelters (Figure 2-12) The reduction of the surface temperatures on the shaded grounds can further decrease turbulent and convective heat transport and thus contribute to achieving decrease in outdoor thermal discomfort (Shashua-Bar et al., 2011; Spronken-Smith and Oke, 1999).

Figure 2-12 Green covering shelters.

To be able to obtain the above-mentioned effects on the parking lots at Sub Demo A (Vilayetler Evi and Sasalı Natural Life Park Parking Lots) where there is no shadow area, green covering shelters will be constructed with a total area of 1 450 m².

The method is composed of two parts;

(1) Air and surface temperature, relative humidity will be measured under the shelters and unsheltered parking lots in-situ (sensors and thermal cameras) and aerial sensors by drone and/or satellite (measured for KPI 7),

(2) The collected data will be processed using the 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) because of its unit (°C).

MEASUREMENTS

Air temperature, relative humidity, wind velocity and direction (at selected locations) will be measured and recorded hourly (at least) on of the five days on which temperatures are forecast to be highest during that month.

If there is safety or working environment restrictions exists for study sites, then these measurements will be taken once every four weeks over the summer months (May- September) at multiple pre-determined (fixed) points at each NBS study site selected for this type of monitoring and at paired control study sites. Temperature measurements at each study site will be taken between 12.00 and 17.00 hours and few nights hour measurements on one of the five days on which temperatures are forecast to be highest during that month.

UNIT OF MEASUREMENT

Temperature in °C, relative humidity in % and wind velocity m/s

CALIBRATION / VERIFICATION

Calibration/verification at laboratory.

STUDY SITES

Figure 2-13 Study Sites

a) Measurements under the shelters and unsheltered parking lots in-situ (sensors and thermal cameras) and aerial sensors by drone and/or satellite.
b) A matching number of locations along equivalent stretches of NBS locations where without any intervention (**control study sites**). Control sites should be a sufficient distance away from intervention sites for the observations made to be considered independent from the effects of NBS.

NUMBER OF STUDY SITES

Two parking lots, one in a highly-urbanised area, the other one in a sub-urban area, are selected as study sites.

DATA SAMPLING

Both intervention and matched control study sites will be monitored with the same schema during the same time (although with a lower number of sensor points). Each fixed sampling location at a study site will be sampled hourly (at least) for a year pre-intervention (September 2018 to August 2019), and for two years following intervention (spring 2020 to spring 2022).

DATA PROCESSING

Calculation of daily, weekly, monthly and annual mean levels (night and day) of temperature and relative humidity at each stretch. Comparison of mean values for NBS intervention and control sample locations will be done at each study site before and after the interventions.

RESULTS

Table 2-1 shows the ranges of the most common thermal comfort indexes PMV and PET (Mayer and Matzarakis, 1997).

The PET index assesses thermal comfort by taking into account thermal-hygric conditions, radiation and wind data, the human metabolic heat exchange rate and other individual-related parameters (e.g., age, gender, and clothing), allowing a comprehensive assessment of the effectiveness of the adaptation measures. The RayMan Pro version 2.1 software (Matzarakis at al., 2010) will be used to calculate PET values from the measured data. This software is well suited for determining microclimatic changes in different urban structures, as it calculates the radiation fluxes of different surfaces and their changes (Gulyas et al., 2006).

PMV (-)	PET (°C)	Thermal Sensation	Grade of Physiological Stress
		PET<4 Very cold 4<PET<8 Cold 8<PET<13 Cool 13<PET<18 Slightly cool 18<PET<23 Comfortable 23<PET<29 Slightly warm 29<PET<35 Warm 35<PET<41 Hot PET>41 Very hot	Extreme cold stress Strong cold stress Moderate cold stress Slight cold stress No thermal stress Slight heat stress Moderate heat stress Strong heat stress Extreme heat stress
-3.5	4		
-2.5	8		
-1.5	13		
-0.5	18		
0.5	23		
1.5	29		
2.5	35		
3.5	41		

Table 2-1 Ranges of the thermal indexes predicted mean vote (PMV) and physiological equivalent temperature (PET) (Source: Mayer and Matzarakis, 1997).

The PET index is based on the Munich Energy Balance Model for Individuals (MEMI), which models the thermal conditions of the human body in a physiologically relevant way (Equation 1) (Höppe, 1999; Matzarakis and Amelung, 2008).

$$M + W + R + C + E_D + E_{Re} + E_{Sw} + S = 0 \qquad (1)$$

Where, M is the *metabolic rate* (internal energy production), W is the *physical work output*, R is the *net radiation of the body*, C is the *convective heat flow*, E_D is the *latent heat flow to evaporate water diffusing through the skin* (imperceptible perspiration), E_{Re} is the *sum of heat flows for heating and humidifying the inspired air*, E_{Sw} is the *heat flow due to evaporation of sweat*, and S is the *storage heat flow for heating or cooling the body mass*. The individual terms in this equation have positive signs if they result in an energy gain for the body and negative signs in the case of an energy loss (M is always positive; W, E_D and E_{Sw} are always negative). The unit of all heat flows is in Watt (Matzarakis at al., 2007).

The calculation of PET includes the following steps (Matzarakis and Amelung, 2008):

- Calculation of the thermal conditions of the body with MEMI for a given combination of meteorological parameters.
- Insertion of the calculated values for mean skin temperature and core temperature into the model MEMI and solving the energy balance equation system for the air temperature T_a (with v = 0.1 m/s, P_v = 12 kPa and $T_{mrt} = T_a$).

Where, P_v vapor is the *pressure of the air*.

2.1.5 Heatwave risks (num. of combined tropical nights (>20°C) and hot days (>35°C)

RATIONALE/INTRODUCTION

The IPCC (2012) defines "heat wave" as ''a period of abnormally hot weather'' (Metric for Izmir: 3 days >35°C during the day, 3 days >20°C during the night). The distribution of heat within urban areas depends on local climatology and urban meteorology combined with urban land-use patterns. Urban heat island represents the difference in temperature between cities and the surrounding rural areas and poses an additional risk to the population while building characteristics, population increase, emissions and lack of green spaces intensify the impact of the heat waves. The impact of a heat wave depends not only on the temperature itself but also on the frequency of high temperatures over a longer time period, on the daily and nightly minimum temperatures, and on the time of the year that they occur (Smoyer-Tomic et al., 2003). However, the consequences of the heat waves are not always related to the hazard itself but also to the characteristics of the population in the affected area. People with pre-existing health problems, socially isolated elderly people with fragile health condition, young children, people suffering from obesity, etc. are particularly vulnerable to heat waves (IPCC, 2012).

Izmir is considered as an important city in the view of heat wave risks and their results such as health problems and thermal discomfort. Table 2-2 depicts the intensive heat waves and the maximum air temperature of summer months between 1938 and 1998 for Izmir (Erlat, 1999).

Intensive Heat waves			
Months	June	July	August
Times	7	12	11
Maximum air temperature (°C)	41.3	42.6	40.1

Table 2-2 Intensive heat waves in Izmir (Source: Erlat, 1999)

NBS TYPES

Green shady structures, green covering shelters, shade and cooling trees, cool and green pavements.

METHOD

According to D'Ippoliti et al. (2010), a day is characterized as a 'hot day' based on values of *maximum apparent temperature* (T_{app}) and high night-time temperatures through *minimum temperature* (T_{min}). T_{app} is a discomfort index based on air (T_a) and dew point (T_{dew}) temperatures, thus accounting for the physiological impact of heat on health. T_{app} can be calculated using Equation 2.

$$T_{app} = -2.653 + 0.994T_a + 0.0153T^2_{dew} \qquad (2)$$

A long-time series is necessary to calculate meaningful statistics for the area under consideration and establish dynamic thresholds that characterize that particular area. In order to calculate the above-mentioned dynamic thresholds necessary for the identification of hot days, a 20-year time series from the meteorological stations at Demo Sites will be obtained and used for the extraction of hot days and the estimation of heat wave intensity. Besides meteorological data, satellite-derived land surface temperature (LST) retrievals will also be used as in-situ estimations of the urban temperature fields at each Demo Sites.

MEASUREMENTS

Air temperature data will be taken from KPI 7 measurements while atmospheric pressure values will be obtained from the meteorological stations at Demo Sites.

STUDY SITES

Vilayetler Evi and Sasalı Natural Life Park parking lots will be the study sites similar to KPI 7 and 8 as shows in Figure 2-4.

DATA PROCESSING

Calculation of the number of tropical nights and hot days monthly (summertime) and yearly assessing hourly mean values of temperature at each stretch. Comparison of mean values for NBS intervention and control sample locations will be done at each study site.

SPATIAL ANALYSIS SOFTWARE

QGIS is the GIS software proposed to be used, due to it is an open source and multiplatform software and it is distributed under Creative Commons Attribution-Share Alike 3.0 licence (CC BY-SA). We recommend using the last long-term release repository, most stable (QGIS 2.18 is currently the last one). Data processing involved in this KPI can be done with the standard version and the standard toolbox.

RESULTS

The calculated values will be compared qualitatively and quantitatively for the periods before and after the interventions in the NBS and reference sections. Quantitative assessment will be done by using the following expression:

$$\textit{Tropical Nights or Heatwaves impact} = \left(\frac{Number\ after\ intervent. - Number\ Expected\ after\ intervent.}{NBS\ Expected\ Temp.average\ after\ intervent.}\right) \times 100$$

Where *Number after intervention.* is the number of tropical nights or heatwaves after interventions and *Number Expected after intervention.* is calculated by this expression (supposing that interventions had not been done):

$$Number\ Expected\ after\ intervent. = \left(\frac{Ref.Number\ after\ intervent.}{Ref.Number\ before\ intervent.}\right) \times NBS\ Number\ before\ intervent.$$

Where *Ref. Number after intervention*. is the number of tropical nights or heatwaves in the reference stretch after the intervention, *Ref. Number before intervention.* is the number of tropical nights or heatwaves in the reference stretch before the intervention and *NBS Number before intervention.* is the number of tropical nights or heatwaves in the NBS stretch after the intervention.

Positive or null *Tropical nights or Heatwaves impact* values indicate negative or no impact of the NBS on average temperatures for that implementation. A Negative value indicates a positive impact of that NBS on temperatures.

2.1.6 Energy and carbon savings from reduced building energy consumption (kWh/y and ton C/year saved)

RATIONALE/INTRODUCTION

Climate change can cause overheating in city centers, especially through the “heat island effect”. Green urban infrastructure can play a role in climate change adaptation through reducing air and surface temperature by providing shading and enhancing evapo-transpiration, which leads to energy and carbon savings from reduced building energy consumption especially in summer (Akbari, 2002). On the other hand, insulating effect of plants reduces heating energy consumption and associated carbon emissions in winter (Alexandri and Jones, 2008; Zinzi and Agnoli, 2011).

NBSs in Izmir do not have any building level interventions such as green roof and green façade. Green shady structures will be implemented in parking lots, which has no connection with buildings. Therefore, energy and carbon savings from reduced building energy consumption will be obtained using a dynamic building energy performance software, Design Builder (v.4.7) (Design Builder, 2018). The buildings in NBS locations will be classified such as residential, commercial, etc. and one example from each class will be modelled. The models will be simulated by air temperature and relative humidity, and surface temperature values which will be obtained from KPI-7 "Decrease in mean or peak daytime local temperatures (°C)". The difference between energy consumption values of pre- and post-intervention will give energy savings. Then, corresponding carbon savings from reduced energy consumption will be calculated by conversion factors given by the Building Energy Performance Regulation (BEP, 2017). Finally, the study would be extended to all buildings at NBS locations.

NBS TYPES

Green shady structures, green covering shelters, shade and cooling trees, cool and green pavements.

METHOD

The methodology consists of measurements, modelling and simulations. The steps of the methodology are:

(1) collecting air temperature and relative humidity, and surface temperature data (measured for KPI 7) from NBS locations both pre- and post-intervention,

(2) classifying the buildings at NBS locations and modelling one building for each class,

(3) simulating the building models to obtain energy consumption values,

(4) converting the energy consumption values to primary energy consumption value using conversion factors provided by the Building Energy Performance Regulation (BEP, 2017),

(5) converting the energy consumption values into CO_2 by means of conversions factors provided by the Building Energy Performance Regulation (BEP, 2017),

(6) obtaining energy and carbon savings by comparing pre- and post-intervention primary energy consumptions and CO_2 emissions at NBS locations,

(5) extending the study to all buildings at NBS locations.

If modelling will not be possible, as Plan B, a city specific heat gain/loss correlation (mean) will be obtained from the literature. Based on the decrease in air temperature by interventions, decrease in energy consumption will be calculated by this correlation. Finally, corresponding carbon savings from reduced energy consumption will be calculated.

SENSOR/SOFTWARE

Design Builder (v.4.7) (Design Builder, 2018) software will be used to model the buildings and simulate the model to obtain energy consumption data based on measured air temperature and relative humidity, and surface temperature data for KPI 7.

MEASUREMENTS

The models will be simulated by air temperature and relative humidity, and surface temperature values which will be measured at KPI-7 "Decrease in mean or peak daytime local temperatures (°C)".

STUDY SITES

Karşıyaka Metropolitan District which is a highly urbanised area will be the study site. The measurements will be conducted at Vilayetler Evi parking lot and surroundings. Decrease in temperature because of the interventions in the Demo Site, will be used to calculate the energy savings in the District.

RESULTS

Energy consumption outputs of the model will be compared for the periods before and after the interventions in the NBS and reference sections. Corresponding carbon savings from reduced energy consumption will be calculated. The study would be extended to all buildings at NBS locations.

Results can be displayed throughout maps and/or tables. KPI cards will be displayed in ICT tool.

2.1.7 Tonnes of stored per unit area per unit time (ton CO_2/ha) (ton CO_2/year). Total amount of carbon stored in soil

RATIONALE/INTRODUCTION

Biochar has received increasing interest in recent years, with the increasing need for soil regulators at global level, as well as the idea of using soils as a carbon sink (Lehmann et al., 2006). The global interest in biochar utilization has increased due to the following reasons: (a) the biochar has a much more stable structure than any organic soil conditioner or fertilizers, either fresh or composted forms; (b) the biochar can survive in the soil for long periods of time; (c) the availability of plant nutrients increases after biochar applied to the soils (Lehmann, 2009).

Significant sources of carbon released into the atmosphere are the decomposition of hydrocarbon compounds and organic compounds of agricultural-soil origin. As one of the reasons for global warming, the increase in the amount of CO_2 in the atmosphere is of great importance. For this reason, the use of biochar as one of the applications that would increase the amount of organic matter in the soil with a sustainable physical and chemical regulatory task and lead to a minimum amount of CO_2 release in the atmosphere has gained importance in Europe in recent years (Kimetu et al., 2008; Steiner et al. 2007). As a result, the application of biochar to the soils appears to be one of the ways of atmospheric CO_2 sequestration. In this process, carbon is separated from its rapid ecological cycle and participates in a much slower and more stable biochar cycle (Lehmann, 2007). In this study is planned considering the above mentioned features, the construction of a strategic pathway to utilize pyrolysis technology and biochar use in agriculture will be actualized with potential and feasible utilization techniques.

NBS TYPES

SINGULAR GI, Smart soil into green shady Structures, Green Car park Covering Shelter, Smart soil production in climate-smart urban farming precinct

METHOD

The experiment followed a split-plot design with two planted systems as main plots (planted soil: PS, and unplanted soil: UPS) and two organic amendments treatments as subplots, where 25 t dry matter ha^{-1} will be applied either as organic waste biochar (BOW), composted organic waste (COW), or fresh organic waste (FOW). A treatment without organic amendments will be used as unfertilized control (CTR) and fertilized control (FCTR). The total experimental area will be 864 m^2 (18x48 m). Test plant to be used in experiment will be maize (Zea mays L.). All treatments were conducted in two replicates. GHGs emissions will be determined by using static chambers.

SENSOR/SOFTWARE

Emission of CO_2 will be measured using a photoacoustic field gas monitor. The respective minimum detection limits (MDL) of the analyser for CO_2 is 1.5 ppm; while the precision is 1% of measured values according to the specifications of the manufacturer.

MEASUREMENTS

The greenhouse gases measurements which can be released depending on the field applications during the two-year field experiments will be carried out with the Innova 1512 instrument as specified in the technical definition during the maize vegetation period to the harvesting time. The results will be obtained in the field experiments, which will continue for two years, can be evaluated both as a comparison between the treatments and the comparison between the unplanted and planted areas. In the second year, we will continue to monitor greenhouse gas emissions with the fixed field experiment at the same place. The effects that will occur as a result of the treatments different from those in the first year to be made in the second year will also be monitored with the Inova 1512 Photoacoustic Gas Monitor.

2.1.8 Energy, Water, Carbon Reduction via Urban farming (Climate-smart Greenhouse)

RATIONALE/INTRODUCTION

Demo Site for climate smart greenhouses is located on Northern periphery of the city of İzmir. Soils and water quality of Demo Site and surrounded agricultural lands has deteriorated for last ten years. The climate smart greenhouse will include vertical and hydroponic plantation system (Figure 2-14, 2-15).

In order to save water to be used in the greenhouse, roofing will be made from material that can condense the water vapor. After water vapor is condensed on the greenhouse roof, water will be stored by collection channels and reused in agricultural production. Some part of water demand for plantation will be obtained from a portable desalination unit (Fig. 2-16).

In order to save energy, parabolic type solar energy collector will be used for heating the greenhouse. Additionally, the photovoltaic solar energy system will be used for lighting (Fig 2-17 a,b).

Additionally, agricultural production methods will be demonstrated in the soil which becomes saline and alkaline soils in Demo Site B. In order to avoid product yield loss, a spatial seeding type on saline soil will be applied (Fig 2-18).

One part of the green house will be used for demonstrating future stress conditions due to climate changes and soil degradation including dried plants, dried soil with cracks and salt crust on the surface etc. Aims of this part of the greenhouse will be used for educative purposes through students and citizens. A seminar room will be establishing beside this part.

Figure 2-14 Climate smart greenhouse

(http://urbanfarmingco.com)

Figure 2-15 Vertical planting system in greenhouse

(www.techbriefs.com)

Figure 2-16 Portable desalination unit

http://www.globalsources.com/si/AS/Shenzhen-Heping

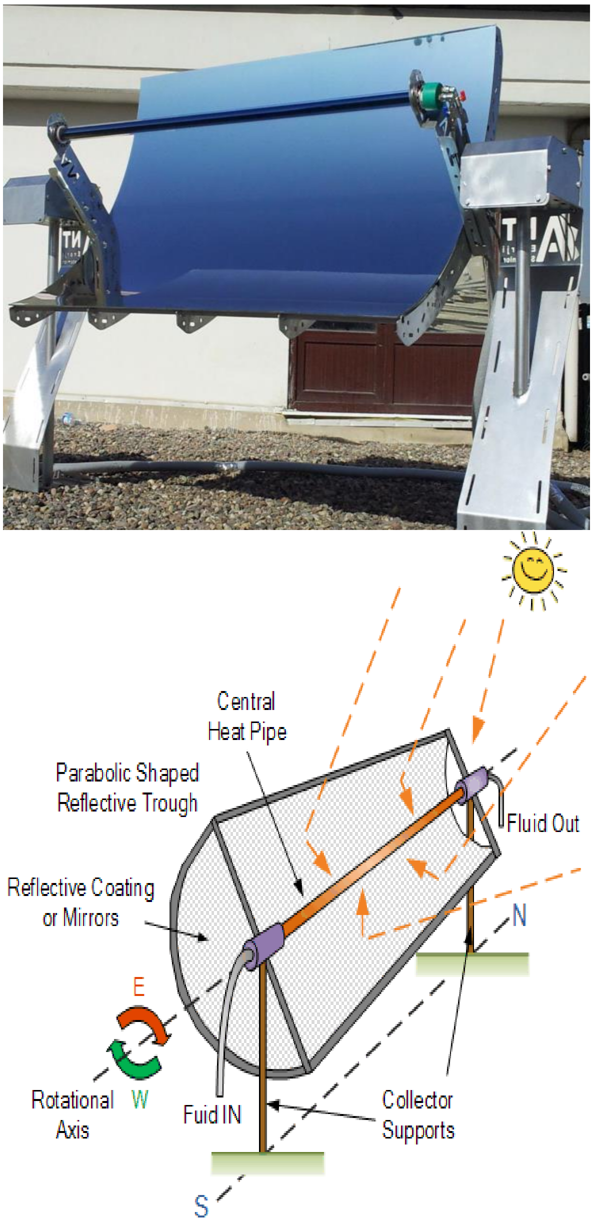


Figure 2-17 a,b. Parabolic type solar energy collector to storage of heat in subsoil tanks

http://www.alternative-energy-tutorials.com/solar-hot-water/parabolic-trough-reflector.html

Figure 2-18 Dibbling process will be done on high ridge (around 70 cm high from soil surface level)

NBS TYPES

Urban farming promotion: Singular GI, Urban Farming, Climate-smart urban farming precinct, educational activity

METHOD

Among of the saving water will be measured by collector in the greenhouse. Saving energy using solar energy will be measured for 200 m^2 greenhouse with comparing energy usage for heating and lighting process.

Desalinated water will be measured by given parameter from producer Company, such as how amount saline water purified in a hour (lt/h).

The agricultural production obtained from the unit area by conventional methods will be compared with the amount obtained from vertical agriculture (kg/m^2).

Visitors or number of the people for training in part of the greenhouse for demonstrating future stress conditions will be counted monthly by officials.

SENSOR/SOFTWARE

All data will be obtained and monitored using the specific equipment (data logger, etc.) to be placed in the greenhouse. Saving water and energy, producing desalinated water will be calculated for agricultural production per ton or kg.

Obtaining agricultural products kg/m^2 from vertical agriculture will be compared with conventional production from both in greenhouse and field (open agriculture). The amount of agricultural product obtained from vertical agriculture will be compared with the amount of agricultural products produced from greenhouse and field by conventional agricultural methods.

MEASUREMENTS

Rain water harvest measurement; Rainwater will be collected in gutters from roof of the greenhouses into barrels in order to store it for later use as irrigation water or for mixing with salty water to reduce salt concentration. A water level measurement system will be installed on barrels. The amount of collected rainwater after each rainfall will be recorded. The amount of collected rainwater annually will be calculated at the end of the rainy season.

Measurement of heat energy from solar energy; In order to save energy, parabolic type solar energy collector will be used for heating the greenhouse. The heating process consists of storing the heat in an isolated water tank in order to be supplied to the greenhouse with a radiator and fan at night. The water temperature inside the isolated tank will be measured daily with a digital thermometer fixed to the tank.

Measurement of agricultural product from vertical agriculture; the agricultural product gained from vertical agriculture will be measured in weight (kg/m) and quantity (piece). Finally, it will be compared with conventional production from both in greenhouse and field (open agriculture).

Desalinated water will be measured (lt/h) by a flowmeter that fixed on desalination unit.

Measurement of agricultural production from high ridge soil preparing system; Agricultural production methods will be demonstrated in the soil which becomes saline and alkaline soils in Demo Site B. In order to avoid product yield loss, a high ridge soil preparing system for seeding on saline soil will be applied. The measurement of product gain will be compared to the control parcel production quantity. For this purpose, a traditional soil tillage system will be applied in a control parcel on saline. The agricultural product gained from high ridge soil preparing system will be measured in weight (kg/m).

3 CHALLENGE 2: WATER MANAGEMENT MONITORING PROCEDURES

3.1 Biophysical KPIs

3.1.1 Drinking water provision (m3 ha-1year-1)

INTRODUCTION

In Izmir drinking water provision KPI will be related with drinking water used in NBSs with plantation. To measure the amount of water equipment and data collection system of IZSU (Izmir Water and Sewerage Administration) will be used and the Directorate of Parks and Gardens of Izmir Metropolitan Municipality will take the responsibility of follow the data and changes in amount of water for related NBSs and also reporting of the results.

NBS TYPES

Tree related actions; SUDs; Bioswale; Green pavements

METHOD

Measurement method for the drinking water supplied to the consumers is direct measurement with the help of water meters. Each consumer has their own meters so, it is possible to measure the provision in terms of amount of water per flat, building and/or any other facilities. With this detailed monitoring consumption of the water can be calculated as $m^3 * ha^{-1} * year^{-1}$. The image and technical specifications of the water flow meter can be seen below:

Figure 3-1 Image of the water flow meter

Nominal diameter	mm	15	20
Nominal flow rate	m^3/h	2.5	4
Maximum flow rate	m^3/h	3.125	5
Minimum flow rate	l/h	15.6	25

Maximum operation pressure	bar	16	16
Pressure loss	bar	0.63	0.63
Maximum water temperature	°C	50	50
Total length of meter	mm	190	190

Table 3-1 Technical Specifications of water flow meter

Apart from supplied water, volume of available drinking water is calculated with the measurement of height of water in dams and water wells. Dimensions of the dams and wells are known and the height of water gives the current volume and occupancy rate of dams. The volume and the occupancy rate can be monitored on the website of Izmir Water and Sewerage Administration.

MEASUREMENTS

Amount of water

UNIT OF MEASUREMENT

m^3, m^3/time, m^3/ha/year

CALIBRATION / VERIFICATION

NA

STUDY SITES

In İzmir, study sites will be along the bio-boulevard (Sub-demo B) area that is located in Çiğli-Sasalı region and parking areas (Sub-demo A) located in Mavişehir and Sasalı.

DATA PROCESSING

NA

RESULTS, Report Format

Results are collected by IZSU and stored in their database. They are publishing annual reports about drinking water provision of whole city. For this KPI in Subdemo areas Directorate of Parks and Gardens of Izmir Metropolitan Municipality will collect the information from flow meters and water bills of this areas month by month.

3.1.2 Water for irrigations purposes (m3 ha-1year-1)

INTRODUCTION

In Izmir treated water is used for different purposes but irrigation is not one of these purposes. Tap water and ground water are used for irrigation purposes. Water quality is not a concern because treated water is not related with irrigation purposes in Izmir case. Under the title of this KPI, volume of the water used for irrigation purpose is measured.

NBS TYPES

Greenhouse related NBSs

METHOD

The method of measurement of this KPI will be the same with the method explained in detail under the title of section 3.1.1: Drinking water provision. Because the same water resources and water infrastructure will be used to provide water for irrigation. So, the measurement equipment and method will be the same with KPI33.

MEASUREMENTS

Amount of water

UNIT OF MEASUREMENT

m^3, m^3/time, m^3/ha/year

CALIBRATION / VERIFICATION

NA

STUDY SITES

Study site for this KPI will be the Sub Demo B which is in 'Sasalı Natural Life Park'. This area is interface between urban and natural areas and ideal for developing climate-smart urban farming practices in a special precinct within the Park.

DATA PROCESSING

NA

RESULTS, Report Format

Results are collected by IZSU and stored in their database. They are publishing annual reports about drinking water provision of whole city. For this KPI in Subdemo areas Directorate of Parks and Gardens of Izmir Metropolitan Municipality will collect the information from flow meters and water bills of this areas month by month.

3.1.3 Runoff volume calculation

INTRODUCTION

This KPI measures capacity information of grassed swale systems by calculating the runoff volume in İzmir case. This calculation is also important for dimensioning the scale of bio-swale systems in bio-boulevard since this area is known by its high groundwater level and in winter times, İzmir has recent heavy rains that cause flood actions in areas where soil has a heavy structure as our study area.

NBS TYPES

This KPI is related to NBS involving bio-boulevard and grassed swales and water retention pounds around bio-boulevard.

METHOD

A GIS based analysis will be made to predict runoff by using the most common method called The Runoff Curve Number (CN), developed for ungauged basins to calculate runoff from rainfall data by USDA NRCS (United States Department of Agriculture Natural Resources Conservation Service) formerly known as the Soil Conservation Service (SCS). The method is used worldwide to predict runoff based on the amount of impervious area, soil group, land cover type, hydrological condition, and antecedent runoff (USDA NRCS, 1986).

MEASUREMENTS

Runoff depth, runoff volume, bio-swale dimensions

UNIT OF MEASUREMENT

Runoff depth: mm

Runoff volume: m^3

Bio-swale dimensions: m^2

CALIBRATION / VERIFICATION

-

STUDY SITES

In İzmir, study sites will be along the bio-boulevard (Sub-demo B) area that is located in Çiğli-Sasalı region.

DATA PROCESSING

ArcMap 10.3 is the GIS software proposed to be used in İzmir. Calculations for baseline values were carried out based on satellite images using GIS techniques. Land cover information is taken on site by visits. Noted down invasive *Eucalyptus* species and native herbaceous plant cover is the dominant vegetation covering app. 80% of the NBS area which is currently abandoned to its own natural dynamics. The needed soil information is provided by in-situ soil analysis. Precipitation values are estimated based on a 10-year return period with a 24-hour duration rainfall data for İzmir city.

RESULTS, Report Format

Results can be displayed throughout maps and/or tables

4 CHALLENGE 4: GREEN SPACE MANAGEMENT MONITORING PROCEDURES

4.1 Biophysical KPIs

4.1.1 Production of food (ton/Ha/year)

RATIONALE/INTRODUCTION

Izmir currently consists of 30 districts under the authority of Izmir Metropolitan Municipality. In this KPI, Izmir team will be focused on Balçova, Bayraklı, Ciğli, Karşıyaka, Konak and Narlıdere districts of city of İzmir. One of the reasons for the selection of these districts is located in the center of the city of Izmir and the other reason is that the all Demo Sites are located in the districts of Çiğli and Karşıyaka (Figure 4-1). In these districts, where urban agriculture is intensively implemented, the production of food will be measured by tones/ha per year.

Figure 4-1 Urban farming in Balçova district of the city of Izmir

(http://www.yurtsuz.net/ReadImage.ashx?id=7508)

NBS TYPES

Urban farming promotion: Urban orchard; Community composting; Small-scale urban livestock

METHOD

In these districts, the production of food resulting from urban farming activities will be measured by tones/ha per year based on fieldworks and data from the Ministry of Agriculture.

SENSOR/SOFTWARE

İzmır Directorate of Provincial Food Agriculture and Livestock database and field surveys.

MEASUREMENTS

The production of food resulting from urban farming activities will be measured by tones/ha per year based on fieldworks and data from the Ministry of Agriculture in Balçova, Bayraklı, Ciğli, Karşıyaka, Konak and Narlıdere districts of city of Izmir. If it is not able to be measured, an estimate of the amount generated will be made.

4.1.2 Increased connectivity to existing GI

INTRODUCTION

This indicator is included in the list of indicators for Challenge 4. Green Space Management. This environmental (biological) indicator evaluates the increases of connectivity related to existing green infrastructures. The extent and spatial arrangement of accessible green space within each sub-demo area may have an important influence on public health and wellbeing; as well as having the potential to increase biodiversity. Vegetated areas provide cooling on hot days through evapotranspiration; and trees reduce radiant heat by shading, making public space and travelling routes more comfortable for people on days when temperatures in urban areas are high (City Diagnosis and Monitoring Procedures WP5 document T5.3).

NBS TYPES

This KPI is related to NBS involving new green corridor.

METHOD

Several landscape metrics are employed, such as Area and Edge Metrics (CA-class area, PLAND-percentage of landscape, GYRATE_AM-area weighted mean radius of gyration, AREA_MN-patch area distribution), Aggregation metrics (NP-number of patches, CONNECT-Connectance index) to identify configuration and connectivity levels of urban green areas. Landscape metrics were calculated at the class level by using FRAGSTATS 3.4 with a cell size of 1 m (McGarigal and Marks, 2003). Two major landscape metrics are highlighted here; a) GYRATE_AM and b) CONNECT to better interpret the connectivity results.

In the monitoring period, a GIS based analysis will be made again at the city level using recent data and information to identify recent land use-land cover, and above-mentioned landscape metrics will be computed to assess the impact of the NBS and make a comparison with baseline values. Although URBAN GreenUP requires a two-year monitoring period after the implementations of the NBS to collect a complete data set and achieve a maximum accuracy in the evaluation process, the measurement for this KPI is going to be executed only once because this is not an analysis or assessment that needs to be repeated.

MEASUREMENTS

In monitoring, calculations for increased connectivity to existing GI will be done and presented in numbers and percentage.

UNIT OF MEASUREMENT

% and numbers

CALIBRATION / VERIFICATION

It was calculated before the interventions and will be executed again after NBSs are implemented in order to make a before and after comparison.

STUDY SITES

In the case of Izmir demo, calculations and analysis for increased connectivity to existing GI (KPI 76) will be executed in Çiğli-Karşıyaka Metropolitan Urban Districts.

DATA PROCESSING

The land use-land cover map will be derived from WorldView2 updated satellite images using screen digitalizing in ArcGIS 10. Based on land use-land cover map, the components of GI will be defined and classified in ArcGIS 10 as well. Izmir Municipality currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS

RESULTS, Report Format

Results can be displayed throughout maps and/or tables.

4.1.3 Pollinator species increase (number)

INTRODUCTION

The presence of pollinating insects such as bees, hoverflies, butterflies and moths visiting flowers is indicative of pollination (ecosystem service). Increased habitat for pollinators in NBS GI may contribute to increased abundance of pollinators in the wider urban area and provide stepping-stones or corridors of habitat from a source site such as an urban park to another urban GI site. Flying pollinating insects are an appropriate indicator of pollination and biodiversity in new NBS GI. Flying pollinating insects are highly mobile, and therefore, considered to have the potential to reach the NBS sites within the project-monitoring period (City Diagnosis and Monitoring Procedures WP5 document T5.3).

NBS TYPES

This KPI is related to NBS involving vertical green interventions, such as fruit wall and green fences, pollinator (houses) modules and bio-swales around the bio-boulevard.

METHOD

The method is composed of setting up sample areas and observing and recording pollinating insects visiting the plants in the sample areas. Sample areas are composed of 10 X 10 m stable quadrats representing the relevant location. For monitoring study, observations will be carried out whole two days in every month in each locality. Simultaneously, microclimatic variables (air temperature and wind speed) of the observation areas (using a data logger) will be recorded. In addition to these observations in 10 x 10 m quadrats for pollinating species, since flying pollinating insects are highly mobile, in the vicinity of the quadrats, additional one whole day/month observation will be made before the NBSs are constructed. It is hoped that at the end of the observation period, two different insect lists will be prepared for per locality.

MEASUREMENTS

Although URBAN GreenUP requires a two-year monitoring period after the implementations of the NBS to collect a complete data set and achieve a maximum accuracy in the evaluation process, for this KPI (KPI 77), the same procedure as in baseline observations will be repeated only once in the second year of the monitoring period when the planting design is firmly settled and all the plants are mature enough to attract pollinating insects. Ultimately, it is hoped to assess if there is an increase in number of pollinator insects visiting the NBS after the implementation. All the observations will be photographed as well.

UNIT OF MEASUREMENT

The number of pollinating insects in different taxon

CALIBRATION / VERIFICATION

NA

STUDY SITES

In the case of Izmir demo, the pollinator study will be conducted at two locations:

a) A green space along Peynircioğlu River in Karşıyaka-Mavişehir region
b) An area around Bio-Boulevard in Çiğli-Sasalı region

First locality has been chosen in a green space along the Peynircioğlu River in Karşıyaka-Mavişehir where the relevant NBS is located. The plant cover is composed of mostly exotic species, and moreover, there is not much plant diversity. Second locality is around the bio-boulevard in Sasali Region. It is a semi-natural area that contains native annuals and some invasive Eucalyptus trees.

DATA PROCESSING

The number of pollinating insects will be counted and recorded manually.

RESULTS, Report Format

Results can be displayed throughout maps and/or tables.

4.2 Socio-Economic KPIs

4.2.1 Accessibility of urban green spaces for population

KPI-53: ACCESSIBILITY OF URBAN GREEN SPACES FOR POPULATION

INTRODUCTION

This social indicator evaluates the accessibility of urban green spaces for population in terms of total distance or time. Green spaces close to where people live, and connect people with the natural environment. Accessibility to green spaces indexes can provide an important information to improve urban management policies (Tamosiunas et al, 2014). Access to Natural Greenspace Standard (ANGSt) proposes minimum distances people would travel to the natural environment (Natural England, 2010):

- An accessible natural greenspace less than 250-300 m (in a straight line) from home (Figure 4.2)
- The Six Acre Standard: 6 acres (2.4 ha) of recreational space is required for every 1.000 people (24 m^2 per person)
- At least one accessible 20-hectare site within 2 km of home
- One accessible 100-hectare site within 5 km of home
- One accessible 500-hectare site within 10 km of home

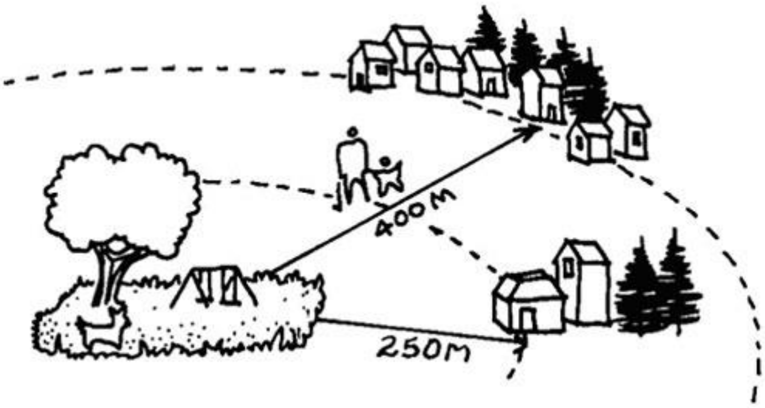


Figure 4-2 Access to green spaces in a straight line

NBS TYPES

This indicator is related to NBS involving horizontal green infrastructures such as green corridor, urban carbon sink, green resting areas, etc.

METHOD - MEASUREMENTS

This KPI can be measured throughout spatial analysis and spreadsheet software. Data are acquired by statistic and GIS processing, so none sensor is required. Results can be displayed throughout maps and/or tables. For spatial analysis İzmir Metropolitan Municipality uses ARCGIS that can be converted to open software platforms like QGIS in order to enhance its usability.

UNIT OF MEASUREMENT

(m) (min)

CALIBRATION / VERIFICATION

İzmir Metropolitan Municipality has recently completed the inventory of green spaces for the whole city by using hi-res digital maps stored in a GIS database. There is also population data and walking distance analysis can be obtained from Transportation Master Plan of 2030.

STUDY SITES

This KPI can be measured for the whole Karşıyaka and Çiğli districts of İzmir, giving a single resulting value for each study campaign. However, a neighbourhood level study around sub-Demo Sites is recommended since it can be useful for detecting deficit areas.

DATA PROCESSING

The first step is to obtain a shape file in which each Entryway is linked to its nearest GI, throughout the tool **Distance to the nearest hub**. As a result, a new shape-file is obtained with an attribute field containing the measured distance in meters.

In order to obtain this KPI in terms of time, **Field calculator** tool can be used. A conversion factor has to be set to measure a pedestrian walking speed. Bosina and Weidmann (2017) sets the average for pedestrian speed walking in Spain were 1.59 m/s, which means 95.4 m/min. So, the distance value in minutes can be obtained dividing by this value.

VARIABLE	DESCRIPTION	UNIT	SOURCE TYPE	NOTES
Distance to nearest GI.	Entryways linked to its nearest Green infrastructures (line).	m	Shapefile – Polyline	Derived variable obtained by GIS processing.
Time to nearest GI.	Entryways linked to its nearest Green infrastructures (line).	min	Shapefile – Polyline	Derived variable obtained by GIS processing.

Table 4-1 Distance and time to nearest GI

Overall statistics can also be calculated by a spatial analysis software like QGIS tool includes **Basic statistics for numeric fields.** The result of this tool is a table (not GIS data), with resume figures of both terms of the KPI, including minimum and maximum values, range, mean and median value, standard deviation and coefficient of variation (Figure 4.3).

VARIABLE	DESCRIPTION	UNIT	SOURCE TYPE	NOTES
KPI 053 (1)	Accessibility (measured as distance) of urban green spaces for population.	m	table	Derived variable obtained by GIS processing.
KPI 053 (2)	Accessibility (measured as time) of urban green spaces for population.	min	table	Derived variable obtained by GIS processing.

Table 4-2 Result of QGIS Tool

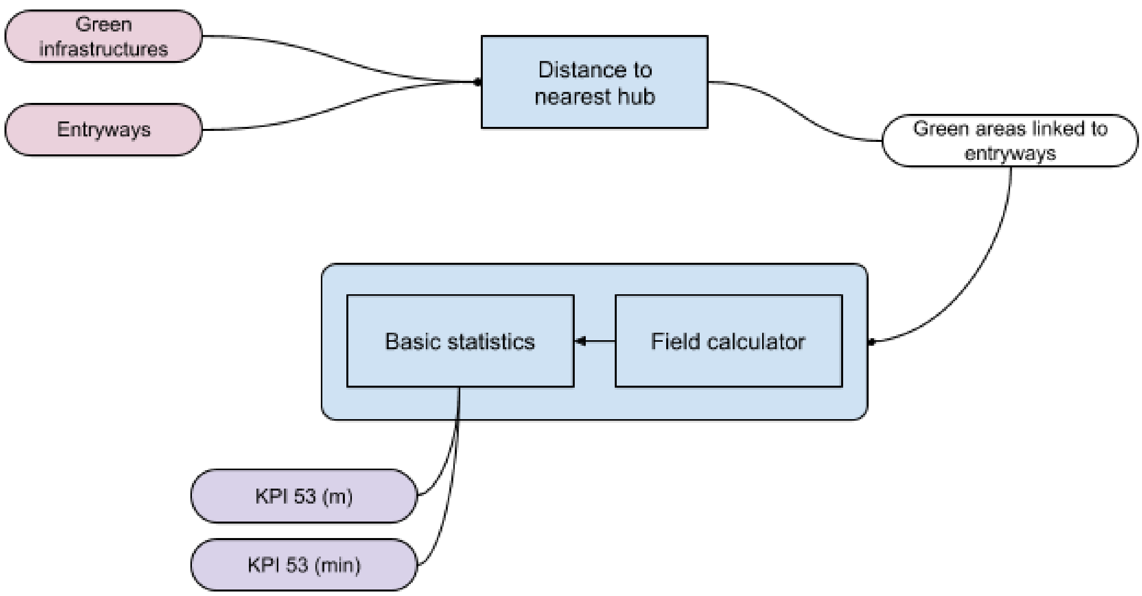


Figure 4-3 Algorithm for this described process

RESULTS

Two final figures are obtained at the end of the process for this KPI. One of them shows the accessibility for green areas in terms of total distance (m), and the other shows the accessibility for green areas in terms of total time (min).

4.2.2 Weighted recreation opportunities provided by Urban Green Infrastructure

KPI-60: WEIGHTED RECREATION OPPORTUNITIES PROVIDED BY URBAN GREEN INFRASTRUCTURE

INTRODUCTION

This KPI aims to measure the increase of opportunities related to green infrastructures (Derkzen et al. 2015), being valued for recreation, social interaction, education and supporting healthy living.

NBS TYPES

Tree related actions; Green cycle lane/pedestrian route/road traffic junction improvements. Urban farming promotion: Urban orchard; Community composting; Small-scale urban livestock. Educational activities: Educational paths (A, C); urban farming educational activities.

METHOD

Recreation opportunities are based on the different types of urban green infrastructure's degree of naturalness, aesthetics-scenic beauty, and presence of water. Baseline and post-intervention measurements of frequency of opportunities through user surveys (Frick et al., 2007).

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. The definition of scores was based on a consultation process via focus group. Alternatively, in case of no consensus for a specific score, a compromise value can be agreed (e.g., average value of suggested scores or sum of voting scores) (Baro, 2016).

MEASUREMENTS

Recreation opportunities including naturalness, aesthetics-scenic beauty etc. can be conducted via user questionnaire through standard spreadsheet software (Excel or SPSS). For the evaluation of user surveys and weighting process, focus group experts can be provided from think-thanks involving environmental issues under the umbrella of İzmir Mediterranean Academy established by Izmir Metropolitan Municipality.

UNIT OF MEASUREMENT

(nº factors) (focus group attended)

CALIBRATION / VERIFICATION

Weighting process can be managed via online survey platform that implements the Delphi method.

STUDY SITES

This core KPI will be measured for the whole Karşıyaka and Çiğli districts of İzmir, giving an impression about the degree of recreation opportunities around sub-Demo Sites where different NBSs are implemented.

DATA PROCESSING

KPI data collected from user surveys and expert focus study groups can be processed by using spreadsheet software by Excel or SPSS and spatial analysis software like ARCGIS or QGIS. Alternatively, weighting process for expert group study can be conducted via online Delphi software.

RESULTS

Results can be displayed throughout maps and/or tables.

4.2.3 Urban green spaces per capita

INTRODUCTION

Green spaces are useful ingredients for spatial planners in achieving a sustainable urban landscape. They can provide elements characterizing the heritage and aesthetics of the area (Madureira et al., 2011; Niemelä, 2014), as well as being valued for recreation (Fors et al., 2015), social interaction (Kaźmierczak, 2013), education (Krasny et al., 2013) and supporting healthy living (Carrus et al., 2015). Green spaces are also important for urban biodiversity (Bennett et al., 2015) as they provide habitats for various species (Niemelä, 2014). However, size, distribution and configuration of urban green spaces are always problematic in urban landscapes. In other words, their configuration is highly fragmented and they show absence of the necessary qualities and quantities and evenly distribution (Hepcan, 2013).

In the case of Izmir demo, urban green spaces are composed of private gardens, roadside vegetation, natural vegetation cover (shrubland, wetlands etc.), and vacant lands with little or no vegetation, agricultural areas and olive groves. The ultimate purpose is to calculate amount of urban green spaces per capita. It is obvious that just the amount of urban green spaces per capita does not make a lot of sense or give the big picture of green spaces in an urban landscape unless quality, connectivity and accessibility aspects are addressed in a sustainable way.

NBS TYPES

This KPI is related to NBS involving green covering shelter, Shade and cooling trees, new green cycle lane and re-naturing existing bike lane, urban carbon sink: planting trees.

METHOD

In the study area, green spaces/total surface per capita is calculated by dividing the sum of all green spaces in the urban development zones by the total urban population in ArcGIS10. It is measured in the project before NBSs are implemented and will be repeated again in a similar fashion after the implementations to make a comparison or evaluate the performance of NBSs in the monitoring period. Izmir Municipality currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS.

Although URBAN GreenUP requires a two-year monitoring period after the implementations of the NBS to collect a complete data set and achieve a maximum accuracy in the evaluation process, this KPI will be assessed once using recent data and information in the monitoring period.

MEASUREMENTS

It is measured at neighbourhood and city scales

UNIT OF MEASUREMENT

m^2/people

CALIBRATION / VERIFICATION

This KPI was measured for obtaining baseline values in the project before NBSs are implemented. For monitoring process, all calculations will be repeated to make a comparison with baseline values.

STUDY SITES

In İzmir, calculation for urban green spaces will be based on confluence of the urban development zones of two urban districts; Karşıyaka and Çiğli. The reasons why the Karşıyaka and Çiğli districts are chosen are that a) all the NBs are located in these two districts and b) the proposed new green bike and pedestrian lane goes through Karşıyaka and Çiğli by acting as a green connecter between them.

DATA PROCESSING

The land use-land cover map will be derived from WorldView2 updated satellite images using screen digitalizing in ArcGIS 10. Based on land use-land cover map, urban green spaces will be defined and classified in ArcGIS 10 as well. The population number will be obtained from the recent census data. Izmir Municipality currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS.

RESULTS, Report Format

Results can be displayed throughout maps and/or tables.

4.2.4 Distribution of public green spaces/total surface per capita

INTRODUCTION

Green spaces are useful ingredients for spatial planners in achieving a sustainable urban landscape. They can provide elements characterizing the heritage and aesthetics of the area (Madureira et al., 2011; Niemelä, 2014), as well as being valued for recreation (Fors et al., 2015), social interaction (Kaźmierczak, 2013), education (Krasny et al., 2013) and supporting healthy living (Carrus et al., 2015). Green spaces are also important for urban biodiversity (Bennett et al., 2015) as they provide habitats for various species (Niemelä, 2014). However, size, distribution and configuration of urban green spaces are always problematic in urban landscapes. In other words, their configuration is highly fragmented and they show absence of the necessary qualities and quantities and evenly distribution (Hepcan, 2013).

Urban green spaces include all the green spaces such as private gardens, roadside vegetation, natural vegetation cover, vacant lands with little or no vegetation and agricultural areas. On the other hand, public green spaces are limited with publicly owned green spaces that are accessible to all city dwellers. Public green spaces are dominated by urban parks (including the coastal promenade), play grounds, sport facilities, and cemeteries in the case of Izmir. They are actively used spaces all year around by the city dwellers and so, having a quantitative picture would be helpful in addressing different aspects of public green spaces, such as strengthening and/or providing connectivity, increasing quality and accessibility, and ecosystem services they provide.

NBS TYPES

This KPI is related to NBS involving grassed swales and water retentions ponds, green covering shelter, shade and cooling trees, new green cycle lane and re-naturing existing bike lane, Urban Carbon Sink: Planting Trees.

METHOD

In the study area, green spaces/total surface per capita is calculated by dividing the sum of all green spaces in the urban development zones by the total urban population in ArcGIS10. It is measured in the project before NBSs are implemented and will be repeated again in a similar fashion after the implementations to make a comparison or evaluate the performance of NBSs in the monitoring period. Izmir Municipality currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS.

Although URBAN GreenUP requires a two-year monitoring period after the implementations of the NBS to collect a complete data set and achieve a maximum accuracy in the evaluation process, this KPI (KPI 52) will be assessed once using recent data and information in the monitoring period.

MEASUREMENTS

It is measured at neighbourhood and city scales.

UNIT OF MEASUREMENT

m^2/people

CALIBRATION / VERIFICATION

This KPI was measured for obtaining baseline values in the project before NBSs are implemented. In the monitoring period, all calculations will be repeated to make a comparison with baseline values.

STUDY SITES

In İzmir, in the monitoring period, calculation for public green spaces will be based on confluence of the urban development zones of two urban districts; Karşıyaka and Çiğli.

DATA PROCESSING

The land use-land cover map will be derived from WorldView2 updated satellite images using screen digitalizing in ArcGIS 10. Based on land use-land cover map, public green spaces will be defined and classified in ArcGIS 10 as well. The population number will be obtained from the recent census data. Izmir Municipality currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS.

RESULTS, Report Format

Results can be displayed throughout maps and/or tables.

5 CHALLENGE 5: AIR QUALITY MONITORING PROCEDURES

5.1 Biophysical KPIs

5.1.1 Annual mean levels of fine particulate matter (e.g. PM10) in cities

RATIONALE/INTRODUCTION

Particle pollution, also called particulate matter or PM, is a mixture of solids and liquid droplets floating in the air. Some particles are released directly from a specific source, while others form in complicated chemical reactions in the atmosphere. Particles would be in a wide range of sizes such as ≤ 10 micrometers in diameter are so small that they can get into the lungs, potentially causing serious health problems.

Coarse dust particles (PM_{10}) are 2.5 to 10 micrometers in diameter. Sources include crushing or grinding operations and dust stirred up by vehicles on roads. **Fine particles ($PM_{2.5}$)** are 2.5 micrometers in diameter or smaller, and can only be seen with an electron microscope. Fine particles are produced from all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

People with heart or lung diseases, older adults and children are most likely to be affected by particle pollution exposure. Numerous scientific studies connect particle pollution exposure to a variety of health issues, including irritation of the eyes, nose and throat, coughing, chest tightness and shortness of breath, reduced lung function, irregular heartbeat, asthma attacks, heart attacks and premature death in people with heart or lung disease. (AirNow, 2018; EPA, 2018).

According to Yatkin and Bayram (2008), the dominant contributor to PM was traffic with >70% at urban and sub-urban sampling locations in Izmir. Demo Sites in Izmir are located in highly urbanised areas with dense population and traffic (Karşıyaka) and close to Çiğli Industrial Zone and traffic (Sasalı&Karşıyaka).

NBS TYPES

Green shady structures, green covering shelter, parklets, urban garden biofilter, shade and cooling trees, grassed swales, new green corridor, green fences

METHOD

BACI (Before, After, Control, Impact)

Measure air concentrations of $PM_{2.5}$ and PM_{10} at sampling points at a range of radii from NBS locations both pre- and post-intervention. Compare these data to measurements taken at equivalent locations on equivalent stretches of road without NBSs at a similar time of day on the same dates.

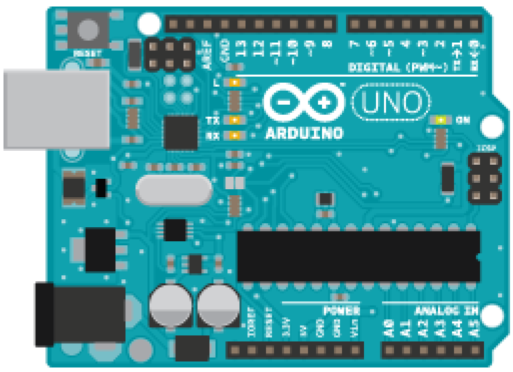
NULL HYPOTHESIS

There is no difference in concentrations of $PM_{2.5}$ or PM_{10} between samples in stretches of road where street trees/green walls are present, and samples taken in stretches of road without street trees/green walls.

SENSOR / SOFTWARE

Monitoring equipment: A portable photometric sampler designed to measure ambient $PM_{2.5}$ and PM_{10} concentrations. This KPI requires a portable monitor because of the quite big measurement points. The cost of installing a monitor in each location to a continuous monitoring is too high.

Monitoring Equipment



Low cost Arduino based sensors which will be used at KPI 7 for the same study sites, will measure $PM_{2.5}$, $PM_{10ç}$.

Data stored on the device can be downloaded later to a PC using the USB cable and software provided with the monitor.

Figure 5-1 Ardunio based low cost $PM_{2.5}$, PM_{10} sensors

Portable sensors as shown in Figure 5-2, such as Aeroqual Series 500 Portable PM monitors, or portable Fluke 985 type sensors may be used for verification and validation of measured data.

Aeroqual Series 500 Portable PM Monitor. A laser and optical sensor are fitted to the sensor head of the monitor to measure light scattered from particles passing through a laser beam. The scattered light is transformed to electrical signals to provide mass measurements of PM2.5 and PM10

(https://www.aeroqual.com/product/portable-particulate-monitor).

http://www.fluke.com/fluke/phen/hvac/iaq-tools/air-testers/fluke-985.htm?PID=74257

.

Figure 5-2 Portable PM2.5 and PM10 Sensors may be used for Verification

MEASUREMENTS

Concentrations of $PM_{2.5}$ and PM_{10} will be measured. These measurements (at selected locations) will be measured and recorded hourly (at least) of the five days on which temperatures are forecast to be highest during that month.

If there is safety or working environment restrictions exist for study sites, then these measurements will be taken once every four weeks over the summer months (May- September) at multiple pre-determined (fixed) points at each NBS study site selected for this type of monitoring and at paired control study sites. Temperature measurements at each study site will be taken between 12.00 and 17.00 hours and few night hour measurements on one of the five days on which temperatures are forecast to be highest during that month.

UNIT OF MEASUREMENT

Micrograms (µg) per cubic metre, µg/m^3. (Microgram (µg) One-millionth of a gram; a milligram (mg) = 1000 micrograms).

STUDY SITES

The impact of NBSs applied to Vilayetler Evi and Sasalı Natural Life Park parking lots, as shown in Figure 2-4 and Figure 2-13 and the stretches of NBS locations (roads with traffic, areas without NBS etc.) will be the study sites.

DATA SAMPLING

Both intervention and matched control study sites should be sampled on the same occasion during each round of samples (i.e. an intervention site and matched control should be sampled on the same date and at as close a same time of day as possible). Each fixed sampling location at a study site should be sampled every week for a year pre-intervention (September 2018 to August 2019), and for two years following intervention (spring 2020 to spring 2022). At each sampling point, two readings should be taken: at heights estimated to represent ***a)*** child and ***b)*** adult head heights.

DATA PROCESSING

Calculation of annual and seasonal mean levels of $PM_{2.5}$ and PM_{10} at each sampling location as the average value of the all the measurements done before and after of the interventions. Comparison of annual and seasonal mean values for NBS intervention and control sample locations at each study site.

SPATIAL ANALYSIS SOFTWARE

QGIS is the GIS software proposed to be used, due to it is an open source and multiplatform software and it is distributed under Creative Commons Attribution-Share Alike 3.0 licence (CC BY-SA). We recommend using the last long-term release repository, most stable (QGIS 2.18 is currently the last one and QGIS 3). Data processing involved in this KPI can be done with the standard version and the standard toolbox.

RESULTS

The calculated values will be compared qualitatively and quantitatively for the periods before and after the interventions in the NBS and reference sections. Quantitative assessment will be done by using the following expression:

$$\boldsymbol{PM\ impact} = \left(\frac{NBS\ Measures\ average\ after\ intervent. - NBS\ Expected\ average\ after\ intervent.}{NBS\ Expected\ average\ after\ intervent.}\right) \times 100$$

Where *measures average after intervention.* is the average value of measurements after interventions and *Expected value after intervention* (but supposing that interventions had not been done) is:

$$\boldsymbol{NBS\ Expected\ average\ after\ intervent.} = \left(\frac{Ref.\ average\ after\ intervent.}{Ref.\ average\ before\ intervent.}\right) \times NBS\ Measures\ before\ intervent.$$

PM impact can be calculated both for $PM_{2.5}$ and PM_{10}. Positive or null PM impact values indicates negative or no impact of the NBS on PM concentration for that implementation. Negative values indicate a positive impact of that NBS on PM concentration.

5.1.2 Air quality parameters and trends in emissions NOx, SOx, PM10 etc.

RATIONALE/INTRODUCTION

Air quality is a major concern worldwide, particularly in urban areas, due to its direct consequences on human health. In order to mitigate these air pollutant problems, the use of urban vegetation is often promoted as an effective measure to reduce concentrations. This measure is based on the underlying argument that trees (and vegetation in general) have the capability of cleaning the air by filtering out the pollutants. Vegetation leaves absorb gaseous pollutants through their stomata, while particles are removed from the air by deposition onto the leaves and the branches (Vos et al., 2013).

People with heart or lung disease (including heart failure and coronary artery disease, or asthma and chronic obstructive pulmonary disease), older adults (who may have undiagnosed heart or lung disease), and children are most at risk (EPA, 2010). Local air quality affects how residents live and breathe. Like the weather, it can change from day to day or even hour to hour. Therefore, it is very crucial to monitor local air quality regularly. The most dangerous air pollutants are carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxides (NO_2), ozone (O_3) and particulate matter (PM2.5 and PM10) (Hepcan et al., 2013).

In European countries, various policy instruments have been implemented to improve air quality in urban areas. The Directive 2010/75/EU was released for industrial emissions, the Euro Standards for road vehicle emissions and the Directive 94/63/EC for volatile organic compounds emissions from oil storage and distribution (Baro et al., 2014). As for many other large European cities, air quality improvement is one of the major environmental policy challenges for Izmir.

İzmir is a fast growing city under the threat of air pollution, heat island effect, heavy traffic and loss of natural areas. Demo Sites in Izmir are either located in highly urbanised areas with dense population and traffic (Karşıyaka) or close to Çiğli Industrial Zone (Sasalı&Karşıyaka). The total greenhouse gas (CO_2 + CH_4 + NO_2) emissions of the industry accounts for 44% while buildings are responsible for 12%. Therefore, the Sites are under the effect of both industrial and building effluents. On the other hand, domestic heating is the most polluting sector contributing about 56% of total PM emissions while traffic has the highest share in NO_X emissions. Especially, emissions from industries located outside the metropolitan city area are much higher in amount. Industries located around the Izmir metropolitan centre contribute to the industrial SO_2 emissions by 93%, PM emissions by 59% and NO_X emissions by 80% of the total (Elbir and Muezzinoglu, 2004). The volatile organic compound (VOC) concentrations around the petrochemical complex and oil refinery close to the Demo Sites, were observed as 4-20 times higher than those measured at a suburban site in İzmir (Muezzinoglu et al., 2004). The CO_2 emission per capita in Izmir is 5.31 tonnes/year. However, pollutants level never exceeded the EU levels (IMM, 2017).

NBS TYPES

Green shady structures, green covering shelter, parklets, urban garden biofilter, shade and cooling trees, grassed swales, new green corridor, green fences

METHOD

PM_{10}, SO_x and NO_x will be measured by stationary Air Quality Measurement Stations located in Çiğli, Bayrakli and Karsiyaka (MEU, 2018), and a mobile station belongs to Izmir Metropolitan Municipality (IMM, 2017) pre-and post-interventions. PM_{10} data will also be measured at different locations at Demo Sites for KPI 83. We are hoping to detect the improvement in air quality in urban level because of the size of the interventions.

MEASUREMENTS

Concentrations of NO_x, SO_x and PM_{10} values will be measured hourly.

UNIT OF MEASUREMENT

PM - Micrograms (µg) per cubic metre, µg/m^3. (Microgram (µg) One-millionth of a gram; a milligram (mg) = 1000 micrograms).

NO_x – Micrograms (µg) per cubic metre, µg/m^3. (Microgram (µg) One-millionth of a gram; a milligram (mg) = 1000 micrograms).

SO_x – Micrograms (µg) per cubic metre, µg/m^3. (Microgram (µg) One-millionth of a gram; a milligram (mg) = 1000 micrograms).

STUDY SITES

Data collection points are the stationary Air Quality Measurement Stations in Çiğli, Bayrakli and Karsiyaka. PM_{10} data will also be collected from KPI 83 measurements. Furthermore, a mobile station will be used where necessary. GIS model will extend the study sites to the whole city.

DATA SAMPLING

Continuous monitoring at stationary and mobile stations hourly. Data sampling example is shown in Figure 5-3

Figure 5-3 Data sampling example

DATA PROCESSING

Calculation of daily, monthly and annual mean levels of NO_2, SO_2 and PM_{10} at each station location.

The stationary stations are located on the roads where the contribution of traffic on air quality is high. Urban background will be measured by the mobile station.

Using a GIS software, a model of the city can be built that classifies all locations/streets/areas of the city in those categories.

SPATIAL ANALYSIS SOFTWARE

QGIS is the GIS software proposed to be used, due to it is an open source and multiplatform software and it is distributed under Creative Commons Attribution-Share Alike 3.0 licence (CC BY-SA). We recommend using the last long-term release repository, most stable (QGIS 2.18 is currently the last one). Data processing involved in this KPI can be done with the standard version and the standard toolbox.

RESULTS

Results can be displayed throughout maps and/or tables. KPI cards will be displayed in ICT tool.

5.1.3 Pollutant's removed by vegetation (in leaves, stems and roots)

INTRODUCTION

Air pollution is one of the main problems of urban areas. Karşıyaka is not an exception. It has been experiencing air pollution especially in winter months owing to fossil fuels. The air pollutants measured in Karşıyaka are CO, SO_2, PM10, NO_2, NOx and NO. Air pollutant removal capacity of trees is estimated based on dry deposition that is considered as the rate of air pollutants removed from the atmosphere (Lovett, 1994; McPherson et al., 1998; Scott et al., 1998). Pollutants are removed on leaf surfaces primarily in two ways: through leaf stomata uptake of gaseous pollutants and leaf interception of particulate matter (Nowak et al., 2006). The first one leads to the diffusion of pollutant into the inner part of leaves. Gases may also be absorbed or react with plant surfaces; while removal through the letter process may be reduced by the suspension of intercepted particles from the leaf surfaces through wind action (Selmi et al., 2016). As this research focused on the ES of trees, air pollutant deposition on other vegetation cover (such as shrubs, grass) and land cover types (like water bodies, and buildings) are not included in the calculation.

NBS TYPES

This KPI is related to NBS involving green parklets, urban carbon sink: planting new trees, green fences/green walls, shade and cooling trees.

METHOD

The trees capacity to removal air pollutant is calculated based on the formulas below (Baldocchi and Camara, 1987):

The *pollutant flux* (Fi) is calculated as the product of the *deposition velocity* (Vd) and the *concentration of air pollutant i* (Ci), Eq.(1):

$$F_i = Vd\ (cm/sn) \times C(g/m^3) \quad (1)$$

Total flux into urban trees of air pollutant i (Fit) can be estimated through multiplying Fi by tree cover (A) in a time period (T), Eq.(2):

$$F_{it} = F_i \times A \times T \quad (2)$$

The *amount of air pollutants removed by trees* (F) could be quantified by Eq.(3);

$$F = \sum_{i=1}^{3} F_{it} \quad (3)$$

Although URBAN GreenUP requires a two-year monitoring period after the implementations of the NBS to collect a complete data set and achieve a maximum accuracy in the evaluation process, calculations for this KPI (pollutant's removed by vegetation) will be done only once using the formulas and equations above following the implementations period.

MEASUREMENTS
It is measured at the level of the related Demo Sites.

UNIT OF MEASUREMENT

kg ha -1 year -1

CALIBRATION / VERIFICATION
It was calculated in Demo Sites before the interventions and will be executed again after NBSs are implemented in order to make a before and after comparison.

STUDY SITES

In İzmir, study sites will be focused in and around the areas of the NBS interventions such as new green corridor, green parklets in Girne Avenue and green fences along Peynircioğlu River where new trees are planted.

DATA PROCESSING

The land use-land cover map will be derived from WorldView2 satellite image using screen digitalizing in ArcGIS 10. The percentage of tree cover is calculated for each Demo Site separately in ArcGIS 10. Izmir Municipality currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS.

RESULTS, Report Format

Results can be displayed throughout maps and/or tables.

6 CHALLENGE 6: URBAN REGENERATION MONITORING PROCEDURES

6.1 Socio-Economic KPIs

6.1.1 Accessibility: Connectivity, distribution, configuration, and diversity of green space and land use changes (multi-scale). - Green spaces quantity

INTRODUCTION

There is already a physical connection between Sasali region and Karşıyaka that is defined by a roadway and bike lane. The bike lane that extends all way from Karşıyaka to Sasalı Natural Life Park has intensively been used especially on weekends. The proposed green corridor, which starts from wild life park in Sasali region and merges into Peynircioğlu Stream and coastal promenade in Karşıyaka, offers a more comfortable, greener and sustainable cycle lane and connection. The coastal promenades and linear parks that encompass the Izmir bay all the all way from north to south would be linked to Sasalı Natural Life Park and South Gediz Delta through proposed cycling friendly greener corridor.

In the case of Izmir demo, this KPI is separated into 3 parts and assessed accordingly; connectivity, distribution-configuration and diversity of existing urban green spaces in two districts, Karşıyaka-Mavişehir and Sasali. This KPI is considered as a mean to assess existing picture of urban green spaces in some aspects in Izmir for two reasons: a) disconnectivity among urban green spaces and b) lack of sufficient green spaces are identified as major challenges based on previous studies and literature (please see Hepcan, 2013; Hepcan et al., 2013).

NBS TYPES

This KPI is related to NBS involving new green cycle lane and re-naturing existing bike lane.

METHOD

In the case of Izmir, the distribution, configuration and connectivity of green spaces were quantified on the basis of land use/cover maps using Area and Edge Metrics (CA-class area, PLAND-percentage of landscape, GYRATE_AM-area weighted mean radius of gyration, AREA_MN-patch area distribution), Aggregation metrics (NP-number of patches, CONNECT-Connectance index). The land use/cover map was derived from WorldView2 satellite images dated 2014. Landscape metrics are calculated at the class level by using FRAGSTATS 3.4 with a cell size of 1 m (McGarigal and Marks 2003).

In the monitoring period, a GIS based analysis will be made again at the city level using recent data and information to identify recent land use-land cover, and above-mentioned landscape metrics will be computed. Although URBAN GreenUP requires a two-year monitoring period after the implementations of the NBS to collect a complete data set and achieve a maximum accuracy in the evaluation process, the measurement for this KPI is going to be executed only once because this is not an analysis or assessment that needs to be repeated.

MEASUREMENTS

It is measured at the city level.

UNIT OF MEASUREMENT

% and numbers

CALIBRATION / VERIFICATION

For monitoring purposes, same assessments as in baseline calculations will be carried out only once using the above-mentioned metrics to evaluate the before and after performances of the NBSs.

STUDY SITES

In İzmir, study sites are Çiğli-Karşıyaka urban development zones.

DATA PROCESSING

The land use-land cover map will be derived from WorldView2 updated satellite images using screen digitalizing in ArcGIS 10. Based on land use-land cover map, urban green spaces will be defined and classified in ArcGIS 10 as well. Izmir Metropolitan Municipality (IMM) currently uses ARCGIS. On the other hand, the maps and models can easily be converted to an open platform such as QGIS.

RESULTS, Report Format

Results can be displayed throughout maps and/or tables.

7 CHALLENGE 7: PARTICIPATORY PLANNING AND GOVERNANCE

7.1 Socio-Economic KPIs

7.1.1 Perceptions of citizens on urban nature - Green spaces quality

KPI-117: PERCEPTIONS OF CITIZENS ON URBAN NATURE - GREEN SPACES QUALITY

INTRODUCTION

Public and stakeholder perceptions of urban nature, and specifically the quality or functionality of nature, are critical to our understanding of the “value” people place on local environments (Priego et al., 2008). This KPI will reflect on how people assess change in their local environments in terms of quality of green space at a site, neighbourhood and city scale.

NBS TYPES

Vertical and horizontal green infrastructure; tree related actions; promotion of NBS at people oriented activities, events, platforms and programs: Engagement Portal for citizen; Promotion of ecological reasoning and intelligence.

METHOD

Social surveys can be conducted periodically. The perceived quality of green spaces will be assessed via a combination of qualitative questions reflecting on the composition, function and utility of green space and quantitative questions using a scaled responses and pre-determined asset/value lists to assess the perceived greenness and quality. Both will assess the socio-cultural values of green spaces, its perceived ecological value, and any economic benefits the respondents personally or communally derive from interactions with NBS.

MEASUREMENTS

Measurements for social survey will be done in person or via online platforms. Perception about the quality of green spaces will be calculated with standard spreadsheet software (Excel or SPSS).

UNIT OF MEASUREMENT

(nº users) (% of satisfaction)

CALIBRATION / VERIFICATION

Perceptions surveys can also be conducted via online opinion polls or via the smartphone applications provided by Izmir Metropolitan Municipality. Reported perception of NBSs in and around sub-Demo Sites in terms of social, economic and ecological landscape can also be recorded.

STUDY SITES

Perceived quality of green spaces will be measured in and around sub-Demo Sites where different NBSs are implemented.

DATA PROCESSING

Survey data can be processed by using spreadsheet software by Excel or SPSS and spatial analysis software like ARCGIS or QGIS.

RESULTS

Results can be displayed throughout maps and/or tables.

7.1.2 Urban Farming Educative/ participate activities, Learning for producers

Especially farmers living in the urban and peri-urban will be informed about climate change and its increasing affects, periodically. First of all, leading farmers living in the urban periphery (Çiğli and Menemen districts), agricultural cooperatives and students will be determined and training seminars will be organized. Secondly, the visitors of the Sasalı Natural Life Park where the Demo Site area is also located will also benefit from these seminars. Visitors to the natural life park (around 1.500.000) area will be able to visit climate sensitive greenhouse and its garden. All visitors will be counted for measuring.

After each training seminar, the participants will complete detailed questionnaires and the success of the training will be measured.

The results of the specially prepared questionnaires will be analyzed using statistical methods. Likewise, after analysing the questionnaires, the results will be shared by using ICT platforms.

8 CHALLENGE 8: SOCIAL JUSTICE AND SOCIAL COHESION

8.1 Socio-Economic KPIs

8.1.1 Green intelligence awareness

KPI-127: GREEN INTELLIGENCE AWARENESS

INTRODUCTION

Changes in behaviour and human attitudes are fundamental to achieve a more sustainable world, so that, it is very interesting to analyse the potential of an activity or intervention to increase the green intelligence awareness of a population.

There is enormous opportunity for nature based solutions to promote understanding of sustainability in ways that positively influence citizen behaviour. There are numerous available resources to learn and understand the fragility of our environment and the responsibility of humans to protect, preserve and respect the world. Therefore, this KPI aims to reflect how the intervention is used for educational purposes and enhancement of public awareness.

NBS TYPES

Non-technical interventions: Educational activities: Educational paths like bio-boulevard; Urban farming educational activities.

METHOD

Creating green awareness through different initiatives is crucial to the success of sustainable development. Activities supporting green intelligence awareness will be quantified per year in form of activities (i.e. number of guided tours, number of educational meetings: courses, conferences, lectures, workshops, seminars, and symposia, civic participation through citizen science activities such as bio-blitz raising public awareness about environmental protection) and publications (i.e. articles, texts, photographs or videos published in magazines, newspapers, books with technical and educational content), online social media campaigns and technical and distribution of brochures, framing educational content related to NBSs.

MEASUREMENTS

Measurements will be conducted periodic recording of quantity of education and promotion activities raising green intelligence.

UNIT OF MEASUREMENT

(nº educ. actions) (inhab attended)

CALIBRATION / VERIFICATION

Izmir Metropolitan Municipality has regularly made user satisfaction surveys about city-wide topics. Green raising awareness can further be added to this format to reach general opinion of citizens regardless of places including sub-Demo Sites.

STUDY SITES

This KPI can be measured for the whole İzmir, giving a single resulting value for each study campaign.

DATA PROCESSING

Degree of awareness level can be processed by using spreadsheet software by Excel or SPSS. To do this, sum of the educational activities per year, and sum of the publications with educational content per year should be taken separately, because the concept and magnitude of each result are different.

RESULTS

The result can be expressed as number of activities per year and number of publications per year. For example, 12a/6p means 12 activities and 6 publications per year related to a NBS in particular. Results can also be displayed throughout infographics and shared as a part of environmental campaigns.

9 CHALLENGE 9: PUBLIC HEALTH AND WELL-BEING MONITORING PROCEDURES

9.1 Socio-Economic KPIs

9.1.1 Increase in walking and cycling in and around areas of interventions

9.1.1. Increase in walking and cycling in and around areas of interventions

KPI-139: INCREASE IN WALKING AND CYCLING IN AND AROUND AREAS OF INTERVENTIONS

INTRODUCTION

This is a social indicator, which links to human health and well-being, as walking and cycling in nature has been shown to improve both physical health and psychological well-being. This KPI measures how NBS interventions can increase engagement of citizens specifically related to walking and cycling inside the interventions and in close proximity. NBS, and specifically green infrastructure, interventions, is thought to increase street attractiveness, which leads to increased engagement with active transport (Adkins, 2012; Tzoulas et al. 2007). Public health policies aimed at promoting healthy lifestyles in urban settings could produce cardiovascular benefits (Tamosiunas et al, 2014).

NBS TYPES

This KPI is related to NBS interventions, such as green corridor, new green cycle lane, horizontal green interventions etc.

METHOD

This KPI can be measured throughout pedestrian and bicycle counter units (Figure 4.3.x3). Surveys may be done as well, in order to know the qualitative impacts of cycling and walking activities in selected areas. These surveys can involve local residents, users and businesses of their perceived and actual use of NBS for walking, cycling and other activities pre- and post-investment.

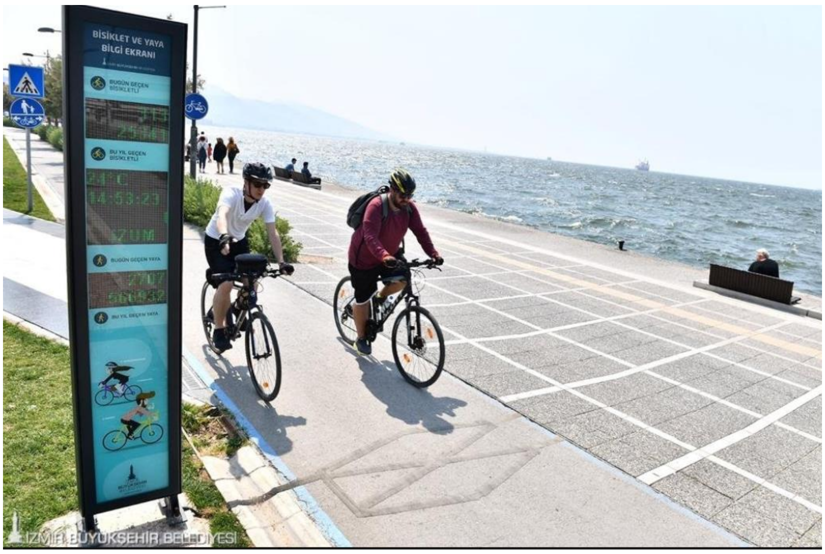


Figure 9-1 A view from Izmir's pedestrian and bicycle counter units

MEASUREMENTS

Frequency counts from both qualitative data and pedestrian and bicycle counter units

UNIT OF MEASUREMENT

Number of users and trips (estimated based on pedestrian and bicycle counter units)

CALIBRATION / VERIFICATION

Measurement data stored via bicycle counter units. Qualitative attributes of this data will be validated via site observation, surveys and related academic studies (i.e. Cubukcu et al., 2015). It can also be compared with bicycle survey data conducted within the frame of recently completed İzmir Transportation Master Plan 2030.

STUDY SITES

In İzmir, study sites will be in and around the areas of the NBS interventions designed to enhance walking and cycling. This area covers 'new green corridor' connecting sub-demo areas (B to C).

For qualitative features of walking and cycling experience random intervention locations will be selected in new green. An alternative location around intervention sites will also be selected as control study site where NBS interventions are not proposed.

DATA PROCESSING

KPI data are acquired by basic statistics in standard software by Excel or SPSS and GIS processing. Data collected via pedestrian and bicycle counter units has been sent to İzmir Transportation Centre called 'İZUM'. For location sensitive data processing İzmir Metropolitan Municipality currently uses ARCGIS that can be converted to open software platforms like **QGIS** in order to enhance its usability.

Data derived from pedestrian and bicycle counter units can be combined with İzmir public bike rental system called BISIM.

RESULTS

Results can be displayed throughout maps and/or tables. Additionally, pedestrian zones can be displayed by using İzmir city dashboard operated by IZUM (Figure 9.2).

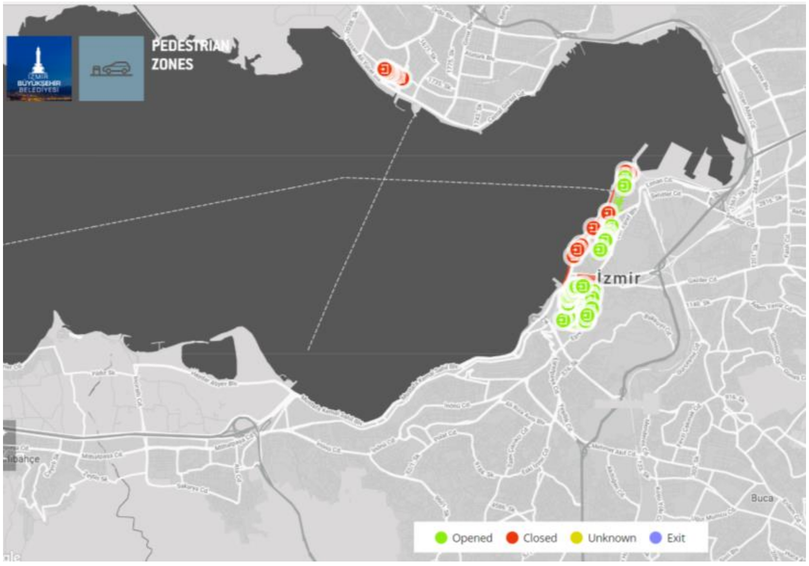


Figure 9-2 A View from pedestrian zones in IZUM's city dashboard

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

10.1 Socio-Economic KPIs

10.1.1 Number of jobs created

KPI-141: NUMBER OF JOBS CREATED

INTRODUCTION

This KPI, related to economic aspects measurements, evaluates how NBS interventions can increase the attraction of businesses, or how to increase the value of the existing ones. This value, evaluated through the measurements of number of jobs created and the percentage of the gross value added, will reflect the economic opportunities and potential of NBS solutions.

NBS TYPES

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, related non-technical actions.

METHOD

The KPI can be calculated by using a methodology defined by URBAN GreenUP Project: BACI (Before, After, Control, Impact)

Essentially a 'before-after' indicator which captures the part of the employment increase that is (a) direct consequence of NBS implementation (workers employed to implement the NBS project should not be directly counted). The positions need to be filled (vacant posts are not counted) and increase the total number of jobs in the enterprise. If total employment in the enterprise does not increase, the value is zero – it is regarded as realignment, not increase. Safeguarded etc. jobs are not included.

Gross: Not counting the origin of the jobholder as long as it directly contributes to the increase of total jobs in the organisation. The indicator should be used if the employment increase can plausibly be attributed to the support.

Full-time equivalent: Jobs can be full time, part time or seasonal. Seasonal and part time jobs are to be converted to FTE using ILO/statistical/other standards.

Durability: Jobs are expected to be permanent, i.e. last for a reasonably long period depending on industrial-technological characteristics; seasonal jobs should be recurring. Figures of enterprises that went bankrupt are registered as a zero employment increase.

Timing: Data is collected before the project starts and after it finishes; the NBS holders are free to specify the exact timing (depending on the NBS time needed to get the profit). Using average employment, based on 6 months or a year, is preferred to employment figures on certain dates.

MEASUREMENTS

Measurement can be done by using measurement instruments such as city official data, city platforms, questionnaires, small-medium enterprise accounts… (Related to NBS investment zone)

UNIT OF MEASUREMENT

(nº jobs) (€/m^2)

(nº jobs or nº users) (kg/year) (€/year)

CALIBRATION / VERIFICATION

The following factors should be considered in correct calibration:

- 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
- Indicators for assessing specific types of NBS 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 applicability of indicators can vary across geographic scales, highlighting of considering regional, metropolitan, urban, street/neighbourhood and building impacts separately
- There is a need for assessing the impacts of NBS over the short, medium and long-term, and thus mechanisms are needed for monitoring NBS effectiveness beyond the end of the project
- Synergies and trade-offs can be associated with NBS impacts, including across elements of the ecosystem and socio-cultural system. NBS impacts are, therefore, likely to be multi-directional and complex
- Investment in NBS can maximize the benefits for provision of environmental, socio-cultural and economic services if multiple challenge areas are considered concurrently and the different stakeholder are involved in the planning and implementation process.

STUDY SITES

This KPI can be measured for the whole İzmir.

DATA PROCESSING

Monitoring systems need to be improved with systematic quality checks in order to ensure that data collected are reliable and there needs to be effective coordination between regional/ area authorities, and measurement team generally, to ensure that the data reported are consistent and comparable. The guidelines, spelling out the frequency of checks, the concept used, the methods for carrying them out, and so on, should be provided for each NBS by specific region.

RESULTS

Results can be calculated and displayed in two categories:

- Number of jobs created (Direct employment): It can be displayed as direct value on employment by zone, before and after implementation, during the established period. Number of jobs created= n * Z [(nº jobs) (€/m^2)] Where n is referring to the *direct full-time employment during the time defined* (directly related to the each particular NBS);

Z- *affected zone/area in reference to the NBS* (should depend on NBS the definition of the area)

- *Gross value added* (GVA): It can be displayed as the difference between the value of goods and services produced and the cost of raw materials and other non-labour inputs, which are used up in production. The research should conclude what is the total contribution of NBS in % of the total GVA to the region/area economy in Euro/ by year.

11 Monitoring Partners and Responsibilities, Monitoring Periods, Monitoring Format.

11.1 Monitoring responsibilities (partners/third parties …)

BitNet will lead Izmir monitoring program and closely work with monitoring partners, Ege University Landscape and Soil Team, Izmir Institute of Technology(IZT), Demir and third parties such as Anadolu University, to ensure proper data capture and KPIs calculation from external sources or from the URBAN GreenUP monitoring systems such as sensors, drones, satellite image or others. Relationship between KPIs, monitoring programs and responsible partners are shown as below. Izmir Metropolitan Municipality (IMM) shall provide study areas and ensure access, safety and proper working environment for monitoring the study areas.

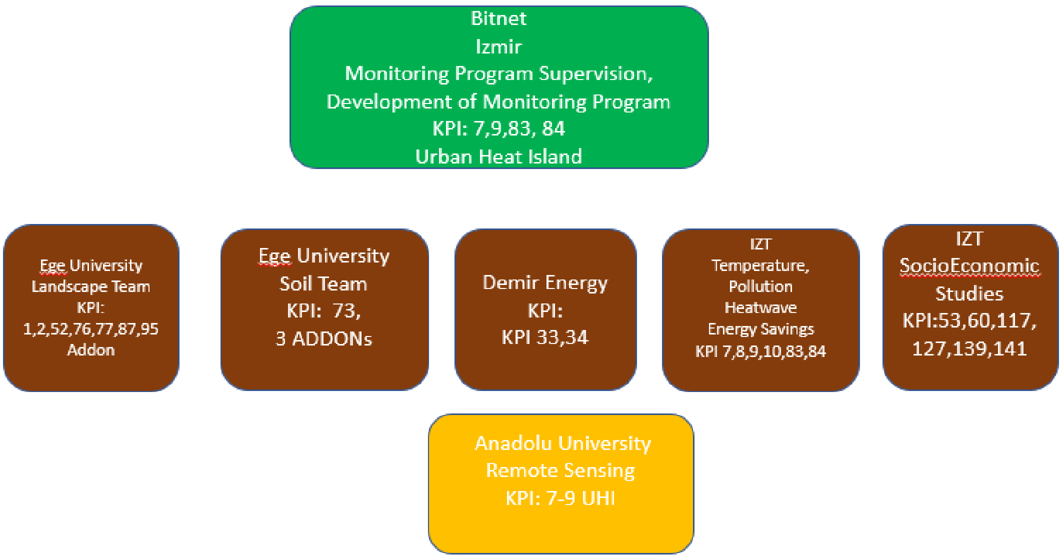


Figure 11-1 Relationship between IZMIR monitoring programs and responsible partners

As third party, Anadolu University Earth and Space Sciences will be involved to provide academic support to Izmir Team, IZT and BIT for Temperature reduction (environmental, physical) indicator measuring land surface temperatures (LST) for Decrease in mean or peak daytime local temperatures (°C), KPI-7 and Heatwave risks (nº of combined tropical nights (>18 °C) and hot days (>20 °C)

Institute of Anadolu University Earth and Space Sciences

The main aim of Anadolu University and Earth and Space Sciences institute is to obtain and analyze the necessary data/information required for the determination of nature friendly and disaster free settlement areas. Remote Sensing and Geographical Information System researches and works, which first started in 1989 under the Computer Research and Application

Center of Anadolu University, have been officially continued and conducted within Satellite and Space Sciences Research Institute, since its foundation in 1993. Team working on this project is provided below.

Uğur Avdan

Ugur Avdan received his MSc and PhD degrees in remote sensing and GIS from the Yildiz Technical University, Istanbul, Turkey, in 2004 and 2011, respectively. Currently, he is an assistant professor doctor at Anadolu University of Research Institute of Earth and Space Sciences, Eskisehir, Turkey. His current research interests include remote sensing, GIS, UAV application, and thermal mapping.

https://www.researchgate.net/profile/Ugur_Avdan

Gordana Kaplan

Gordana Kaplan received her MSc degree in geodesy from St. Kiril and Metodij University, Skopje, Macedonia, in 2014. In February 2015, she started her PhD studies at Anadolu University, Eskisehir, Turkey, as a winner of the Turkiye Burslari Scholarship. Currently, she is working as a researcher at the Earth and Space Scientific Institute at Anadolu University. Her current research interests include observing water and wetland areas using image fusion techniques and remote sensing data, as well as Land Surface Temperature and Urban Heat Island analyses.

https://www.researchgate.net/profile/Gordana_Jovanovska_Kaplan

Serhan Tuncer

Serhan Tuncer is an Art History graduate from Hacettepe University. He completed his first master's degree at the faculty of architecture at Anadolu University and is currently completing his second master's degree in the fields of Remote Sensing and GIS. He commenced his doctorate studies in Art History at Hacettepe University in 2016. His main areas of research are advanced technology documentation methods, remote sensing and GIS.

https://www.linkedin.com/in/serhantuncer/

Resul Çömert

Resul Çömert received his MSc degree and PhD degree in remote sensing and geographic information systems from Anadolu University, Eskisehir, Turkey, in 2014 and 2018. Currently, he is working at the department of Geomatic Engineering at Gumushane University. His current research interests include object based image analysis, machine learning algorithms, landslides mapping, forest fires, unmanned aerial vehicles systems, monitoring erosional process and 3D cultural heritage documentation.

https://www.researchgate.net/profile/Resul_Comert

11.2 Monitoring 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.

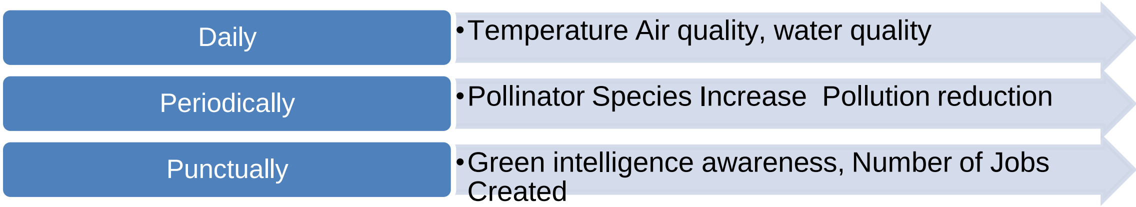


Figure 11-2 Data collection periodicity

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 local monitoring platform quarterly. It is noted that some indicators will not show quarterly variations.
- **Annual reporting**: Grouped global KPI calculation will be submitted to ICT platform annually.

In various sections specific to KPIs, measurement periods are provided. As an example, It is our intention to perform measurements of Air temperature, relative humidity, wind velocity and direction (at selected locations) will be measured and recorded hourly (at least) of the five days on which temperatures are forecast to be highest during that month. If there is safety or working environment restrictions (please see risks and mitigation section) exist for study sites, then these measurements will be taken once every four weeks over the summer months (May- September) at multiple pre-determined (fixed) points at each NBS study site selected for this type of monitoring and at paired control study sites. Temperature measurements at each study site will be taken between 12.00 and 17.00 hours and few nights hour measurements on one of the five days on which temperatures are forecast to be highest during that month.

12 Data Management: Data Quality, Privacy, Security Trust Relations with Users and Devices, Data Storage and Backup.

12.1 Quality Assurance of Data

Quality assurance of data is integral to ensure the overall quality and reliability of the monitoring of KPIs in URBAN GreenUP. Specific measures taken during data collection, data entry, and data checking will be employed. Fundamental to quality assurance of data is the need to develop, ahead of data collection, a protocol for data collection, entry, handling and checking procedures. In order to ensure data quality, various tests detailed in 5.3 deliverable of URBAN GreenUP will be deployed. One important test is the indicator 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.

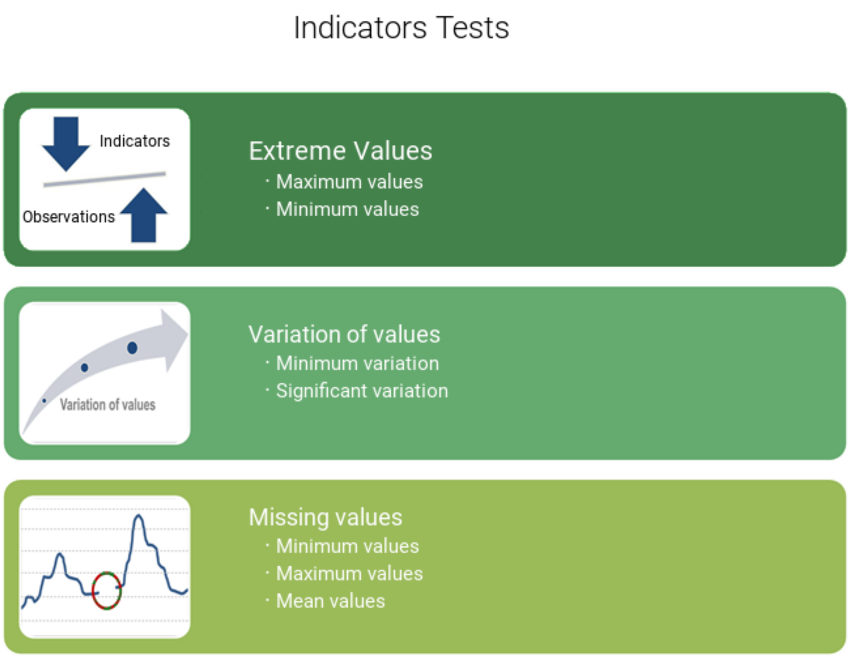


Figure 12-1 Indicators tests

Another test is 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 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 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.

Finally, other tests such as variation of values, Minimum and Significant Values, Resilience to missing values, minimum and mean values, data sources validation, reference data sets will be used to evaluate the measurements.

12.2 Data management and data privacy and Security

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.

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 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 in the project website[2].

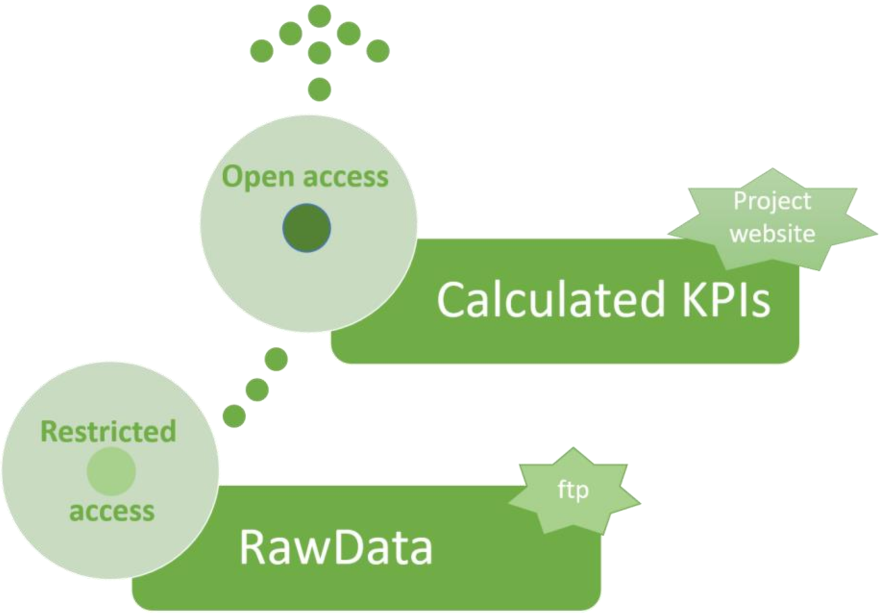


Figure 12-2 Data Relation

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 withdraw.
- 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.

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

Although not sensitive data, personal data will need to be processed as a part of this research, especially for Survey data before the transcripts are edited to remove identifiers. Access to transcripts and audio files will be password protected and limited to the four researchers directly employed on the project. Clear version numbers and dates will be recorded as part of the file name while the project is active, and the final versions will be archived. When working in the field, the data will immediately (if possible) be transferred to back end server.

12.3 Backup and Security of Data

All Data and metadata will be stored securely in the specific security protected cloud back end servers, which is a centralised, secure, and supported data storage facility set up to store digital research data throughout the lifespan of a project. This storage is backed up daily and keeps two independent copies of the research data which is physically held in separate data centres and then backed up to a create a third copy in a third location. Storage is free for up to 4TB of data, which will not be exceeded for this project. Backup and security protocols will follow those Izmir Metropolitan Municipality (IMM) management policies. Methods of back-up, security procedures, and version control of data will be included in the releases.

In ICT platform, All Users will have trust relations and governance between devices. All accesses are password protected and relevant privileges will be issued accordingly.

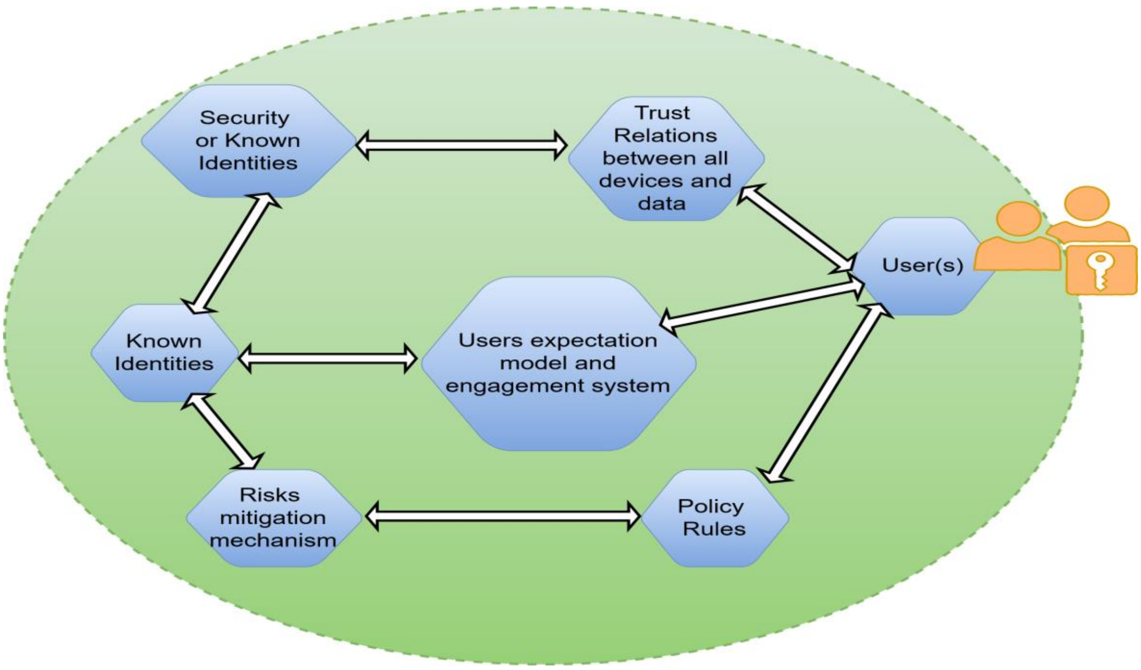


Figure 12-3 Data, Device and User identity management in Izmir Platform

12.4 Data for Biophysical and Socio-Economic KPIs

12.4.1 Biophysical Data Management

All data will be tagged within metadata file with data source, description, location, exact time created, modified, downloaded or uploaded, validity of data owner and privileges, terms of use, reference, and citation. We will call this Biophysical metadata.

Data Sources can be

1) GIS files. (Thermal Surface maps, aerial, insitu map layers Shape files from various sources Ege Soil and Landscape, IZT and municipality
2) Environment Sensor USB downloaded data files from portable temperature, thermal camera surface, wind direction, PM2.5 , PM10 etc. loggers
3) Intermediary Lab analysis data such Drinking Water
4) Any handwritten ecological Survey files that will be digitised with QGIS.
5) KPI calculated output files.

Data will be kept in csv format and processing and analysis will be done via python language. Izmir Municipality has ArcGIS software from ESRI so some KPI analysis will done using this software however it is our intention to convert and achieve all GIS models open source QGIS.

12.4.2 Socio-Economic KPI Data Management

As detailed above in corresponding KPI sections, the project will make use of existing external data, such as Census data, economic data, maps, crime statistics and Turkish Statistics Institute.

Newly created data will qualitative data from social surveys, geospatial data, scenario mapping data. Survey data will be managed in csv format and will be analysed by R or Phyton language. Geospatial data will be managed and converted to ESRI format as Izmir Municipality currently uses ArcGIS. However,data can be converted to QGIS open source as well.

13 Izmir ICT NBS Platform: KPI Ingestion, Communication, Interfaces Visualization and Mobility

Newly developed Izmir ICT NBS platform will be used to raw data and calculated KPI ingestions. The architecture is very similar to proposed global ICT platform in 5.2, shown as below. The agent of the local ICT infrastructure pushes the files into its own ICT Platforms FTP server. Another data ingestion will be via specific Restful API allowing clients to push the information directly into Local ICT Platform. Almost all Biophysical KPIs data will be pushed into the platform and storage in predetermined periods. Metadata and relevant data will be stored in these backend servers. Similarly, All external data, Census data, Socio-Economic KPI data will also be pushed into the platform regularly.

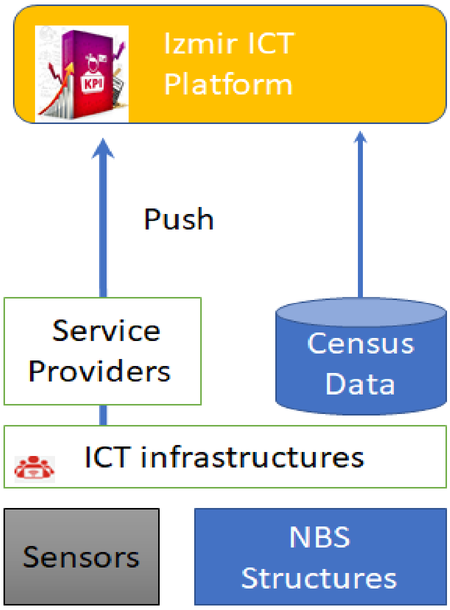


Figure 13-1 Izmir ICT Platform KPI Ingestion

Data Communication and Protocols

As in Kubicek, et al., 2013and Bugs, et al., 2010., URBAN GreenUP Izmir ICT platform shall store its KPIs data in a database or data-bank storage. Web service shall be used to access the data as needed through JSON (JavaScript Object Notation) format to the client. Since JSON uses a format that fits easily for web service client-side components then it is a good data service. For huge data volumes, JSON is with a lightweight system better than XML. Also for unstructured data extraction in any form with respect to the global platform JSON is a better option

Basically, the KPIs or dataset and a JSON schema are registered or input into the URBAN GreenUP Izmir ICT platform so that at the end of data retrieval query and users' data, a set of required data validation results is output for the client-side user as requested. Client applications will use secure communications in order to ensure the privacy of all the information exchanged with the servers and the platform. There will be user authentication, and all messages will be ciphered using HTTPS with a server-side certificate (so that the client devices can verify the destination server).

Mobility

The ICT platform will create a web site; therefore, all mobile or local users will be able to access Izmir NBS ICT platform via published web site. Upon login, user can upload or push information, survey data to the platform. This ICT platform works as engagement portal for citizens will be prepared integral to İzmir Green Infrastructure Strategy Website: http://izmirdoga.izmir.bel.tr (delivered in Turkish only). This portal will also directly be linked to real-time information like İZUM Dashboard illustrating the real time urban transportation data of Izmir. If city budget allows this website and other associated links could easily be converted to a 'İzmir's Green Dashboard' that allows basic infographics (i.e. carbon emissions), real time environmental data (i.e. air quality), list of NBSs and some other interactive features. Therefore, after the URBAN GreenUP project completed, this website and green dashboard will alive engaging the community with online. There is another possibility that if the realization of Izmir's Biodiversity Atlas is completed at later stages, the ICT platform can also be connected to this database which is using crowd-sourced data by means of specifically designed mobile apps and events like Bio-blitz (See Technical specifications of Izmir demo Report -D.4.3-for more details).

On the other hand, the local ICT platform will provide web services APIs so if/when third party develops native mobile application to interact with the Izmir ICT platform, it would be possible to do so.

14 Risks and Mitigation Strategies.

Throughout the development of this document, risks are considered and mitigation strategies are proposed. For example, where flight restriction zones exist, then different surface thermal camera is used to take thermal pictures from tall buildings and in-situ based thermal measurements by covering the park area by walking. Another risk mitigation strategy is to plan on taking measurements in specific critical times and dates rather than taking continuous measurements on study sites.

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