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URBAN GreenUP

D4.2: Baseline definition by zone and challenge

WP 4 , T 4.2

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[1] PU = Public

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0 Executive summary

In the final analysis, the Urban Green UP Project, aims to obtain a tailored methodology to support the co-development of Renaturing Urban Plans, focused on climate change mitigation and adaptation as well as efficient water management, and to effectively assist in the implementation of NBS in urban areas. Through the Project, NBS classification and parametrization will be addressed conclusively and resources to support decision making will be established as part of the project activities. A large scale and fully replicable set of demonstration actions related to NBS accompanied by innovative business models will provide evidence about the benefits of NBS contributing to the creation of new market opportunities for European companies, and fostering citizen insight and awareness about environmental problems.

Large scale demonstration actions in three European cities; Valladolid (Spain), Liverpool (UK) and Izmir (Turkey), which are the front-runners of the Project, are at the core of the Urban Green UP Project. WP4 is dedicated to the large-scale demonstration actions in the city of Izmir where a set of Deliverables address the initial state of play in the city, thus resulting in the present report.

D4.2 Baseline document pertaining to Izmir; pin points the position of the sub-demo areas of Izmir implementation, summarizes the current situation and provides baseline values of the sub demo areas so as to support the evaluation process after the implementations are carried out.

Detailed assessments of sub demo areas, their description, exact locations and NBS to be realized in these areas are detailed in the report.

A discussion of various challenges and limitations to NBS implementation and adaptation as well as indicators pertaining to the baseline is also included in the Report.

In the report, Chapter 2 is a general description of the interventions planned for the Izmir Metropolitan Municipality within the URBAN GreenUp project in three Sub-Demo Areas (A, B, C). The chapter ends with non-technical interventions on socio-economic and communicative purposes to enhance the value of selected NBSs

The target of the 3rd chapter is to summarize and identify challenges and limitations to Nature Based Solutions in terms of design, construction, implementation, maintenance and adaptation.

In the 4th chapter Baseline conditions for each demo area is examined and brief description of study areas covering interventions, NBSs and their approximate implementation are provided. Baseline values are given according to selected indicator metrics and scale.

Chapter 4, section 1, includes detailed information about study areas of Sub-Demo A “Abatement of Heat Island Effect in Urban-Nature Continuum” with the NBSs planned to be implement on this Sub Demo. Section 2 and section 3 of this chapter following section 1 with the same structure but information about Sub Demo B “Climate-Smart Urban Farming” and Sub Demo C “New Green Corridor including Renaturing Peynircioğlu Stream and Bio-Boulevard”.

Conclusions about the report are given in the chapter 5.

1 Introduction

Although Urban Green Up is not precisely an engineering project where quantitative descriptions may succinctly summarize "before" and "after" conditions for a project, it is necessary to frame "interventions" in Urban Green UP in an as closely quantitative manner as possible for the replication and sustainability of projects in the NBS field. Urban development targeting such goals as climate mitigation and adaptation, public welfare and social inclusion necessarily involve a large number of qualitative aspects.

This deliverable reflects the work that has been carried out defining the group of main KPIs that will be used in the definition of the baseline and of the calculation methodologies. As well, the results of applying these methodologies to some of the actions foreseen in the previous phase are collated, and expressed as available data or expected data. This inventory is either provided by the URBAN GreenUp project or obtained from bibliography.

The report thus demonstrates the current state of play in the definition and calculation processes of the baseline and the demonstration projects involving NBS planned for İzmir. Both the accurate definition of the indicators to be used and their use to define the current state of the locations (the baseline) where the interventions will be implemented will be completed in the forthcoming months.

The Report also contains the collection of present Regulations and other legislative limitations that are or may be constricting for the actions developed in İzmir, which are expressed for every action/intervention (Nature Based Solutions, NBS) or by groups of NBS; as well as the challenges and barriers identified for each one.

The selection process of URBAN GreenUp Key Performance Indicators' (KPIs) are included in the Report.

1.1 Key performance indicators (KPIs) of URBAN GreenUp

URBAN GreenUP project aims to create evidence about the NBSs impact in cities to fight climate change, improve wellbeing and build more sustainable livelihoods.

In URBAN GreenUP project WP1, WP5 and WP7 are dedicated; i) to the construction of a methodology to set a city baseline, ii) to create a set of KPIs to measure NBSs performances, iii) to monitor NBSs performances and iv) to evaluate cost and benefits of NBSs. Each NBSs generate several impacts; these may be assessed through a set of indicators by using specific types of methods. An objective method to evaluate the actions, impacts and performance is necessary. Urban GreenUp will adopt several KPIs for the evaluation of NBSs impacts in front-runner cities. The EKLIPSE framework will be used as starting point to elaborate a homogeneous framework for the evaluation of NBS and to compare results through cities. Other KPIs will be adopted in order to frame the project evaluation not just in the European context but also in an international one. This framework will take into consideration all NBS impacts at different scales. Initiatives that have been included are: European Green Capital Award, Sustainable Development Goals (SDGs), Convention on Biological Diversity - Aichi targets, The Economics of Ecosystem Services (TEEB) and Mapping and Assessment of Ecosystem Services (MAES).

The chapter is composed by three sections. The first one will describe the EKLIPSE framework and methodology used to evaluate NBSs. The second section will introduce the Ecosystem Services Assessment (ESA) methodology. The last one will describe i) the KPIs construction process adopted in URBAN GreenUP, ii) the results obtained and iii) the next steps needed to complete the process.

1.1.1 EKLIPSE methodology

The European Commission requested the EKLIPSE H2020 project to help building up an evidence and knowledge base on the benefits and challenges of applying NBS. The aim of this EKLIPSE activity is to devise an impact evaluation framework that can guide the design, development, implementation and assessment of NBS demonstration projects in urban contexts. The framework takes into account insights from recent studies into the mapping and assessment of ecosystems and their services, ecosystem-based adaptation projects, and relevant information on climate adaptation, natural water retention, green infrastructure, greening cities and other European Commission based initiatives.

The result of the EKLIPSE activities is a methodology to evaluate NBSs based on 10 challenges:

1. Climate mitigation and adaptation;
2. Water management;
3. Coastal resilience;
4. Green space management (including enhancing/conserving urban biodiversity);
5. Air/ambient quality;
6. Urban regeneration;
7. Participatory planning and governance;
8. Social justice and social cohesion;
9. Public health and well-being;
10. Potential for new economic opportunities and green jobs.

For each challenge, a set of KPIs to measure NBSs impacts at different scales (micro-scale, meso-scale and macro-scale) has been individuated.

URBAN GreenUp aims to integrate the EKLIPSE methodology with the Ecosystem Services Approach (ESA) in order to generate a homogeneous evaluation framework to be adopted by cities during the project. This framework is based on the ecosystem services produced or enhanced by NBSs and will take into consideration all NBSs impacts at different scales.

1.1.2 Ecosystem Services Assessment methodology

Natural Capital can be defined as the world's stock of natural assets, which include geology, soil, air, water and all living things. It is from Natural Capital that *humans derive a wide range of services, often called ecosystem services*, which make human life possible[2].

Ecosystem services are "*the direct and indirect contributions of ecosystems to human wellbeing*"[3]. Several classifications of ecosystem services exist including those presented by the *Millennium Ecosystem Assessment*[4], *TEEB*[5] and the *Common International Classification of Ecosystem Services* (CICES 2013). Building on previous categorizations of ecosystem services[6][7] the TEEB report identifies 22 types of ecosystem services grouped in four categories:

1. provisioning;
2. regulating;
3. supporting;
4. cultural.

Figure 1-1, represents the four categories of ecosystem services and their impact on human well-being[8]. NBS are recognized for being multi-function, multi-purpose and multi-beneficial[9]. NBS are actions "inspired, supported by or copied from nature"[10] that use complex system processes of nature to reduce disaster risk, to improve human well-being and to promote a socially inclusive green growth. Furthermore, NBS can deliver services, such as the ability to regulate water or store carbon, comparable to traditional, grey infrastructures in a more cost-efficient way; on the other hand, by their intrinsic nature NBS do deliver a series of other services that are commonly defined as social, economic and environmental co-benefits.

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[2] Natural Capital Coalition, (2016). "Natural Capital Protocol". (Online) Available at: www.naturalcapitalcoalition.org/protocol

[3],[5] The Economics of Ecosystems and Biodiversity, (TEEB). (2010). "The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations". London: Earthscan.

[4,8] Millennium Ecosystem Assessment, (MA). (2005). "Ecosystems and human well-being: the assessment series". Island Press, Washington DC.

[6] Millennium Ecosystem Assessment, (MA). (2003). "Ecosystems and human well-being: a framework for assessment". Island Press, Washington, D.C., USA

[7] De Groot, R.S. De Groot, M.A. Wilson, R.M.J. Boumans. (2002). "A typology for the classification, description and valuation of ecosystem function, goods and services". Ecological Economics, 41, pp. 393-408

[9] EEA (2015), "Exploring nature-based solutions - The role of green infrastructure in mitigating the impacts of weather- and climate change-related natural hazards".

[1012] European Commission (2015), "Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities".

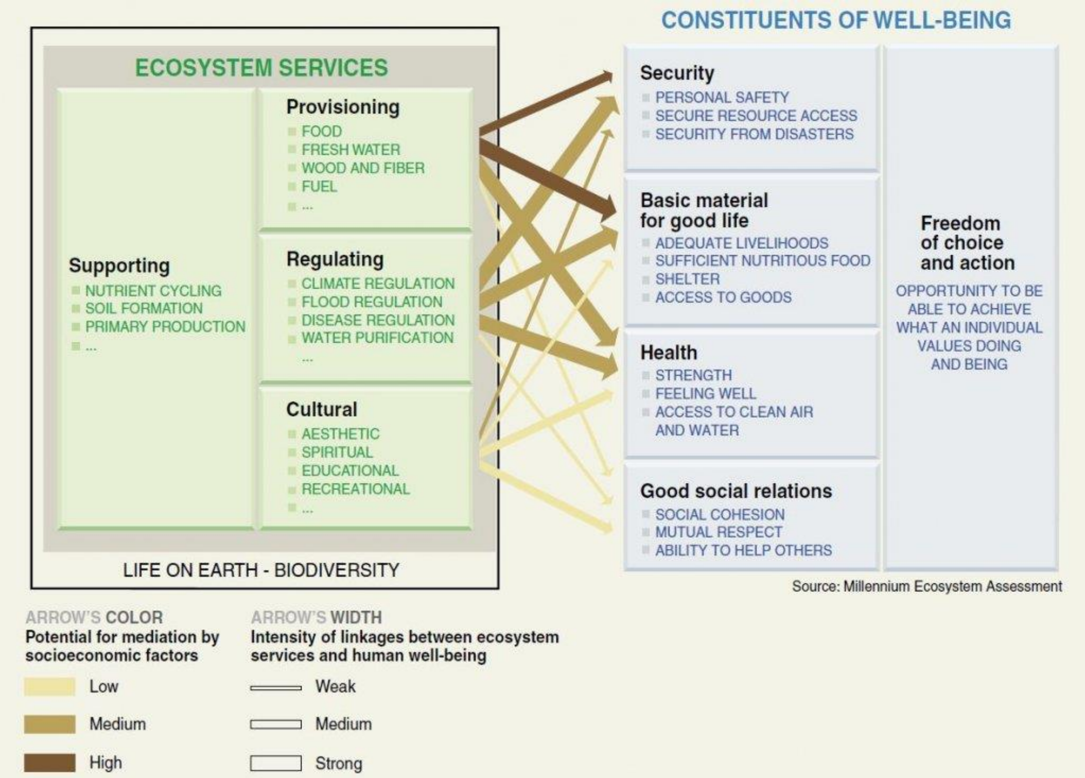

Figure 1-1: Ecosystem services and human well-being, Millennium Ecosystem Assessment[11]

In cities, for example, urban parks and green areas in general can offer ecosystem services such as storm control, carbon dioxide conversion, wildlife diversity, outdoor recreation opportunities, noise dampening and offsetting city pollution.

However, these benefits are not valued in a consistent and complete way. There is the need to compile a more comprehensive evidence base on the social, economic and environmental effectiveness of NBS[12], since the current knowledge base is rather dispersed and fragmented. "The valuation (monetary and nonmonetary) of the multiple benefits of NBS and the development of performance indicators, standards, technical and scientific reference models for NBS is necessary for their wider and systemic implementation", as well as the availability of tailored assessment tools[13].

URBAN GreenUP project in order to evaluate impacts and trade-offs of NBSs implemented in front-runner cities will adopt the *Ecosystem Services Assessment (ESA)* approach. ESA approach is based on urban ecosystem services. It will identify and assess the generation of new, enhanced, restored flows of ecosystem services promoted by urban renaturing and the NBSs implemented in coach cities, quantifying these flows in physical and monetary terms. A

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[11] Millennium Ecosystem Assessment, (MA). (2005). "Ecosystems and human well-being: the assessment series". Island Press, Washington DC.

[13] European Commission (2015), "Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities".

categorization of ecosystem services tailored on the urban context will be elaborated within the project. An indicative, draft grid identifying ecosystem services impacted by NBS is depicted in the following table (Table 1-1Figure 1-2). The grid and classification of urban ecosystem services will be further refined and finalized during next steps of *URBAN GreenUP* project based also on the information elaborated in the deliverable 1.1 NBSs Catalogue, deliverable 1.2 Climate change challenge catalogue, deliverable. 2.3 Technical specification of Valladolid demo, deliverable. 3.3 Technical specification of Liverpool demo, deliverable. 4.3 Technical specification of Izmir demo and through the involvement of the demo sites cities Liverpool, Izmir and Valladolid.

Nature-based solution	Ecosystem Services
Sustainable Urban Drainage Systems (i.e. ponds and wetlands)	Waste regulation (water) Runoff mitigation Air filtration Micro-climate regulation Aesthetic beauty
Phytoremediation and phytostabilisation Biodegradation and bioconversion	Waste regulation (soil and water) Disease reduction
Green roofs/walls	Runoff mitigation Air filtration Micro-climate-regulation Erosion control Aesthetic beauty
Tree planting alongside roads	Air filtration Micro-climate-regulation Aesthetic beauty
Urban greenspace	Air filtration Micro-climate-regulation Erosion control Pollination and seed dispersal Disease reduction (establishment of vector feeding species) Aesthetic beauty Outdoor recreation Cognitive development

Table 1-1: Draft grid of ecosystem services affected by urban NBS (source: UB-IEFE, 2016)

Design and apply an innovative analytical framework to evaluate NBSs based on their provision of ecosystem services explicitly tailored on the urban context will allow to assess their cost-effectiveness also in relation to alternative solutions (if necessary).

The ESA approach will be integrated into commonly used decision-making mechanisms, ranging from the more general trade-off analysis and scenario analysis, to specifically cost-benefit analysis, cost-effectiveness analysis.

The logic behind ecosystem valuation is to unravel the complexities of socio-ecological relationships, make explicit how human decisions would affect ecosystem service values, and to express these value changes in units (e.g., monetary) that allow for their incorporation in public decision-making processes. The methodology that will be applied for the monetary evaluation of NBSs is the Total Economic Value (TEV). It should be emphasized that "total" TEV is summed across categories of values (i.e., use and non-use values) measured under marginal changes in the socio-ecological system, and not over ecosystem or biodiversity (resource) units in a constant state[14].

Recent contributions in the field of ecosystem services have stressed the need to focus on the products (benefits) when valuing ecosystem services. This approach helps to avoid double counting of ecosystem functions, intermediate services and final services[15] [16]. The picture below (Figure 1-2) resumes the TEV methodology and the evaluation techniques that will be used to measure NBSs impacts in cities.

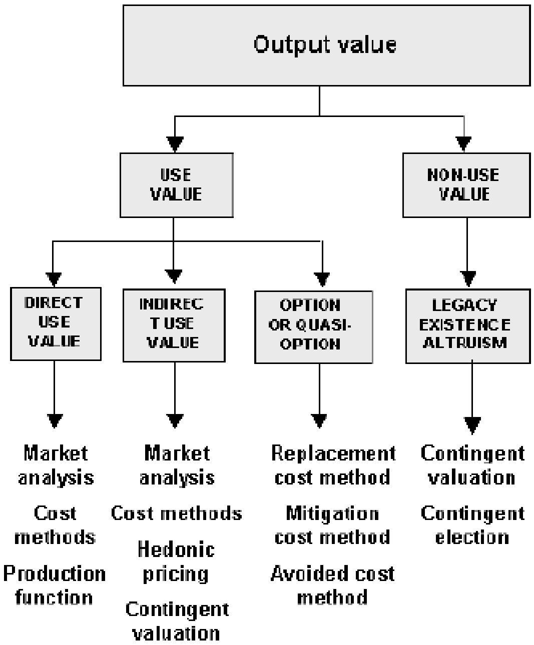

Figure 1-2: Methods for ecosystem services monetary evaluation (TEEB, 2010)

[14] The Economics of Ecosystems and Biodiversity, (TEEB). (2010). "The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations". London: Earthscan.
[15] Boyd, J., and S. Banzhaf. (2007). "What are ecosystem services?". Ecological Economics 63: 616-626.
[16] Fisher, B., Turner, R.K., Morling, P.. (2009). "Defining and classifying ecosystem services for decision making". Ecological Economics 68, 643 – 653.

1.1.3 KPIs design process

URBAN GreenUp will adopt several KPIs for the evaluation of NBSs impacts in front-runner cities. The starting point for the creation for a set of KPIs will be the EKLIPSE framework in order to elaborate a homogeneous framework for the evaluation of NBSs and to compare results through cities. Other KPIs will be adopted in order to frame the project evaluation not just in the European context but also in an international one.

In fact, initiatives like the European Green Capital Award, SDGs, Aichi targets, TEEB and MAES have been analysed in order to verify the possibility to build up a more complete set of KPIs for the evaluation of NBSs in *URBAN GreenUP* project.

The KPIs creation process has been developed taking into account also front-runner cities and their capacity to adopt and use the set KPIs proposed.

The KPIs creation process included the following steps:

1. KPIs analysis of European and international initiatives to evaluate sustainability and the performances of NBSs in cities and their territories (European Green Capital Award, SDGs, Aichi targets, TEEB and MAES);
2. Involvement of coach cities in the selection of the KPIs based on their experiences and needs;
3. Identification and categorisation of core KPIs in order to measure and evaluate ecosystem services.

Through the analysis of the European Green Capital Award, SDGs, Aichi targets, TEEB and MAES initiatives a list of 70 indicators have been individuated to complete the EKLIPSE framework. Each indicator has been associated to a category of ecosystem services in order to measure and evaluate the performances of NBSs implemented in cities. The KPIs have been categorised based on the ecosystem services categories:

- 16 for the evaluation of cultural services;
- 6 for the evaluation of provisioning services;
- 39 for the evaluation of regulating services;
- 9 for the evaluation of supporting services.

These indicators have been integrated with the EKLIPSE framework, the KPIs set has been sent to coach cities in order to involve them in the process. Valladolid, Liverpool and Izmir have selected the KPIs that potentially will be used in the monitoring and evaluation process of NBSs implemented in their territories. Furthermore, front-runner cities have included in the set of indicators several KPIs that they are going to use in their territories to monitor NBSs performances. In total, the KPIs individuated are 152. The table below (Table 1-2Table 1-3) summarizes the KPIs selected by each city and the categorization of the KPIs per “challenges” (based on the EKLIPSE methodology) and per ecosystem services category (based on the ESA methodology).

Challenges	KPIs (Number)	Ecosystem services measured	Valladolid	Liverpool	Izmir
Climate mitigation & adaptation	15	regulating	4	5	7
Water Management	24	regulating supporting provisioning	13	4	4
Costal resilience	14	regulating supporting cultural	0	0	9
Green space management	24	provisioning supporting cultural	6	5	5
Air quality	14	supporting regulating	4	4	5
Urban Regeneration	18	regulating supporting cultural	2	2	13
Participatory Planning and Governance	7	cultural	2	2	6
Social Justice and Social Cohesion	9	cultural	0	1	8
Public Health and Well-being	12	cultural regulating	0	2	3
Potential of economic opportunities and green jobs	11	/	4	2	11

Table 1-2: Draft grid of KPIs for NBSs evaluation in coach cities (source: UB-IEFE, 2017)

An additional selection of KPIs has been made to individuate a group of indicators that have to be adopted by all front-runner cities. The core group of KPIs will be used i) to create a homogeneous dataset of NBSs impacts and performances and ii) to ensure the evaluation of co-benefits and side effects of NBSs. 32 KPIs have been individuated to evaluate regulating, provisioning, supporting and cultural ecosystem services provided by NBSs implemented by cities and to compare their performances. Front-runner cities have the possibility to use additional specific KPIs during the monitoring phase.

<table>
<tr><th>ECOSYSTEM SERVICES</th><th>Number of KPIs per ecosystem service</th><th>Evaluation class</th></tr>
<tr><td rowspan="2">Cultural</td><td rowspan="2">7</td><td>Physical use of land/seascapes in different environmental settings</td></tr>
<tr><td>Social engagement</td></tr>
<tr><td rowspan="3">Provisioning</td><td rowspan="3">3</td><td>Surface/ground water for drinking</td></tr>
<tr><td>Surface/ground water for non-drinking</td></tr>
<tr><td>Cultivated crops</td></tr>
<tr><td rowspan="6">Regulation</td><td rowspan="6">17</td><td>Filtration/sequestration/storage/accumulation by ecosystems</td></tr>
<tr><td>Micro and regional climate regulation</td></tr>
<tr><td>Hydrological cycle</td></tr>
<tr><td>Flood protection</td></tr>
<tr><td>Global climate regulation by reduction of GHG concentration</td></tr>
<tr><td>Mediation of smell/noise/visual</td></tr>
<tr><td>Supporting</td><td>5</td><td>Habitat for species</td></tr>
</table>

Table 1-3: Core set of KPIs for NBSs evaluation in coach cities (source: UB-IEFE, 2017)

The NBS impact evaluation framework developed in this initial phase of the project will be used as a starting point for NBSs assessment and it will be completed during the development of URBAN GreenUP project if necessary. Next step to be develop in order to complete the evaluation framework id related with the methodologies to measure the KPIs selected for ESA. These methodologies will be analysed and discussed with front-runner cities and their technical partner in order to create an inclusive design process to include all stakeholders.

2 Predefinition of zones and sub-demos

Izmir Province has a surface area of 12.019 km^2 and a population of 4.2 million inhabitants at the western part of Turkey. As a well-known port city at the Eastern Mediterranean, the city comes in the third rank among all cities in Turkey. Throughout the text four different working scales are mentioned. Metropolitan scale (M) refers to whole provincial area. Urban scale (U) covers central urban areas referring to 11 metropolitan district municipalities around the Izmir Gulf with a population of 2.9 million inhabitants. Neighbourhood scale (N) refers to areas of each metropolitan district municipalities and their associated neighbourhoods. In this case, Çiğli and Karşıyaka municipal districts, where sub demos are located, covers 0.56 million inhabitants at the northern part of the city. Demo site scale (D) refers to site-specific area of some demos that are the scales of given intervention (Figure 2-1).

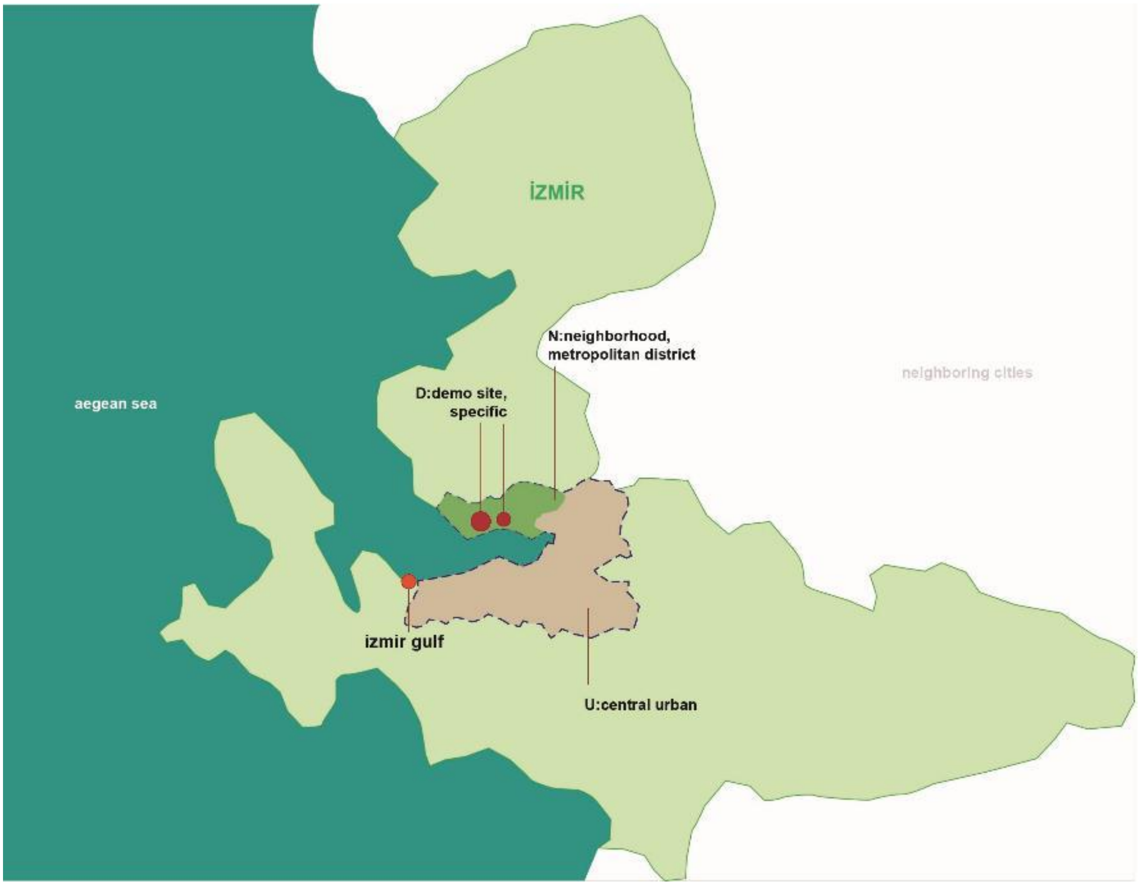

Figure 2-1: Working Scales for Izmir Metropolitan City

Izmir’s demo sites have been selected according to principles of urban-nature continuum. Each of the character zones refers different types of environmental problems. As a fast-growing city, Izmir’s urbanisation extends towards highly fragile nature sites. Therefore, nature-based solutions should be flexible enough to tackle with challenges of each character area (Figure 2-2).

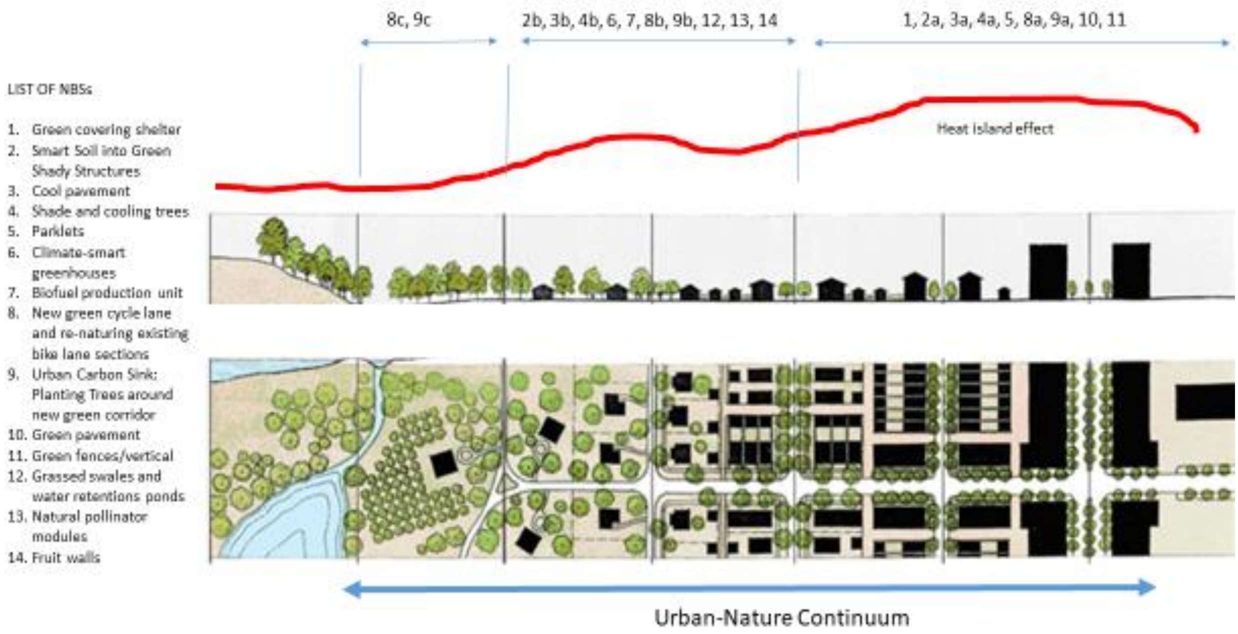

Figure 2-2: Distribution of Izmir's NBSs according to urban-nature continuum

The following is a general description of the interventions planned for the Izmir Metropolitan Municipality within the URBAN GreenUp project in three Sub-Demo Areas (A, B, C). The chapter ends with non-technical interventions on socio-economic and communicative purposes to enhance the value of selected NBSs.

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

Sub Demo A will be deployed in the central area of Karşıyaka Metropolitan District characteristic of highly-urbanized areas (see Figure 2-3 & Figure 2-6). It includes different transportation related locations (car parking areas and on-street parklet areas) that will reduce maximum/average temperatures and will reduce air pollutants. Car parking areas will be deployed in different locations in dense urban locations in Karşıyaka and Çiğli (in Sasalı Natural Life Park) in order to illustrate peculiarities of urban heat island effect.

List of the proposed NBSs are as follows:

- Green covering shelter on car parking areas
- Smart Soil into Green Shady Structures
- Cool pavements around selected car parking areas
- Shade and cooling trees alongside parking lots
- Parklets in Girne Avenue

Figure 2-3: Sub Demo A: Karşıyaka Metropolitan District

2.2 Sub Demo B: Climate-smart Urban Farming

Within the heart of Sub Demo B there is ‘Sasalı Natural Life Park’ designed by Izmir Metropolitan Municipality and was recently considered to extend its activity through new ecologically-sensitive developments (see Figure 2-4 & Figure 2-6). 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. Sub Demo B is also supported by non-technical interventions regarding urban farming and bio-diversity increasing activities.

List of the proposed NBSs are as follows:

- Climate-smart greenhouse in urban farming precinct
- Biofuel production unit

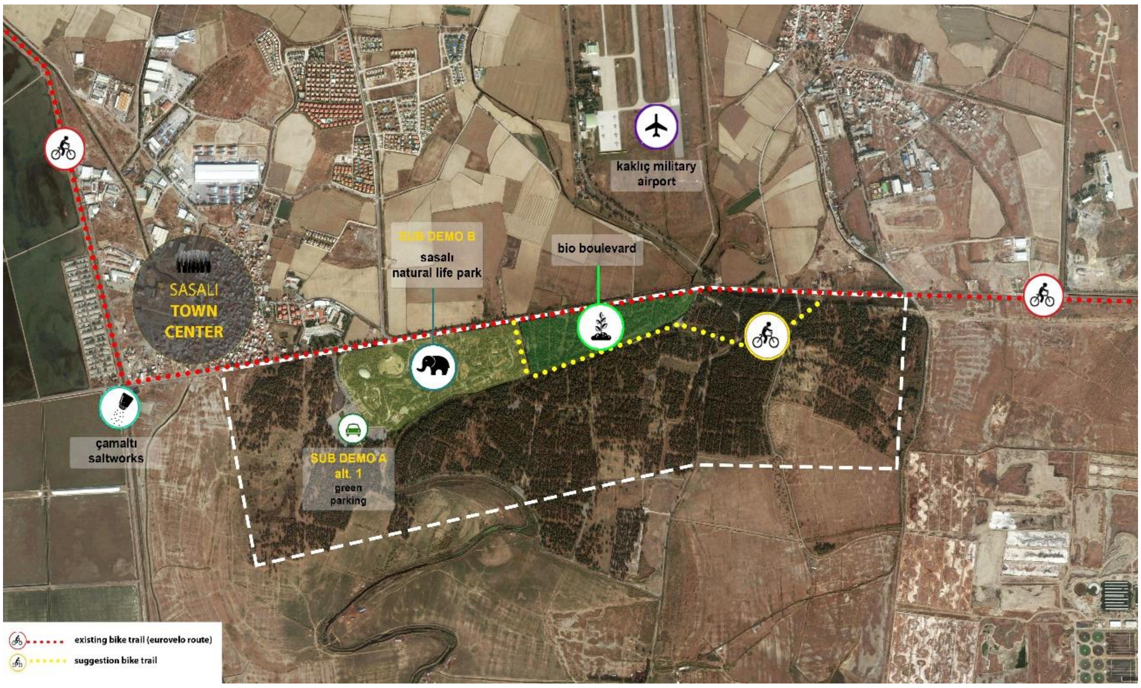

Figure 2-4: Sub Demo B: Sasalı Natural Life Park

2.3 Sub Demo C: New Green Corridor including Renaturing Peynircioğlu Stream and Bio-Boulevard

Sub Demo C is formed by a 10 km long green corridor from the coastal areas, river beds to highly sensitive nature protection areas (see Figure 2-5 & Figure 2-6). The proposed green corridor includes sustainable transportation options (cycling &walking) and special sections like the Bio-Boulevard that will provide important ecosystem services for urban biodiversity. Sub Demo C also includes non-technical interventions aiming bio-diversity increasing education activities.

List of the proposed NBSs as follows:

- New green cycle lane and re-naturing existing bike lane sections
- Urban Carbon Sink: Planting Trees to maximize carbon sequestration around new green corridor
- Green pedestrian road pavements alongside with Peynircioğlu Stream
- Green fences/vertical alongside Peynircioğlu Stream
- Grassed swales and water retentions ponds around Bio-Boulevard
- Natural pollinator modules (Pollinator nesting blocks across bio-boulevard)
- Fruit walls

Figure 2-5: Sub Demo C: Peynircioğlu Stream and Bio-Boulevard

2.4 Non-technical interventions

Foreseen non-technical interventions of the proposed Sub Demo A, B and C are listed as;

- Community meeting facility and market stalls for agricultural cooperatives
- Urban farming educational activities
- Municipality-enabled urban farming (community supported and collaborated with women cooperatives)
- Bio-blitz event for Sasalı Region
- Bio-boulevard's educational path

Figure 2-6: Location of Demo Sites (A, B, C) in Karşıyaka and Çiğli Metropolitan Districts

3 Challenges and Limitations

The target of this section is to summarize and identify challenges and limitations to Nature Based Solutions in terms of design, construction, implementation, maintenance and adaptation. Detailed identification for limitation and barriers will be explained in Deliverable 1.5.

3.1 Legal Limitations

One of the main issues in terms of legal limitations is the rapid growth phenomenon of the city. The dynamics of urban growth is strongly related to overall economic climate, in both global and national context and cannot be diverged from the long-range socio- economic trends and developments impacting on all cities despite with differences. In most cases, it is often not possible to implement even some of the simple urban planning decisions and designs. Conflicting economic interests and short-term political considerations can be another important limitation for the implementation of nature-based solutions. Decision makers are often in need of being convinced regarding the "right" solution rather than the more attractive ones. In any case, lack of adequate institutional frameworks and the lack of a culture of collaboration may create a problem.

- Political limitations

In the Turkish case, strong polarization witnessed in politics also plays a significant role in cases where local political power is held by opposition political parties. As a significant economically contentious sector, creation of urban rent seeking may be said to be a critical issue regarding "scientific" and/or contemporary urban planning approaches.

Sectoral and silo approaches need to be overcome to create an integrated approach. It is important to remove the lack of institutional interest for multidisciplinary work. NBS approaches to urban (re)generation projects should attract consensus and become the first-tier tasks for local government as well as other impacting administrations. The rapid urban growth, challenges current and embedded practice, where social needs of the city and citizens also change rapidly. In the face of planning chaos, so often the case in Turkish cities, local governments tread through a minefield of changing and often conflicting regulations. Some regulations and legislative aspects related to sub-demos can be seen in following paragraphs.

3.1.1 Regulations

The following is a general description of the regulations that may affect NBSs in a national and international regulatory context:

- Natural Conservation Areas (Doğal Sit Alanı -1. Derece) based on Legislation No. 2863 Protection of Natural and Cultural Heritage, permitted by Preservation District Boards
- Gediz Delta Wetland protected by Ramsar Convention (green dots in Figure 3-1)

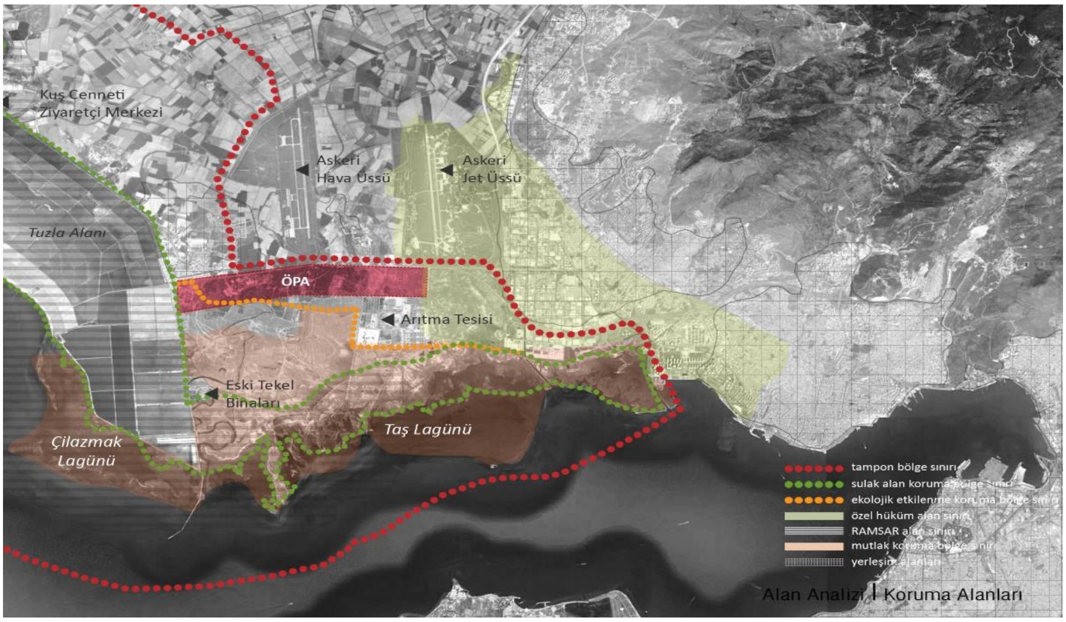

Figure 3-1: Borders of important national and international regulations around sub-demo sites

3.2 Social/Cultural Limitations

In terms of social limitations, low levels of knowledge of NBS among the public and their multiple benefits must be remedied. It is an important problem that the citizens are not sufficiently conscious of and supportive of the advantages of living in a natural and intact nature / landscape. This may be overcome by constructing NBS to result in socially inclusive urban space and going beyond accessibility concerns. Attracting the right actors is needed - participation of local people, stakeholders, and not the institutions with bad reputation. It is also important not to create the appearance of " green gentrification" which the previous concern addresses. Public "commons" as green recreation should be designed as a socially equating and levelling force.

Another important problem is, insufficient integration of human/social sciences and natural sciences in projects. Intersection between disciplines is needed. Short term solutions are favoured for environmental investments but long-term motivation of participants is needed for most of the NBS projects.

3.3 Organizational Limitations

Organizational limitations are closely related with the structure of institutions. Qualified staff is a necessity for institutions during the design, implementation and maintenance processes of NBS projects. Time limitation is another important factor in terms of organizational limitations, since long-term projects are hard to maintain and plan in terms of human and financial resources.

One strong barrier for NBS implementation may be the lack of knowledge, sufficient education and sustainability awareness that decreases the efficiency in decision making. Also for long-term projects data monitoring may become an issue and effects the maintenance of NBS projects. Interest in qualitative data has different importance for different level of organizations and also for citizens and this may create problems to make a common decision on projects. According to scale of the city, scale of the projects should be coherent to observe visible effects of implementations. So, organizations of relatively big and crowded cities feel more pressure in terms of their actions.

3.4 Financial Limitations

In terms of financial limitations, budgetary limitations come first. In rapidly expanding and growing cities, the pressure of building new infrastructure and subsistence structures are overwhelming. Determination of realistic budgets for projects, requires both financial and technical knowledge. Local governments must spend their budgets for effective projects in terms of relatively medium-term political aims and short-term expectations of citizens. Although some funding programmes exist, there is a need for qualified staff that will create projects and apply for this type of programmes especially in municipalities.

Importance of multidisciplinary work is critical in NBS projects but the amount of funding is not enough to involve stakeholders from different sectors for most of the cases. Another limiting factor for NBS projects is the conflicts arising from competition for urban land use, where rent seeking behaviour would prefer to create private urban land value from public land. Property issues are also often important barriers in that they create severe limitations for instance allocating and planning for NBS by the Municipality which may involve claiming urban space to use for NBS. Claiming land for NBS may involve private and/or public property which brings a varied set of barriers from financial to legislative ones.

3.5 NBS Specific Limitations

3.5.1 Environmental

One of the limitations of İzmir demo case is establishing baselines for pollinator species. As time is limited for establishing baselines (4.2) in the project, it was not possible to make observations for a period of time for pollinator species in the study area. Since there are no pervious bio-diversity observations or studies on demo site and its surroundings, it was planned to conduct baseline data collection starting in March of 2018. Collection of pre-intervention data before the deadline for the baseline report on Izmir (as it is on Liverpool) would be unrealistic. We are in touch with Liverpool to come up with a comparable method for pollinator species. The website[17] would be useful for simple measure of flowers and pollinators abundance on demo site.

3.5.2 Technical

Another topic that is worth mentioning in this category is baseline values and the results that are going to be obtained after interventions are applied and monitored. Quantifiable results are always appreciated in assessing the performances of the interventions. However, in some cases quality matters as much as quantity. For instance, quality and ecological sustainability of urban green spaces are always questionable in Turkey. The interventions made possible by this project

[17] (https://www.ceh.ac.uk/our-science/projects/pollinator-monitoring).

may be able to help to increase quality and ecological sustainability of green spaces by setting good examples in the form of pilot projects (demo sites).

3.6 Barriers

A significant number of different potential barriers to action for implementing NBS were described in this section. They have been clustered into five different groups (Figure 3-2).

A potential barrier to action is the fear of the unknown by several stakeholders including policy, practice but also residents. It considers both uncertainties and risks of implementing NBS and the resulting changes this may bring in planning. Due to its nature, NBS must be handled differently than other approaches and requires new and other implementation and maintenance criteria. Additionally, NBS have not yet received assessments of their effectiveness in dealing with climate mitigation and adaptation targets such as carbon offsets that may also create a performance unknown. This may be related to the lack of awareness regarding climate change induced problems and the benefits NBS can bring. With local urban policy officers and planners often being risk averse, these unknowns create roadblocks for the uptake of NBS in cities.

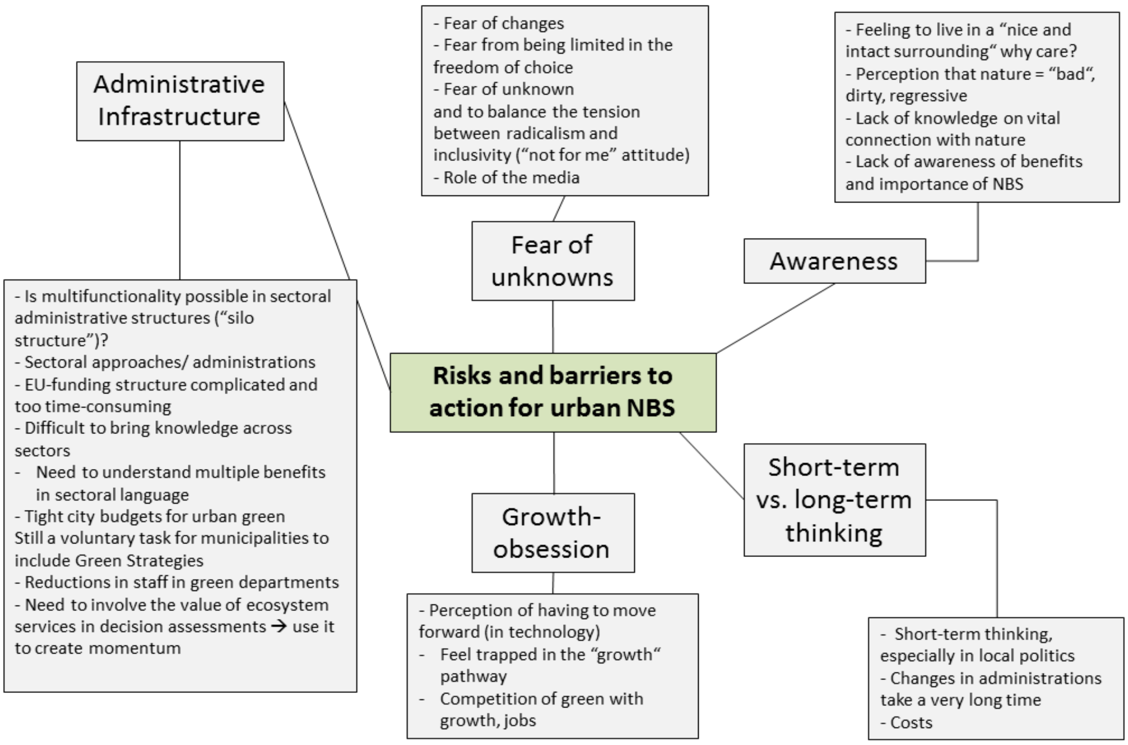

Figure 3-2: Schematic view of risks and barriers to action for urban NBS[18]

A second barrier includes the disconnection between long-term and short-term benefits. Changes in administration, for example, often need a long-term process which also involves costs. This is contrary to an often rather short-term thinking of local politics. In some cases, responsibilities for the maintenance of the project remains unspecified, which poses a risk to

[18] Nadja Kabisch, Jutta Stadler, Horst Korn and Aletta Bonn - Nature-based solutions to climate change mitigation and adaptation in urban areas - BfN-Skripten 446 - 2016

the continuity of delivering the desired socio-economic and environmental benefits in the long-term. Even in cities where long-term policy plans undergo adaptive monitoring for taking up new innovative solutions, it is often the case that scientific validated options and knowledge are not ready at the time the policy windows are open for new ideas. In parallel, there is also a discontinuity between short-term actions and how they relate or build up to long-term plans and goals. A number of projects researching NBS more generally and looking at implementation aspects more specifically only exist for a certain (short) time; there is, however, the need for long-term projects (particularly regarding solutions about how to address implementation and maintenance after the project and related funding end). This is mirrored in the activities working to develop long-term ecological research (with research sites established all over the world; see http://www.ilternet.edu) into long-term socio-ecological research[19]. The focus is suggested to not only rest on researching the design and early-stage implementation of NBS, but also to enable a monitoring of the impacts they have in terms of human-environment relationships over time.

Another barrier is the lack of awareness regarding climate change induced problems and the benefits NBS provide to city residents. Often, problems are connected to the general infrastructure of administration. Funding is often not available, thinking is based on traditional structures/departments and the focus is often rather on economic-growth oriented issues (creating jobs, attract investments) while less attention and money is left for the development of urban green and the related benefits of NBS even in a context of economic and demo-graphic decline.

Another major barrier to action refers to the existing administrative infrastructure. This concerns traditional structures of city departments often having their own "sectoral language". Knowledge is thus trapped in sectoral silos. Furthermore, city departments have defined fields of duty and restricted responsibilities, where multifaceted fields of responsibilities or projects such as NBS often may not fit into given decision-making structures. Relating to this, an associated barrier to action also refers to "strong stakeholders" with whom a city or municipality has to set up interactions; they include other public bodies such as housing as associations, investors or developers.

The last barrier concerns the growth obsession. Even in the context of economic and demographic decline, cities promote growth strategies and growth-dominated visions that we capture as 'the growth obsession barrier'. Increase in built-up area including spaces for commerce, infrastructure, etc. seems to be the main focus for development, even under conditions of population decline[20]. The focus remains on economic growth-oriented issues (creating jobs, attract investments), while less attention and money remains for the development of urban green spaces and the related benefits of NBS. City budgets for green

[19] Ohl, C., K. Johst, J. Meyerhoff, M. Beckenkamp, V. Grüsgen, and M. Drechsler. 2010. Long-term socio-ecological research (LTSER) for biodiversity protection - a complex systems approach for the study of dynamic human-nature interactions. Ecological Complexity 7:170-178. http://dx.doi.org/10.1016/j.ecocom.2009.10.002

[20] Haase, D., N. Kabisch, and A. Haase. 2013. Endless urban growth? On the mismatch of population, household and urban land area growth and its effects on the urban debate. PLoS ONE 8(6): e66531. http://dx.doi.org/10.1371/journal.pone.0066531

development and maintenance of green spaces often face severe budget constraints while staff and related expertise is decreasing ([21],[22],[23]). Tight financial and time budgets combined with reductions in staff and expertise may also lead to not using existing funding options for green space implementation projects. EU-funding instruments are available for cities, but they are complicated to apply for (requiring additional administrative staff and time) and - more importantly- require co-financing, which many cities cannot afford.

[21] Baur, J. W. R., J. F. Tynon, and E. Gómez. 2013. Attitudes about urban nature parks: a case study of users and nonusers in Portland, Oregon. Landscape and Urban Planning 117:100-111. http://dx.doi.org/10.1016/j.landurbplan.2013.04.015

[22] Davies, C., Hansen, R., Rall, E., Pauleit, S., Lafortezza, R., Bellis, Y. De, Santos, A., Tosics, I., 2015. Green infrastructure planning and implementation. EU FP7 GREEN SURGE Deliverable, Report 5.1. doi:10.13140/RG.2.1.1723.0888

[23] Kabisch, N., S. Qureshi, and D. Haase. 2015a. Human environment interactions in urban green spaces—a systematic review of contemporary issues and prospects for future research. Environmental Impact Assessment Review 50:25-34. http://dx.doi. org/10.1016/j.eiar.2014.08.007

4 Baseline Situation

Baseline conditions for each demo area is examined and brief description of study areas covering interventions, NBSs and their approximate implementation are provided. Baseline values are given according to selected indicator metrics and scale.

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

Sub-Demo A "Abatement of Heat Island Effect in Urban-Nature Continuum" includes the following NBSs:

- Green covering shelter on car parking areas
- Smart Soil into Green Shady Structures
- Cool pavement around selected car parking areas
- Shade and cooling trees alongside parking lots
- Parklets in Girne Avenue

Heat Island Measurement Thermal Imagery Analysis[24]

Satellite:

Urban Heat Island (UHI) can be obtained from lower resolution thermal data that can be captured from satellite data. The major differences in using satellite data instead of airborne (e.g. Drone) is the pass-over time of the satellite might not be optimum for the study purposes and the ground resolution (LandSat) is much less than with an airborne camera. Satellite remote sensing data can complement UHI analysis, and help to draw out information and generalisations from the thermal image about urban land use and design. LandSat ETM+ provides 60m resolution with 16-day frequency with specific time of the day.

Aerial-Drone Flight Specifications: FIR cameras will Sensefly ebee + drones that is tolerant up to 40 mph winds. However, it is best to take the measurement during no wind at time of flight to restrict surface cooling effects. Low wind speeds are important, as high turbulence can affect the drone and push the sensor off-nadir, reducing the accuracy of the thermal image. With increasing wind speeds and reduced atmospheric stability, any correlations between surface and air temperatures will be lost through micro-scale advection. This condition also supports optimal conditions for ground based at temperature observations.

The combination of these meteorological conditions tends to support optimal canopy layer UHI genesis. Meeting all of these meteorological conditions is a challenge, so some discretion and flexibility is needed in determining the choosing the best days to fly.

Given the interest in using airborne thermal mapping as a tool in mitigating excess heat, flight times should target times of excessive urban warming, and periods that will demonstrate the

[24] Richard Harris, Andrew Coutts, 2011 Airborne thermal Remote Sensing of Analysis of the Urban Heat Island, Technical Report, VCCCAR, Victorian Centre for Climate Adaptation Research, Australia

largest contrasts in surface heating between surface types (urban versus natural surfaces) due to intense surface warming of urban materials. Ideally, the flights should be aimed to be undertaken during a period of 2-3 consecutive hot days. It is very important to validate with the data taken from local meteorological stations.

Camera Resolution:

The camera and altitude of the flight are important to determine the resolution for the thermal data. The resolution of the thermal image is dependent on what type of analysis the user is after. Previous studies have shown that a resolution between 1m and 5m is sought after. The larger resolutions are used to show 'hot' spots and thermal patterns while the better 1m resolution is used to focus on smaller, individual elements.

Ground validation of surface temperature:

During the time of flight, it is very important to have ground monitoring and validation points set up. Previous studies have used different approaches of either fixed point sources of surface temperature data or mobile transect measurements of surface temperature at the time of the flights. Surface temperatures are measured using an infrared temperatures sensor. The ground validations are used to demonstrate the accuracy of the thermal flight.

Fixed ground validation points are provided via climate stations that are established before the flight is flown, providing climate data over a period of time. The advantage of fixed stations over mobile transect is that they can provide a longer-term measurement of the diurnal variation of different surfaces for use in analysis. Fixed stations can also provide a larger temporal resolution for different areas[25] rather than a snapshot in time like the thermal image. Fixed stations also ensure that validation data is collected at the precise time of the flight. In contrast, mobile transects are likely to provide a higher number of ground validation, but may risk misalignment in timing of the surface temperature measurement taken by the ground based station and the airborne thermal camera.

Ground validation points need to be selected over homogeneous areas that are a minimum of 5 m^2. This is so the area can be singled out on the thermal image and a direct comparison of the two data sets can be done. The fixed stations can be information from local climate stations (if surface temperature is recorded) or by stations set up by the investigator. Observational studies commonly conduct air temperature measurements to complement the airborne thermal imagery and to resolve any patterns between surface and air temperatures as[26] have done. Air temperature transects provide a good spatial coverage of canopy layer air temperatures for the pre-defined areas of interest. Measurements are normally carried out by having sensors

[25] LO, C. P., QUATTROCHI, D. A. & LUVALL, J. C. 1997. Application of high-resolution thermal infrared remote sensing and GIS to assess the urban heat island effect. *International Journal of Remote Sensing*, 18, 287- 304

[26] Saaroni, H., BenDor, E., Bitan, A., Potchter, O., 2000. Spatial distribution and microscale characteristics of the urban heat island in TelAviv, Israel. Landsc. Urban Plan. 48, 1–18

attached to vehicles and driven the throughout the pre-defined area of interest[27]. Systems usually consist of an air temperature sensor and a GPS.

Flight time	Nocturnal: Pre-dawn, ideally between 0300 and 0500, however flights at midnight for instance are still extremely useful, and may be more practical for data collection
Flight time **Resolution**	Daytime: Solar maximum, between 1300 and 1500
	Aim for a resolution of between 1-5 meters. With an altitude of 5oooft a ground resolution of 1.5 meters
Resolution **Ground validation**	Surface temperature: Fixed ground monitoring stations using IR temperature sensors
	Canopy layer air temperatures: mobile transects through areas of interest using an air temperature sensor and a GPS.
Meteorological requirements	Preferably 2-3 consecutive days of warm-hot sunny periods.
	Clear skies and low wind speeds are critical

Table 4-1: Summary table for heat island measurement thermal imagery Analysis

Post-processing of airborne thermal imagery

It is absolutely critical that full details of the thermal capture are known. In cases where a service provider acquires the thermal image, full details of the capture and any post processing must be fully documented and supplied. Raw radiometric data from the capture should also be provided so that re-processing can be completed if required.

Key details are the minimum forward and side overlaps, the pixel size, the spatial accuracy, and whether the image pixel resolution has been re-sampled. In cases where a geo-referenced and Orth-rectified mosaic image is provided, precise details of the approach used should be provided.

Atmospheric correction

With some low altitude thermal imaging studies, atmospheric correction has been applied, while with others there is no mention of it. Depending on atmospheric conditions like humidity during

[27] BÄRRING, L., MATTSSON, J. O. & LINDQVIST, S. 1985. Canyon geometry, street temperatures and urban heat island in malmö, sweden. *Journal of Climatology*, 5, 433-444

the flight, and the flight altitude, atmospheric correction may need to be applied to the thermal data.

Emissivity

Different materials have different abilities to emit thermal radiation due to the amount of incoming solar radiation they absorb, the ability to store heat and the wavelength of energy emitted. As different materials have different emissivity values these will need to be taken into account when calculating the temperatures. This will be aided by ground validations and knowledge from previous studies about land use emissivity.

Following any necessary correction for atmospheric effects, the emissivity values can be applied in an adjustment to the image. The emissivity corrections are done by using a land use classification layer with typical emissivity values assigned different urban surface types, and reprocessing the image depending on type of land cover. Typical average emissivity values of some materials can be seen in the table (Table 4-2) below:

Material	Typical average emissivity (over 8-14 µm)
Wet snow	0.98 – 0.99
Healthy green vegetation	0.96 – 0.99
Wet soil	0.95 – 0.98
Brick	0.93 – 0.94
Wood	0.93 – 0.94
Dry vegetation	0.88 – 0.94
Dry snow	0.85 – 0.90
Glass	0.77 – 0.81
Aluminium foil	0.03 – 0.07

Table 4-2: Typical average emissivity values of some materials

As a summary our analysis can be explained as follows:

Preliminary step is to perform initial studies with LandSat Satellite before starting the studies with Drone. This will not provide good fine granular thermal results but it will help us provide a methodology to for the process.

We will start the aerial analysis by flying drones without thermal camera first. The proposal area will be photogrammetrically mapped by using a Sensefly Ebee plus drone with photogrammetric camera and then UAV photogrammetry software (Pix4D mapper). As an outcome of this job, current distribution and situation of land objects, details and topography, so that Land Use and Land Coverage (LU&LC) for the area are going to be produced on a high resolution orthophoto map in digital and even in hardcopy

Afterwards; following procedures, several times in a day (with correct meteoritical conditions), thermal data (images) for the proposal area will be collected using thermal camera (Fir camera) attached to a Sensefly drone. Each image covers almost 60m x 45m land part @ 100m flying height

Finally, is the ground validation of land thermal data will also be collected by the help of thermal devices onboard municipal public transportation vehicles or fixed ground monitoring. So, this data will be used for the verification of

For post processing drone imagery and to analyse the change detection and monitoring, for all analyses, ArcGIS or open source QGIS location based data analyse software will be used. Pre, on time and post event images will be separately analysed and then changes will be computed and recorded for further decisions if any improvement is achieved or not for each interaction done for reducing the heat at where the heat spots appear. For example, plantation or city agricultural activities can be applied at where heat spots appear to reduce heat naturally.

The Airborne Thermal Imagery Analysis flow path is illustrated below.

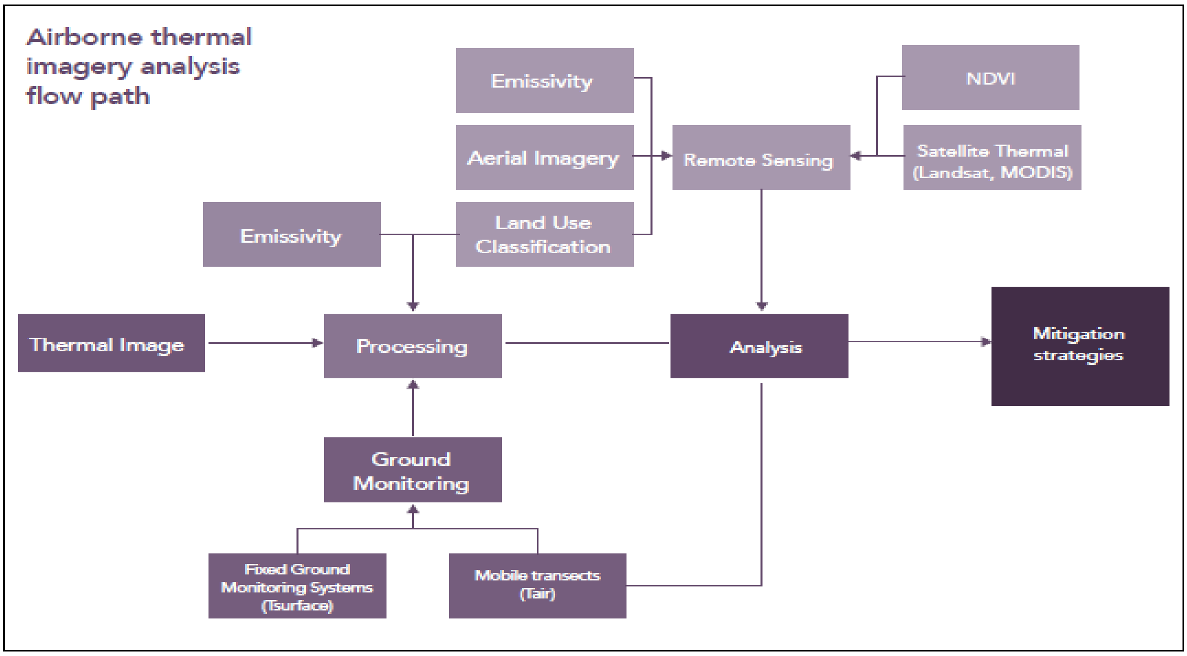

Figure 4-1: The Airborne Thermal Imagery Analysis flow path

4.1.1 Green covering shelter on car parking areas

- ***Study Area in Brief***

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	NBS	Quantity
Eklipse Framework	City-Specific Environmental Problems	Horizontal GI	Green Covering Shelter (for Sasalı Natural Life Car Parking Lot)	1 600 m²
Climate mitigation & adaptation	Urban heat island			

Table 4-3: Summary of green covering shelter on car parking areas

Thermal comfort is one of the main issues to be addressed because of climate changes and increased heat stress in cities. The outdoor thermal comfort analysis showed that Demo Site

Areas have poor bioclimatic comfort conditions like most of the residential areas in İzmir. Especially poor thermal comfort conditions occur due to the heat stress in hot and humid summer months[28].

Considering the current situation of Sub Demo A which is a large parking lot at Sasali Natural Life Park, has little or no vegetation and no structure for shading and is completely covered with concrete surface (Figure 4-2). Thus, outdoor thermal comfort conditions will likely to be poor as a baseline value.

Figure 4-2: Sub Demo A: Sasalı Natural Life Park Car Parking Lot

- ***Baseline Calculation***

Indicators (social, economic, physical, environmental etc.)	**Metrics (a;b;c;d...)** from EKLIPSE & NBS Impact Table (or new metrics)	**Scale**	**Baseline Values**
Environmental, Physical	Decrease in mean or peak daytime local temperatures (°C)	D	0
	Heatwave risks (number of combined tropical nights (>20°C) and hot days (>35°C))	M, U	To be measured in summer 2018
	Increase in shadow surface (m^2)	D	To be measured in summer 2018

Table 4-4 Metrics and baseline for green covering shelter on car parking areas

Cities represent thermal load areas compared with their surrounding environments. Due to climate change, temperatures and heat wave risks in summer will increase. Therefore, mitigation and adaptation are needed[29]. Climate change is often discussed in terms of changes in air temperature, cloud, wind, etc. as trends in either averages or extremes. However, in order to evaluate its impact on people's thermal perception, health and wellbeing, it is necessary to

[28] Kestane, O. and Ülgen, K., (2013). İzmir İli İçin Biyoklimatik Konfor Bölgelerinin Belirlenmesi. Journal of Technical Sciences, 3 (5), 18-25.
[29] Müller, N., Kuttler, W. and Barlag, A., (2014). Counteracting urban climate change: adaptation measures and their effect on thermal comfort, Theor Appl Climatol, 115, 243–257

analyse their combined effect. In summer, the mean radiant temperature is one of the most important meteorological parameters governing human energy balance and thermal comfort[30]. This is the sum of all short- and long-wave radiation fluxes to which a human body is exposed and is thus a critical issue in assessing the human comfort outdoors.

A common adaptation measure to decrease radiation fluxes and outdoor temperatures is to increase shadow surfaces by plantations and/or shelters (Figure 4-3). 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 ([31];[32]).

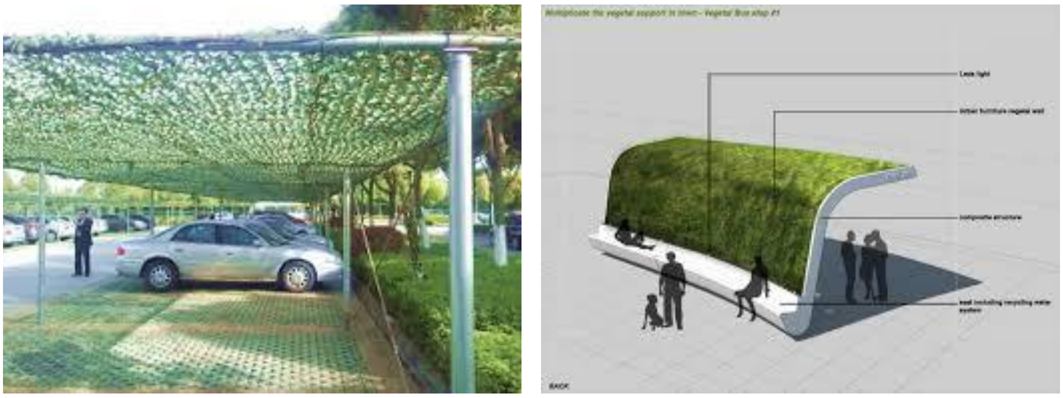

Figure 4-3: Green covering shelters

To be able to obtain the above-mentioned effects on the parking lot at Sub Demo A where there is no shadow area, green covering shelters will be constructed with an area of 1 600 m². In summer 2018, the surface and air temperatures (T_a), humidity (RH), wind velocity (v) and mean radiant temperature (T_{mrt}) will be measured under the shelters and unsheltered parking lots in-situ (sensors and thermal cameras) and aerial sensors by drone and/or satellite. The collected data can be processed using the RayMan model ([33];[34]) 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 indices such as Predicted Mean Vote (PMV) because of its unit (°C). (Table 4-5) shows the ranges of the most common thermal comfort indexes PMV and PET[35].

[30] Mayer, H. and Höppe, P., (1987). Thermal comfort of man in different urban environments, Theoretical and Applied Climatology, 38 (1), 43–49.

[31] Shashua-Bar, L., Pearlmutter, D. and Erell, E., (2011). The influence of trees and grass on outdoor thermal comfort in a hotarid environment. – Int. J. Climatol. 31, 1498–1506.

[32] Spronken-Smith, R.A and Oke, T.R., (1999). Scale Modelling of Nocturnal Cooling in Urban Parks, Boundary-Layer Meteorology, 93 (2), 287–312

[33] Matzarakis, A., Rutz, F. and Mayer, H., (2007). Modelling radiation fluxes in simple and complex environments—application of the RayMan model, Int J Biometeorol, 51, 323–334

[34] Matzarakis, A., Rutz, F. and Mayer, H., (2010). Modelling radiation fluxes in simple and complex environments: basics of the RayMan model, Int J Biometeorol, 54, 131–139

[35] Mayer, H. and Matzarakis, A. (1997). The urban heat island seen from the angle of human-biometeorology. In: Proceedings of the International Symposium on Monitoring and Management of the Urban Heat Island, Fujisawa, 84–95

The PET index assesses thermal comfort (Table 4-5) 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[36] 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[37].

<table>
<tr><th>PMV (-)</th><th>PET (°C)</th><th>Thermal Sensation</th><th>Grade of Physiological Stress</th></tr>
<tr><td></td><td></td><td rowspan="10">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</td><td rowspan="10">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</td></tr>
<tr><td>-3.5</td><td>4</td></tr>
<tr><td>-2.5</td><td>8</td></tr>
<tr><td>-1.5</td><td>13</td></tr>
<tr><td>-0.5</td><td>18</td></tr>
<tr><td>0.5</td><td>23</td></tr>
<tr><td>1.5</td><td>29</td></tr>
<tr><td>2.5</td><td>35</td></tr>
<tr><td>3.5</td><td>41</td></tr>
<tr><td></td><td></td></tr>
</table>

Table 4-5: 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) ([38];[39]).

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

Where, M the metabolic rate (internal energy production), W the physical work output, R the net radiation of the body, C the convective heat flow, E_D the latent heat flow to evaporate water diffusing through the skin (imperceptible perspiration), E_{Re} the sum of heat flows for heating and humidifying the inspired air, E_{Sw} the heat flow due to evaporation of sweat, and S 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 ([33]).

[36] Matzarakis, A., Rutz, F. and Mayer, H., (2010). Modelling radiation fluxes in simple and complex environments: basics of the RayMan model, Int J Biometeorol, 54, 131–139

[37] Gulyás, A., Unger, J. and Matzarakis, A., (2006). Assessment of the microclimatic and human comfort conditions in a complex urban environment: Modelling and measurements, Building and Environment, 41 (12), 1713-1722

[38] Höppe, P., (1999). The physiological equivalent temperature-a universal index for the biometeorological assessment of the thermal environment. Int J Biometeorol 43, 71–75

[39] Matrazakis, A. and Amelung, B., (2008). "Seasonal Forecasts, Climatic Change and Human Health", Ch.9: "Physiological Equivalent Temperature as Indicator for Impacts of Climate Change on Thermal Comfort of Humans, Climatic Change and Human Health", Eds: M.C. Thomson et al., Springer Science + Business Media

The calculation of PET includes the following steps[40]:

- 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 pressure of the air.

Baseline for decrease in mean or peak daytime local temperatures

Based on the current situation, Sub Demo A has little (sparsely distributed some small trees) or no vegetation, no structure for shading and is completely covered with concrete surfaces. Therefore, decrease in mean or peak daytime local temperatures is zero (0) as a baseline value. A considerable decrease in temperatures is expected after construction of green shelters and cool pavements.

Baseline for outdoor thermal comfort

Baseline for outdoor thermal comfort will be calculated after measuring micro climate conditions in Sub Demo A in summer 2018. But considering the current situation of the Demo Site, it is expected that values of thermal comfort will be "strong heat stress" or "extreme heat stress" level according to (Table 4-5).

Baseline for heat wave risks

The IPCC[41] defines “heat wave” as ‘‘a period of abnormally hot weather’’. The distribution of heat within urban areas depends on local climatology and urban meteorology combined with urban land-use patterns. The urban heat island represents the difference in temperature between cities and the surrounding rural areas. The urban heat island effect 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[42]. 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-

[40] Matrazakis, A. and Amelung, B., (2008). “Seasonal Forecasts, Climatic Change and Human Health”, Ch.9: “Physiological Equivalent Temperature as Indicator for Impacts of Climate Change on Thermal Comfort of Humans, Climatic Change and Human Health”, Eds: M.C. Thomson et al., Springer Science + Business Media

[41] IPCC (Intergovernmental Panel for Climate Change) (2012). Managing the risks of extreme events anddisasters to advance climate change adaptation. In: Field CB, Barros V, Stocker TF, Qin D, Dokken, DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner G-K, Allen SK, Tignor M, Midgley PM (eds) Aspecial report of working groups I and II of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp

[42] Smoyer-Tomic, K.E., Kuhn, R. and Hudson, A., (2003). Heat wave hazards: an overview of heat wave impacts in Canada. Nat Hazards 28:463–485

existing health problems, socially isolated elderly people with fragile health condition, young children, people suffering from obesity, etc. are particularly vulnerable to heat waves[43].
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 4-6 depicts the intensive heat waves and the maximum air temperature of summer months between 1938 and 1998 for Izmir[44].

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

Table 4-6: Intensive heat waves in Izmir (Source: Erlat, 1999)

According to (Table 4-6), the heat waves were occurred 30 times in summer months (June, July and August). The reason of the heat waves might be the increase in urbanization and global warming.

According to D'Ippoliti et al.[45], 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 Equation2.

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

Hot days were then defined as days with either (1) T_{appmax} exceeding the 90th percentile of the monthly distribution or (2) days in which T_{min} exceeds the 90th percentile and T_{appmax} exceeds the monthly median value. As an empirical rule, a hot day is defined as a day during which the air temperature exceeded 37°C for more than 3 hours[46].

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

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[43] IPCC (Intergovernmental Panel for Climate Change) (2012). Managing the risks of extreme events anddisasters to advance climate change adaptation. In: Field CB, Barros V, Stocker TF, Qin D, Dokken, DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner G-K, Allen SK, Tignor M, Midgley PM (eds) Aspecial report of working groups I and II of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp

[44] Erlat, E. (1999). *İzmirde Maksimum Sıcaklıklar ve Sıcak Dalgaları.* İzmir: Ege Coğrafya Dergisi, 10 :125-148

[45] Daniela D'IppolitiEmail, Paola Michelozzi, Claudia Marino, Francesca de'Donato, Bettina Menne, Klea Katsouyanni, Ursula Kirchmayer, Antonis Analitis, Mercedes Medina-Ramón, Anna Paldy, Richard Atkinson, Sari Kovats, Luigi Bisanti, Alexandra Schneider, Agnès Lefranc, Carmen Iñiguez and Carlo A Perucci (2010). The impact of heat waves on mortality in 9 European cities: results from the EuroHEAT project

[46] Keramitsoglou, I., Kiranoudis, C.T., Maiheu, B., De Ridder, K., Daglis, I.A., Manunta, P. and Paganini, M. (2013)., Heat wave hazard classification and risk assessment using artificial intelligence fuzzy logic, Environ Monit Assess, DOI 10.1007/s10661-013-3170-y.

above-mentioned dynamic thresholds necessary for the identification of hot days, a 20-year time series from the meteorological station based on an airport nearby Sasalı Wildlife Park 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.

4.1.2 Green Shady Structures with Smart Soil

- ***Study Area in Brief***

In this project, the construction of a strategic pathway to utilize pyrolysis technology and biochar use in agriculture will be actualized with potential and feasible utilization techniques.

As time is limited for establishing baselines in the project, it was not possible to make observations for a period of time for soil carbon in the study area. Since there is no pervious carbon sequestration or status observations on demo site, it was planned to conduct baseline data collection sometime starting in first period of 2018.

CHALLENGES & ENVIRONMENTAL PROBLEMS		Urban GreenUP Category	NBS	Quantity
Eklipse Framework	**City-Specific Environmental Problems**	Smart Soils	Smart Soil into Green Shady Structures	590 m^2
Climate mitigation & adaptation	Urban heat island & Air pollution			
		Horizontal GI	Green Shady Structures (for Sasalı Natural Life Car Parking Lot)	200 m^2

Table 4-7 Summary of green shady structures with smart soil

- ***Baseline Calculation***

Indicators (social, economic, physical, environmental etc.)	**Metrics (a;b;c;d...)** from EKLIPSE & NBS Impact Table (or new metrics)	**Scale**	**Baseline Values**
Environmental, Chemical	Carbon storage and sequestration in vegetation	D	16.15 tones/year
	Carbon storage and sequestration in soil	D	To be calculated in first period of 2018
Environmental, Physical	Increase in shadow surface (m^2)	D	To be measured in summer 2018

Indicators (social, economic, physical, environmental etc.)	**Metrics (a;b;c;d...)** from EKLIPSE & NBS Impact Table (or new metrics)	**Scale**	**Baseline Values**
	Decrease in mean or peak daytime local temperatures (°C)	D	0
	Heatwave risks (number of combined tropical nights (>20°C) and hot days (>35°C))	M, U	To be measured in summer 2018

Table 4-8: Metrics and baseline for green shady structures with smart soil

Methods – Soil carbon under biochar applications

Pot experiment

After characterization of biochars, a pot experiment will be conducted under greenhouse conditions in randomized plots experimental design with decided biochars or biochar mixtures. Application doses will be ranged between 10-50 t/ha and may be regulated depending on a normalization of different carbon content of each biochar, for a constant application of Org-C. As an indicator plant, maize (*Zea mays L.*) or wheat (*Triticum aestivum L.*) will be grown in pots.

Soil fertility analyses

Soil samples representing each pot will be collected as vertical sections from soil surface to bottom. Then, samples will be air dried and sieved through 2 mm sieve for analyses. pH and electrical conductivity values were measured directly from saturation pastes of soils after 2 h of waiting period. Organic matter and total N contents will be determined with rapid dichromate oxidation and macro-Kjeldahl methods, respectively. Plant-available phosphorus content of soils will be determined by 0.5 M $NaHCO_3$ (pH: 8.5) extraction; plant-available Ca, Mg, K and Na were extracted by 1 N NH_4OAc (Page et al., 1982); Ca, K and Na will be determined by flame photometry and Mg by AAS; plant-available Fe, Mn, Zn and Cu will be extracted by DTPA (diethylene triamine pentaacetic acid) solution (pH: 7.3)[47]. Concentrations of these nutrients will be determined by AAS[48].

Black carbon

The grinded soil samples will be weighed and taken to porcelain crucibles. After wetting soil samples in crucibles, 1 M HCl solution will be added two times in 2 h. Then, they will be dried at 60 °C and HCl addition will continue until there is no observable reaction in soils. Soil will again be grinded and left for 24 h at 375 °C. After oxidation, the residue will be considered as the black carbon[49].

[47] Lindsay, W.L., Norvell, W.A., 1978 "Development of a DTPA Soil Test for Zinc, Iron, Manganese and Copper", Soil Sci. Soc. Amer. J., 42, 421, 1978

[48] AOAC, 1990. Official methods of analysis In: Helrich K (ed) Association of official analytical chemists, Washington, DC

[49] Gustafsson, O., Bucheli, T.D., Kukulska, Z., Andersson, M., Largeau, C., Rouzaud, J.N., Reddy, C.M. and Eglinton, T.I., 2001. Evaluation of a protocol for the quantification of black carbon. Global Biogeochemical Cycles, 15, pp.881-890

Mineral associated org-C, particulate org-C, dissolved org-C

40 g of air-dry soil sieved from a 2-mm mesh will be shaken at 250 rpm in 0.5% Calgon solution for 18 hours at 90 rpm. The suspension is then will be washed with distilled water on a 53 µm sieve. The fraction remaining on the sieve will be considered particulate organic matter. The part under the sieve will be collected in a beaker and this solution will be vacuum pumped through a membrane with a pore diameter of 0.45 µm. While the remaining on the membrane is regarded as a mineral-related organic substance, the liquid under the membrane will be regarded as dissolved organic matter. The carbon contents of all organic fraction fractions subjected to physical separation will be determined by the Total Organic Carbon (TOC) analyser device ([50];[51]).

Microbial biomass carbon (MBC)

The soil samples which moisture content is determined will be rinsed with 0.5 M K_2SO_4 after being fumigated with chloroform according to Jenkinson (1976)[52] ([53]). The extract will be analysed on the TOC device. MBC will be calculated as follows:

MBC = $(C_{fumigated} - C_{control})$ / kEC. In the calculation, k_{EC} factor of 0.45 will be used ([54]).

Carbon management index

A carbon management index (CMI) for soil samples was developed based on changes in the total carbon content of soils and carbon availability determined by oxidation of $KMnO_4$[55]. $KMnO_4$ oxidation is briefly based on the spectrophotometric evaluation of the supernatant at 565 nm wavelength after shaking of the soil samples with 333 mM $KMnO_4$ for 1 hour at 60 rpm and centrifuging at 2 000 rpm for 5 min[56]. Accordingly, based on changes in total organic carbon between the treatments and control, Carbon Pool Index (CPI) will be calculated as:

CPI = *Tot. Org-C*$_{(application)}$ / *Tot. Org-C*$_{(control)}$

Based on C fraction oxidized by KMnO4 (POXC), lability of carbon (L) will be calculated as:

L *= Carbon in fraction oxidized by KMnO4 / Carbon remaining unoxidized by KMnO4*

Based on changes in the proportion of labile C, a lability index (LI) will be calculated as:

[50] Zhang, M.K., He, Z.L., 2004. Long-term changes in organic carbon and nutrients of an ultisol under rice cropping in southeast China. Geoderma 118, 167-179

[51] Plante, A.F., Conant, R.T., Paul, E.A., Paustian, K., Six, J., 2006. Acid hydrolysis of easily dispersed and microaggregate-derived silt- and clay-sized fractions to isolate resistant soil organic matter. European Journal of Soil Science 57, 456-467

[52] Jenkinson, D.S., 1976. The effects of biocidal treatments on metabolism in soil. IV. The decomposition of fumigated organisms in soil. Soil Biology and Biochemistry 8: 203 – 208

[53] Vance, E.D., Brookes, P.C., Jenkinson, D.S. 1987. An extraction method for. measuring soil microbial biomass C. Soil Biology and Biochemistry. 19: 703 – 707

[54] Joergensen, R.G., Wu, J., Brookes, P.C. 2011. Measuring soil microbial biomass using an automated procedure. Soil Biol. Biochem. 43, 873–876

[55] Graeme J. Blair, Rod D. B. Lefroy and Leanne Lisle, 1995 - Soil Carbon Fractions, Based on their Degree of Oxidation, and the Development of a Carbon Management Index for Agricultural Systems Department of Agronomy and Soil Science, University of New England, Armidale, N.S.W. Australia. 2351.

[56] Demisie, W., Liu, Z. and Zhang, M., 2014. Effect of biochar on carbon fractions and enzyme activity of red soil. Catena, 121, pp.214-221

LI = $L_{(application)} / L_{(control)}$

Taking the two indices (CPI and LI), the CMI was calculated as:

CMI = *CPI x LI x 100*

Higher CPI (CPI > 1) or lower (CPI < 1) indicates higher organic C accumulation or loss, respectively. Similarly, higher LI (LI > 1) indicates higher labile organic C content which can be due to more organic matter decomposition. On the contrary, lower (LI < 1) indicates lower labile organic C content which is directly related to less decomposition of organic matter. The CMI expresses the soil quality in terms of increments in the total C content and in the proportion of labile C fraction compared to the control which arbitrarily has a CMI of 100. Hence, higher CMI (CMI > 100) or lower CMI (CMI < 100) indicates increase or decrease in soil quality, respectively.

Aggregate size distribution and aggregate associated organic carbon

The soils will be passed through a sieve set having horizontal sieve diameter of 8, 4, 2, 1, 0.5, 0.25, 0.106 mm respectively (Horizontal Sieve Shaker AS 400, Retsch, Germany) to determine the aggregate size distributions. After sieving, soil samples will be collected and classified depending on their specific diameter as >2, 2-0.25, 0.25-0.106 and <0.106 mm. Organic carbon content of each class will be determined in TOC device[57].

Determination of macro and micro aggregate distributions of soils and revealing of the organic carbon content of these aggregates will enable the investigation of the effect of biochar material on soil physical properties in terms of aggregate-related stabile organic carbon contents.

Dehydrogenase enzyme activity

Dehydrogenase enzyme activity will be determined by photometric measurement of TPF (1,3,5-Triphenyltetrazolium formazan) at 546 nm wavelength formed after 16-hour incubation of soils at 25 °C in which TTC (Triphenyl T-tetrazolium chloride) solution is applied at different concentrations depending on the amount of soil texture and organic matter[58]. Dehydrogenase enzyme activity will be tested as a basic indicator of microbial life in soil.

Figure 4-4: Smart soil into green shady structures

[57] Song, K., Yang, J., Xue, Y., Lv, W., Zheng, X., Pan, J. 2016. Influence of tillage practices and straw incorporation on soil aggregates, organic carbon, and crop yields in a rice-wheat rotation system. NATURE, Scientific reports, 6

[58] Thalmann, A. 1968. Zur methodik der bestimmung der dehydrogenaseaktivitaet im boden mittens triphenyltetrazoliumchlorid (TTC), Landwirtsch Forsch 21:249–258

4.1.3 Cool Pavement

- ***Study Area in Brief***

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	NBS	Quantity
Eklipse Framework	**City-Specific Environmental Problems**	Green pavements	Cool pavement	762 m²
Climate mitigation & adaptation	Urban heat island			

Table 4-9 Summary of cool pavement

Conventional pavements such as impervious concrete and asphalt used in the Sub Demo A (Figure 4-2), can reach quite high surface temperatures in summer. These surfaces can transfer heat downward to be stored in the pavement subsurface, where it is re-released as heat at night. These effects contribute to the Urban Heat Island effect[59]. Thus, cool pavements are very important for the local cooling strategies in a city using high-reflective or permeable paving materials and/or thinner pavements to reduce absorption and retention of heat. As a main determinant of maximum surface temperatures, solar reflectance or albedo is the percentage of solar energy reflected by a surface[60]. According to EPA, every 10% increase in solar reflectance could decrease surface temperatures by 4°C. Further, if pavement reflectance throughout a city were increased from 10% to 35%, the air temperature could potentially be reduced by 0.6°C. Reflective pavements are made from a variety of materials (e.g. resin, coloured asphalt or concrete) and are mostly used at low-traffic areas such as footpaths and car parks.

Some parts of the conventional pavements (762 m²) in Sub Demo A will be replaced with cool pavements using high reflective materials. In summer 2018, the temperatures on the conventional and cool pavement surfaces will be measured in-situ (sensors and thermal cameras) and aerial sensors by drone and/or satellite, then the reduction in temperature will be determined.

- ***Baseline Calculation***

Indicators (social, economic, physical, environmental etc.)	**Metrics (a;b;c;d...)** from EKLIPSE & NBS Impact Table (or new metrics)	**Scale**	**Baseline Values**
Environmental, Physical	Decrease in mean or peak daytime local temperatures (°C)	D	0
	Heatwave risks (number of combined tropical nights (>20°C) and hot days (>35°C)	M, U	To be measured in summer 2018

[59] Kazmierczak, A. (2012), Heat and social vulnerability in Greater Machester: a risk – response case study. EcoCities project, University of Manchester, Manchester, UK

[60] EPA, (2012). Reducing Urban Heat Islands: Compendium of Strategies Cool Pavements, U.S. Environmental Protection Agency, https://www.epa.gov/heat-islands/heat-island-compendium

Table 4-10 Metrics and baseline for cool pavement

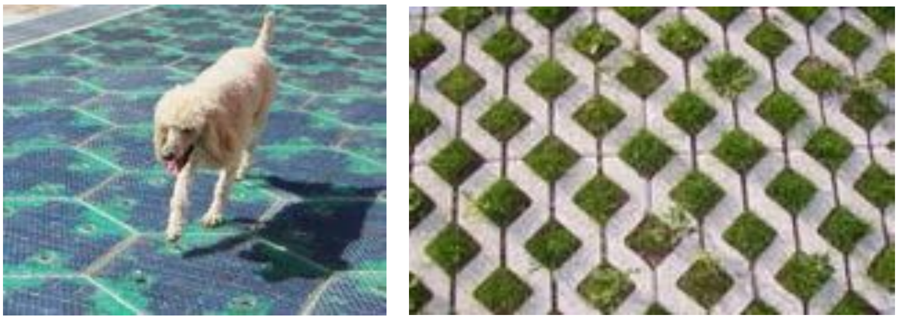

Figure 4-5 Examples for cool pavement

4.1.4 Shade and cooling trees

- ***Study Area in Brief***

Shade and cooling trees will be planted along Peynircioğlu Stream and its surroundings.

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	NBS	Quantity
Eklipse Framework	**City-Specific Environmental Problems**	Arboreal Interventions	Shade and cooling trees	26 units
Climate mitigation & adaptation	Urban heat island			

Table 4-11 Summary of shade and cooling trees

- ***Baseline Calculation***

Indicators (social, economic, physical, environmental etc.)	**Metrics (a;b;c;d...)** from EKLIPSE & NBS Impact Table (or new metrics)	**Scale**	**Baseline Values**
Environmental, Physical	Increase in shadow surface (m^2)	D	To be measured in summer 2018
	Decrease in mean or peak daytime local temperatures (°C)	D	0
	Heatwave risks (number of combined tropical nights (>20°C) and hot days (>35°C)	M, U	To be measured in summer 2018
	Increase in thermal comfort (°C)	D	To be calculated in first period of 2018

Table 4-12: Metrics and baseline for shade and cooling trees

 

Figure 4-6: Shade and cooling trees

4.1.5 Parklets

- ***Study Area in Brief***

Parklets are similar to pocket parks. However, parklet can be seen an extension the footpath that uses street space for car parking ([61],[62]).

Air pollution is one of the main problems of urban areas. Karşıyaka is not the exception of course. It has been experiencing air pollution especially in winter months owing to fossil fuels. Although natural gas has been used for the heating, unfortunately low-income neighbourhoods in the Karşıyaka district still use fossil fuels. The air pollutant measurements showed that especially December, July and August in 2016 are the worst months in terms of air quality. The air pollutants measured in Karşıyaka are CO, SO_2, PM10, NO_2, NO_x and NO.
If the existing situation is taken into account, as the vegetation cover is poor around the proposed parklets, the air pollutant removal capacity of vegetation will likely to be low as a baseline value.

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	NBS	Quantity
Eklipse Framework	**City-Specific Environmental Problems**	Resting areas	Parklets (in Girne Avenue)	2 units
Air Quality	Air pollution			

Table 4-13: Summary of parklets

- ***Baseline Calculation***

Indicators (social, economic, physical, environmental etc.)	**Metrics (a;b;c;d...)** from EKLIPSE & NBS Impact Table (or new metrics)	**Scale**	**Baseline Values**
Environmental, Chemical	Pollutant's removed by vegetation (in leaves, stems and roots) (kg ha -1 year -1)	**D**	**Parklet 1** 604.96 mg/year

[61] Speck, J. (2018). Introduce Parklets: Hand-crafted decks are the cheap path to wider sidewalks, In book: Walkable City Rules, Island Press.
[62] Endo, A. (2016). A Study on The Parks Design of Streets In San Francisco: ― Making a human centered street by the Parklet and Plaza, Journal of Architecture and Planning (Transactions of AIJ) 81(725):1589-1599.

Indicators (social, economic, physical, environmental etc.)	**Metrics (a;b;c;d...)** from EKLIPSE & NBS Impact Table (or new metrics)	**Scale**	**Baseline Values**
			Parklet 2 642.77 mg/year
Environmental, Chemical	Carbon sequestration in vegetation	**D**	**Parklet 1** 19 kg/per year
			Parklet 2 20.16 kg /per year

Table 4-14: Metrics and baseline for parklets

Baseline for carbon sequestration

Carbon sequestration potential of trees has been quantified using many different measures and metrics. The amount of carbon sequestration by trees was calculated in three steps by using the following method; (1) determine the above-ground weight of the tree (multiply the diameter of the trunk and the height, and 120 per cent), (2) Determine the dry weight of the tree (on average 72.5 per cent of the total weight), (3) Determine the weight of carbon in the tree (50% of the tree's total volume) (Broward County 2012) Eq. (1-2).

$$\boldsymbol{W} = [\mathbf{0.25} \times \boldsymbol{D}^{\mathbf{2}} \times \boldsymbol{H} \times \mathbf{120\%} \times \mathbf{72.5\%} \times \mathbf{50\%}] \times \mathbf{0.45359237} \qquad \text{D < 11 inch (1)}$$

$$\boldsymbol{W} = [\mathbf{0.15} \times \boldsymbol{D}^{\mathbf{2}} \times \boldsymbol{H} \times \mathbf{120\%} \times \mathbf{72.5\%} \times \mathbf{50\%}] \times \mathbf{0.45359237} \qquad \text{D} \geq \text{11 inch (2)}$$

Where; W = Aboveground weight of the tree in kg, D = Diameter of the trunk in inches, and H = Height of the tree in feet.

Carbon sequestration by vegetation in Parklet 1 is calculated to be 19 kg/year.
Carbon sequestration by vegetation in Parklet 2 is calculated to be 20.16 kg/year.

Baseline for pollutants removed by vegetation

Airborne particles and gas molecules can be deposited when they pass close to a surface. Most plants have a large surface area per unit volume that increases the probability of deposition compared to the smooth surfaces present in urban areas[63].

[63] Roupsard, P., Amielh, M., Maro, D., Coppalle, A., Branger, H. 2013. "Measurement in a wind tunnel of dry deposition velocities of submicron aerosol with associated turbulence onto rough and smooth urban surfaces", Journal of Aerosol Science, 55,12-24

Air pollutant removal capacity of trees was estimated based on dry deposition that is considered as the rate of air pollutants removed from the atmosphere ([64];[65];[66]). Pollutants are removed on leaf surfaces primarily in two ways: through leaf stomata uptake of gaseous pollutants and leaf interception of particulate matter[67]. 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 re-suspension of intercepted particles from the leaf surfaces through wind action[68]. 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) were not included in the calculation.

The pollutant flux (Fi) is calculated as the product of the deposition velocity (Vd) and the concentration of air pollutant i (Ci), Eq. (3):

$$\boldsymbol{F_i} = \boldsymbol{Vd(cm/sn)} \times \boldsymbol{C(g/m^3)} \tag{3}$$

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. (4):

$$\boldsymbol{F_{it}} = \boldsymbol{F_i} \times \boldsymbol{A} \times \boldsymbol{T} \tag{4}$$

The amount of air pollutants removed by trees (F) could be quantified by Eq.(5);

$$\mathbf{F} = \sum_{\mathbf{i=1}}^{\mathbf{3}} \mathbf{F_{it}} \tag{5}$$

In Parklet 1, pollutants removed by vegetation are calculated separately as 192.96 mg/year SO_2, 397.44 mg/year PM 10 and 14.56 mg /year NO_2. It was found that 604.96 mg/year pollutants are removed in total.
In Parklet 2, pollutants removed by vegetation are calculated separately as 205.02 mg/year SO_2, 422.28 mg/year PM 10 and 15.47 mg/year NO_2. It was found that 642.77 mg/year pollutants are removed in total.

[64] Lovett, G.M. (1994), “Atmospheric deposition of nutrients and pollutants in North America: an ecological perspective”, Ecological Application, 4, 629-650
[65] McPherson, E.G., Scott, K.I., Simpson, J.R. (1998), “Estimating cost effectiveness of residential yard trees for improving air quality in Sacramento, California, using existing models”, Atmospheric Environment, 32, 75-84
[66] Scott, K. I., J. R. Simpson, and E. G. McPherson. 1998. Air pollutant uptake by Sacramento's urban forest. J. Arboriculture. 24:224-234
[67] Nowak, D.J., Crane, D.E., Stevens, J.C. (2006), “Air pollution removal by urban trees and shrubs in the United States”, Urban Forestry and Urban Greening, 4, 115-123
[68] Selmi, W., Weber, C., Riviere, E., Blonda, N., Mehdi, L., Nowak, D.J. 2016). “Air pollution removal by trees in public green spaces in Strasbourg city France”, Urban Forestry & Urban Greening, 17, 192-201

4.2 Sub Demo B: Climate-Smart Urban Farming

4.2.1 Climate-smart greenhouse in urban farming precinct

- ***Study Area in Brief***

Climate-smart greenhouses will be built in Sasalı Natural Life Park to illustrate the current and future effects of climate change on urban and rural green vegetation. The greenhouses will demonstrate producing agricultural crop continuously under changed climate condition. Urban farming/community practices/new social forms of organization will be illustrated in the climate-smart urban farming precinct in the special precinct of Sasalı Natural Life Park. In demo side B not only climate smart greenhouse will be built but also special farming will be demonstrated on saline and alkaline soils compatible with chancing climate condition. Because of that "urban farming" preferred as general terminology.

In greenhouse area water savings from water-resistant plants will be 7.5t/year. It also will benefit from nearby peri-urban agricultural areas that give farmers to better production planning and implementation abilities.

As time is limited for establishing baselines in the project, it was not possible to make observations for a period of time for soils in the demo site. Since there is no pervious measurements or status observations on demo site, it was planned to conduct baseline data collection sometime starting in first period of 2018.

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	LIST OF NBSs	Quantity
EKLIPSE Framework	City-Specific Environmental Problems	Urban farming	Climate-smart Greenhouses	2 000 m^2
Climate mitigation & adaptation	Discontinuity risk of agricultural production (soil & water)			

Table 4-15 Summary of climate-smart greenhouse in urban farming precinct

- ***Baseline Calculation***

Indicators **(social, economic, physical, environmental etc.)**	Metrics (a;b;c;d...) from EKLIPSE & NBS Impact Table (or new metrics)	Scale	Baseline Values
Environmental	Metrics based on non-technical interventions	D	To be calculated in first period of 2019

Table 4-16: Metrics and baseline for climate-smart greenhouse in urban farming precinct

Figure 4-7: Climate smart greenhouse

4.2.2 Biofuel production unit

- ***Study Area in Brief***

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	LIST OF NBSs	Quantity
Eklipse Framework	**City-Specific Environmental Problems**	Urban farming	Bio-fuel production unit	1 unit
Climate mitigation & adaptation, Air quality	Air pollution			

Table 4-17: Summary for biofuel production unit

- ***Baseline Calculation***

Indicators (social, economic, physical, environmental etc.)	**Metrics (a;b;c;d...)** from EKLIPSE & NBS Impact Table (or new metrics)	**Scale**	**Baseline Values**
Environmental, Physical	Energy and carbon savings from reduced building energy consumption kWh/y and tonnes carbon/y saved	U, N, D	0
Environmental, Chemical	Net air quality improvement (pollutants produced – pollutants captured + GHG emissions from maintenance activities)	U	0
Environmental, Chemical	Pollutant fluxes per m^2 per year	U	To be calculated in winter 2018

Table 4-18: Metrics and baseline for biofuel production unit

Baseline for Energy Consumption and Greenhouse Gas Emissions

¡Error! No se encuentra el origen de la referencia. Figure 4-8 gives the sectoral distribution of total electricity consumption in İzmir. Industry and building sectors are responsible from 41% and 40% of electricity consumption.

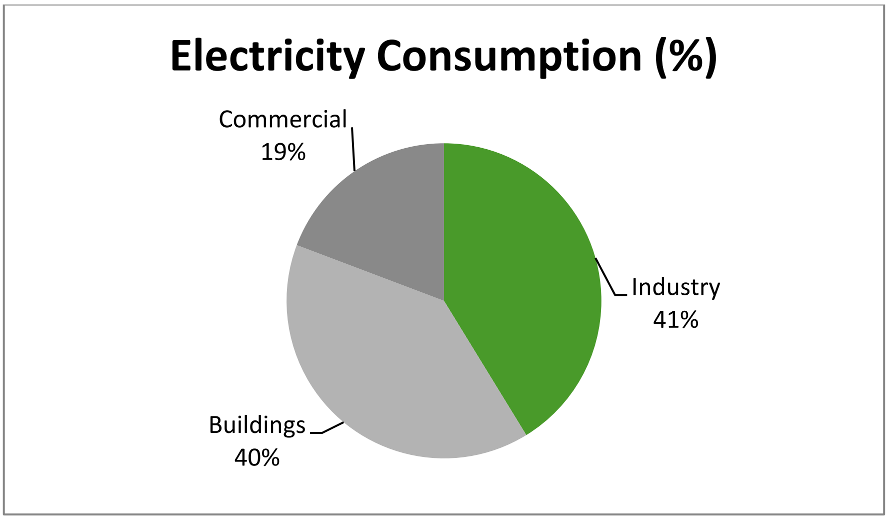

Figure 4-8: Sectoral distribution of total electricity consumption in İzmir (Source: IMM, 2016)[69]

Figure 4-9 represents the total electricity consumption of buildings in Izmir (2010-2012)[70]. The Figure indicates that total electricity consumption of buildings was increased by 15% from 2010 to 2012. The reason of increase in electricity consumption could be increase in cooling loads and, increase in air-conditioners and heat pump use.

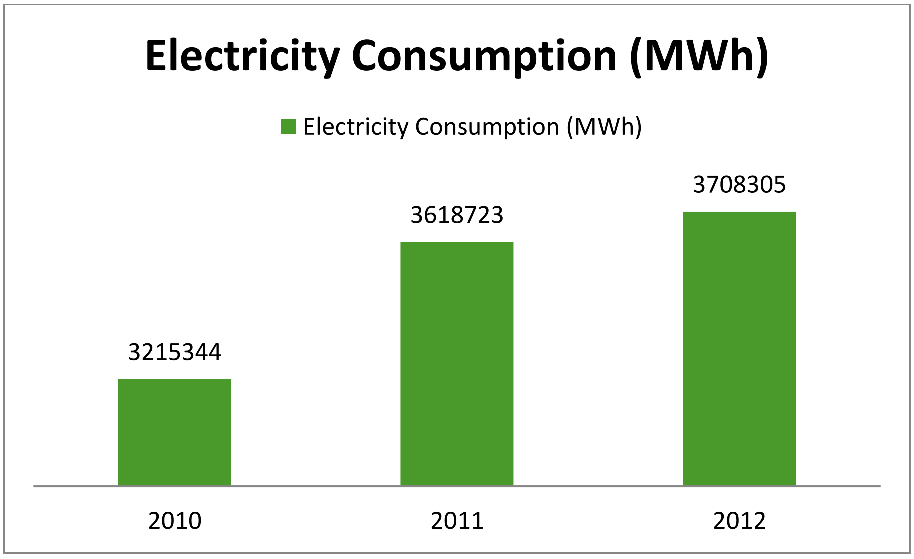

Figure 4-9: Electricity consumption of buildings in Izmir (Source: TUIK, 2013)[71]

[69] IMM (İzmir Metropolitan Municipality). (2016). *Sustainable Energy Action Plan.* İzmir
[70] *TUIK,* (2013). Retrieved from http://www.tuik.gov.tr/ilGostergeleri/iller/IZMIR.pdf
[71] *TUIK,* (2013). Retrieved from http://www.tuik.gov.tr/ilGostergeleri/iller/IZMIR.pdf

¡Error! No se encuentra el origen de la referencia. Figure 4-10 illustrates the sectoral greenhouse gas emissions of Izmir[72]. The total greenhouse gas (CO_2 + CH_4 + NO_2) emissions of the industry accounts for 44% while buildings are responsible for 12%. The Demo Sites are located in the vicinity of Çigli Industrial Zone. Therefore, they are under the effect of both industrial and building effluents.

According to a study conducted to evaluate the heating energy consumption and related greenhouse gas emissions of 148 multi-storey residential buildings for Konak, Karabağlar and Balçova Municipalities of Izmir, heating energy consumption of buildings varies between 100 and 240 kWh/m^{2}y (Energy Class B-C). Regarding with the CO_2 emissions, 57% of total buildings using autonomous heating system (as coal-fired stove) were in CO_2 Class G (60-150 kgCO_2/m^{2}y)[73].

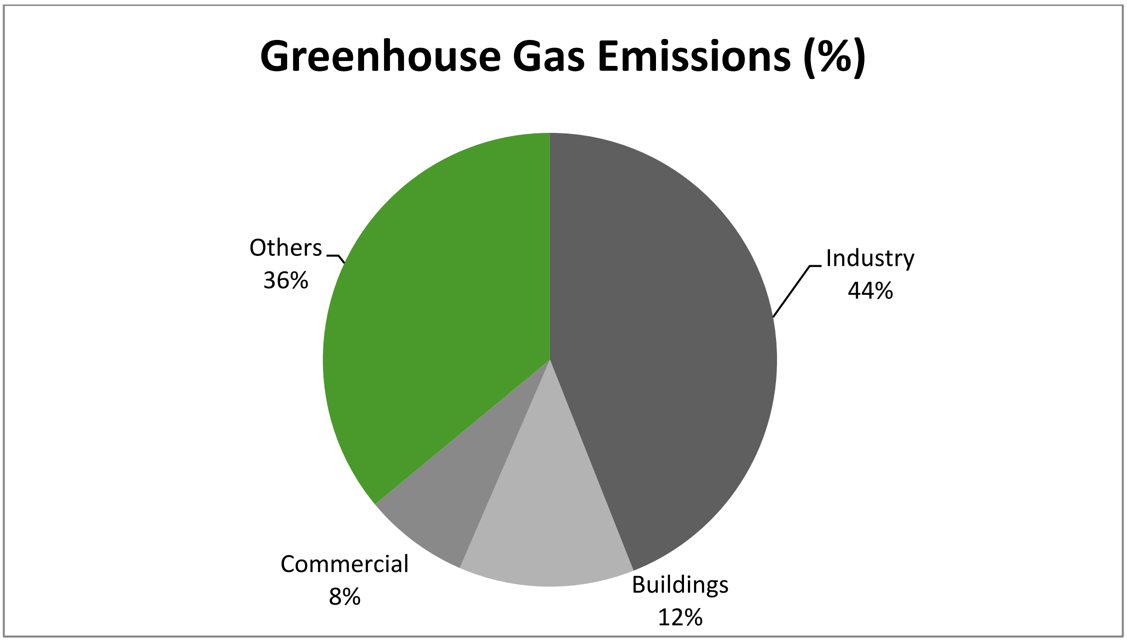

Figure 4-10: The sectoral greenhouse gas emissions in Izmir (Source: IMM, 2016)[74]

Baseline for kWh/y and tonnes carbon/y saved

At the moment, the value for baseline is zero (0) since the intervention is not initiated yet. After initiating a bio-fuel production unit in Sub Demo B, the produced pellets will be used at stoves, and the amount of energy consumed, fossil-fuel replacement rate and decrease in greenhouse gas emissions will be calculated based on the measured calorific value of the pellets and

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[72] IMM (İzmir Metropolitan Municipality). (2016). *Sustainable Energy Action Plan.* İzmir

[73] Kazanasmaz, T., Erlalelitepe, İ., Gökçen Akkurt, G., Turhan, C., Ekmen, K.E., (2014). On the relation between architectural considerations and heating energy performance of Turkish residential buildings in Izmir, Energy and Buildings, 72: 38-50

[74] IMM (İzmir Metropolitan Municipality). (2016). *Sustainable Energy Action Plan.* İzmir

greenhouse gas emission factors taken from IPCC, USEPA and CORINAIR[75]. Then the calculations will be extended to whole metropolitan area to obtain energy and greenhouse gas emission savings.

The pellets will be obtained using energy plants which will be grown in Sub Demo B.

Air Pollution

The Demo Sites are either located in highly urbanised areas with dense population and traffic or close to an industrial zone. Industry is the most polluting sector for SO_2 in the study area contributing about 88% of total emissions. 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 centre 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[76]. 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[77]. The CO_2 emission per capita in Izmir is 5.31 tonnes/y. Figure 4-11 displays the annual emissions of two main air pollutants (PM10 and SO_2) in Çiğli/Izmir from 2012 to 2016. PM10 level of Çiğli/Izmir is increased gradually while SO_2 level is decreased[78]. However, pollutants level never exceeded the EU levels.

[75] USEPA, (2010). Compilation of air pollutant emission factors: AP-42. Volume I: stationary point and area sources, chapter 1: external combustion; 1998 [Retrieved July 15, 2010, from http://www.epa.gov/ttn/chief/ap42/ch01/index.html]

[76] Elbir, T., & Müezzinoğlu, A. (2004). Estimation of emission strengths of primary air pollutants in the city of İzmir, Turkey. *Atmospheric Environment 38*, 1851–1857

[77] Müezzinoğlu, A., Elbir, T., Dinçer, A., Bayram, A., Odabaşı, M., Çetin, E., & Seyfioğlu, R. (2004). Emission of Air pollutants: Measurements, Calculations and Uncertainties. In *Developing emission inventories for Turkey* (pp. 318-334)

[78] IMM (İzmir Metropolitan Municipality). (2017). Retrieved from: http://www.izmir.bel.tr/eislem/HavaDegerleri/HavaDegerleri.aspx

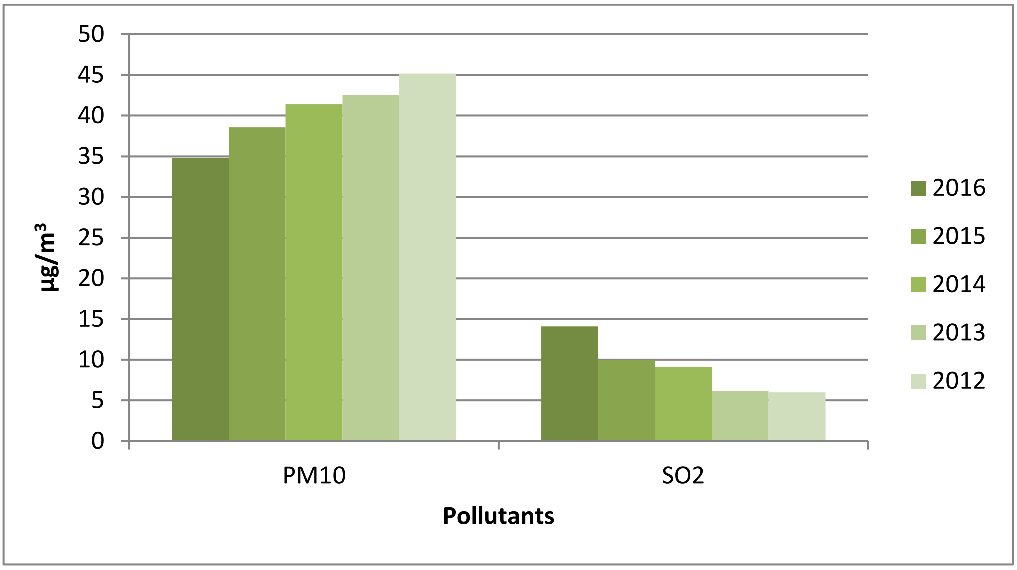

Figure 4-11: The annual emissions of PM10 and SO2 in Çiğli-Izmir (Source: IMM, 2017)

Baseline for non-spatial indicators of net quantities: net air quality improvement and Spatial indicators: pollutant fluxes per m^2 per year

Since the metric considers the "improvement" in net air quality, the value for baseline is zero (0). The contribution of CO_2 emission by building heating systems, on air quality will be calculated as given in "Baseline for kWh/y and tonnes carbon/y saved".

The other pollutants such as PM10, SO_2, NO_x and ozone will be measured/collected from a stationary Air Quality Measurement Station located in Çiğli and a mobile station belongs to Izmir Metropolitan Municipality. Then the improvement in air quality and pollutant fluxes in urban level will be determined.

Figure 4-12: Pollutant filters / Biofilters

4.3 Sub Demo C: New Green Corridor including Renaturing Peynircioğlu Stream and Bio-Boulevard

In Sub Demo C, there are three unique areas that constitutes a district/neighbourhood wide green corridor from dense urban areas to natural protection sites:

- The first part covers linear elements (NBSs in 4.3.1 and 4.3.2) start from central coastline, goes through Peynircioğlu Stream and reaches to Sasalı Natural Life Park and possible other extensions towards nature protection areas like Izmir Bird Paradise.
- The second part, as a major component of new green corridor, illustrates NBSs (4.3.3, 4.3.4) alongside Peynircioğlu Stream. Both sides of the stream and its opening to central coastline is the focus of NBSs in this category.
- The third part is a special section of new green corridor called "Bio-Boulevard". NBSs taken on the Bio-Boulevard (4.3.5, 4.3.6 and 4.3.7) presents a unique learning opportunity about green infrastructure elements and raising awareness about bio-diversity.

New Green Corridor in Karşıyaka and Çiğli Districts in Brief

The proposed green corridor, which starts from Sasalı Natural Life Park in Çiğli District and merges into Peynircioğlu River and coastal promenade in Karşıyaka District, offers a more comfortable, greener and sustainable green connection at the northern end of the city. The coastal promenades and linear parks that encompass the Izmir Bay all the all way from north to south would be linked to Sasalı Natural Life Park and South Gediz Delta through proposed cycling friendly greener corridor.

The proposed new green corridor starts in Çiğli and ends in Karşıyaka is a connecter between two districts. Therefore, calculation for urban green and public green spaces was based on confluence of the UDZs of two urban districts.

Open and green spaces cover 39.71 % of the Karşıyaka and Çiğli UDZ. Green spaces were classified as natural and managed urban green spaces in this study (Table 4-19).

Type of green spaces	% cover
Parks	1.17
Gardens	4.65
Wetlands	7.84
Open spaces	10.04
Cemetery	0.19
Native vegetation	9.16
Agriculture	12.27
Other (roadside vegetation, canals)	2.09

Table 4-19: Diversity of green spaces

Open spaces are dominant land cover type in the Karşıyaka and Çiğli UDZ and represented by vacant lands with little or no vegetation cover in the built-up area. They occupy 8.84 % of the total area and located both in and peripheries of built-up area. Agricultural land and native vegetation covers come right after open spaces. These areas are mostly located at the peripheries of the Karşıyaka and Çiğli UDZ with the relatively intact patches. Wetlands occupy 5.48 % of the southern coast of the area.

Gardens, with the 4.15 %, are represented by the apartment yards (mostly multiple story tall buildings) and single-family house gardens, and gardens of public and government buildings, such as schoolyards, hospital gardens and commercial centres.

Parks showing different characteristics (small and medium size neighbourhood park, plazas, playgrounds, waterfront promenades etc.) cover just 2.43% of the area.

City	CA	NP	PLAND (%)	AREA_MN	GYRATE_AM	CONNECT
Built-up	3395.63	21.00	60.29	161.69	3358.79	14.76
Green spaces	2236.07	2026.00	39.71	1.10	32.32	1.41

Table 4-20: Landscape metrics values of the Karşıyaka and Çiğli UDZ

In terms of distribution, configuration and connectivity of green spaces 60.29 % of the Karşıyaka and Çiğli Metropolitan Districts are covered by urban built up area. Green areas exist in 39.71 % of the area. Number of patch value of green areas is high while mean patch size values are very low. This means that green areas are composed of small patches (Table 4-20). Urban pattern map shows that green areas are unevenly in UDZ (Figure 4-13).

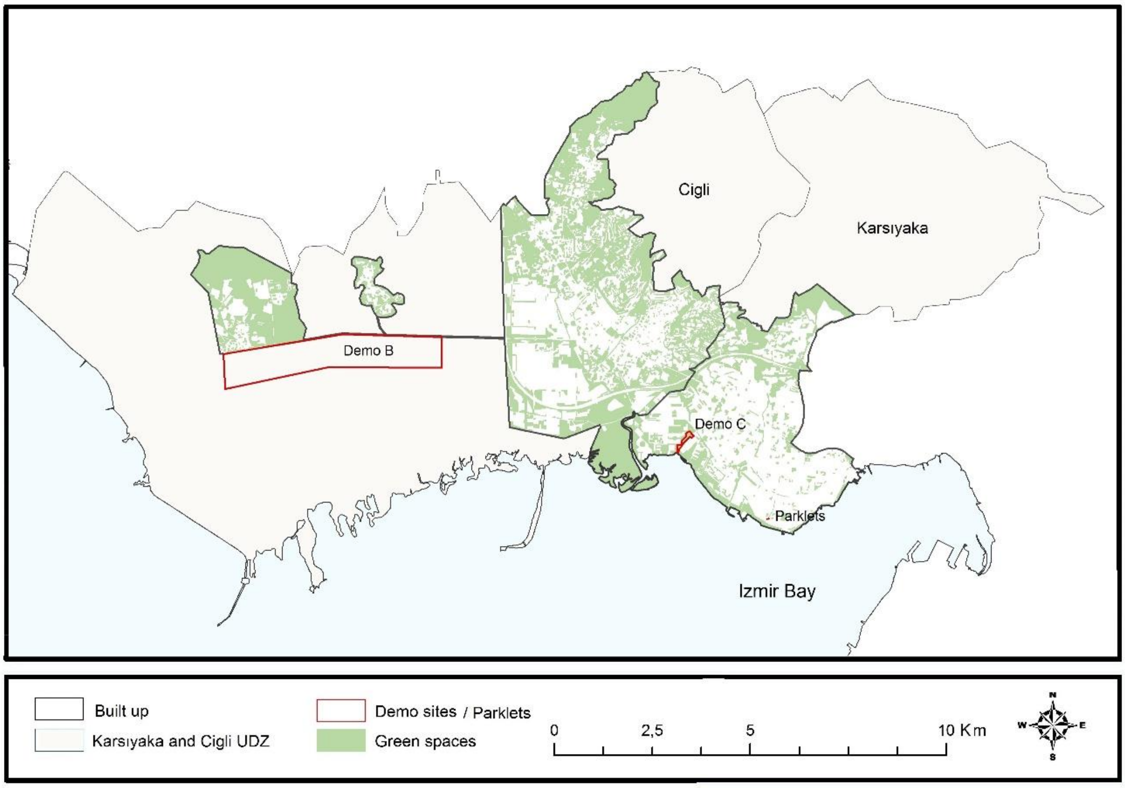

Figure 4-13: The map of green spaces in the Karşıyaka and Çiğli UDZ

GYRATE_AM is used for interpretation of the physical connectedness of the landscape. As the GYRATE_AM value of green spaces is very low compare to built-up, it can be predicted that green areas in considerably subdivided (Table 4-20). This is also supported by the connectivity index value that is 1.41.

Based on the calculations done for this project, it is not possible to mention that there is a well-connected and well-functioning GI pattern or network in the Çiğli-Karşıyaka Districts because of insufficient numbers of corridors and highly fragmented pattern of patches as well as size of the patches (Figure 4-13). Moreover, configuration of existing corridors in the urban landscape does not serve linkage purposes. As the components of existing GI in the study area, patches cover 36.38% of the area while corridors cover just 3.32%.

Patches are characterized by natural and managed green spaces. Agricultural lands, native vegetation (shrubland), open spaces and wetland patches are the dominant elements of existing GI. Unfortunately, except some parts of wetland habitats in the southern Gediz Delta, these areas are not legally protected and naturally they are under the risk of future urbanization process. Urban parks only constitute 0.93 km2 of the study area and they are considered as medium or small-scale parks located between building blocks. High NP, and very low mean patch size show that their sizes in the urban pattern are considerably small. Therefore, connectivity between these patches is very low (Table 4-20). Private gardens, on the other hand, cover more than twice the size of urban parks in the study area.

Corridors in the study area are defined as canals, river corridors, linear parks, open spaces, and roadside vegetation. They are blue and green network elements of GI. Elements of blue network are parts of natural drainage pattern but unfortunately during the urbanization process many of them were destroyed and/or channelized.

The canals are represented by concrete water canals with the variety of sizes (width and deep/profile) and they are distributed across the study area. While some of canals are seasonal watercourses because of the Mediterranean precipitation regime, some are irrigation canals (in the agricultural lands in Çiğli), and others are channelized streams and rivers. They mostly carry fresh water with some exceptions that carry brackish and seawater. River corridors are the waterways that flow in its beds and cover only one tenth of the total number of the canals.

Green corridors on the other hand are represented by linear parks mainly located along the coastline, linear open spaces and roadside vegetation. Parks and open spaces cover almost the same area (Table 4-21).

Type	Area (km^2)
Patch	
Agriculture	4.64
Cemetery	0.23
Garden	2.35
Park	0.93
Native vegetation	4.46
Wetland	3.10
Open space	4.52
Road vegetation	0.06
Corridor	
Canal	0.84
River corridor	0.08
Park (linear)	0.45
Open space (linear)	0.44
Road vegetation	0.20

Table 4-21: GI components of the Karşıyaka and Çiğli Districts

GYRATE_AM value of patches and corridors are in the same range and considerably lower than built-up areas' value. This reflects that GI elements are highly subdivided in the Karşıyaka and Çiğli Districts (Table 4-22).

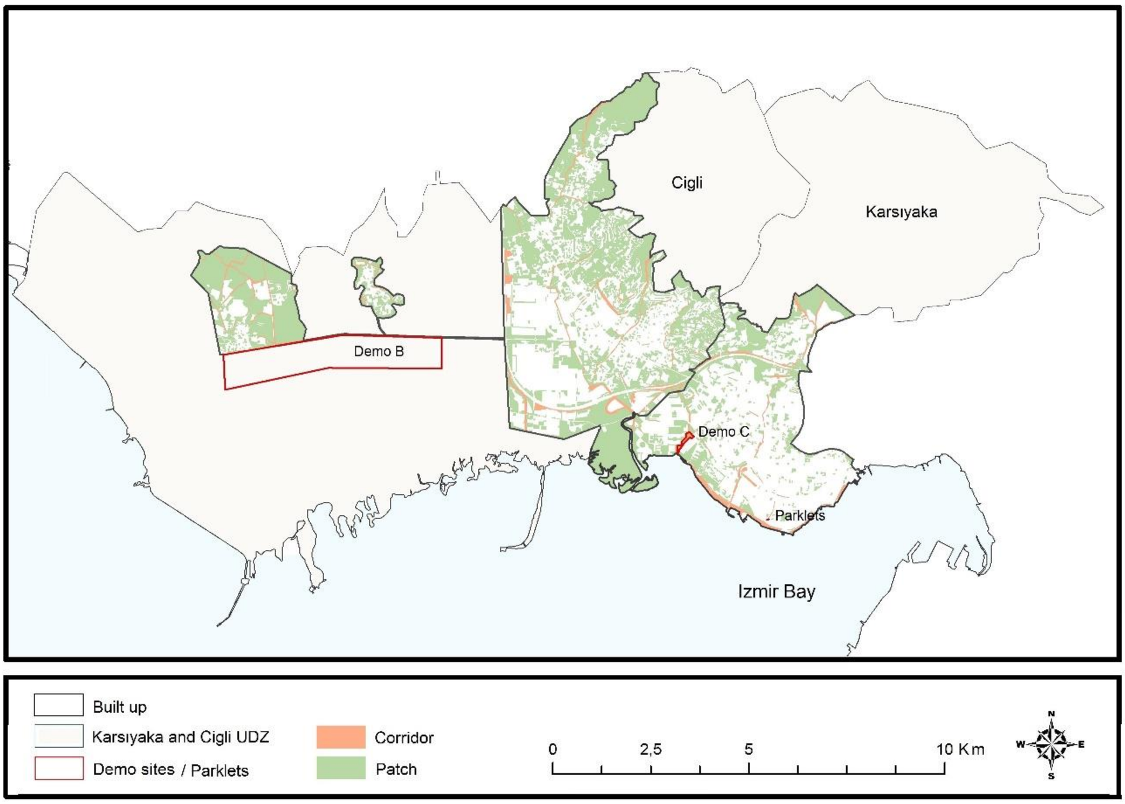

Figure 4-14: The elements of green infrastructure in Karşıyaka and Çiğli Districts

There are missing elements of GI needs to be established. Corridors have a high potential to establish a functional GI, but they need to be connected with green patches. Especially, open spaces and roadside vegetation are potential components of GI.

City	CA	NP	PLAND (%)	AREA_MN	GYRATE_AM	CONNECT
Built-up	3395.63	21.00	60.29	161.69	3358.79	14.76
Green spaces patch	2048.82	2072.00	36.38	0.98	236.85	1.36
Green - Blue corridor	187.25	220.00	3.32	0.85	230.81	2.79

Table 4-22: Landscape metrics values of the Karşıyaka and Çiğli Districts

4.3.1 New green cycle lane and re-naturing existing bike lane sections

- ***Study Area in Brief***

There are 40 km existing cycle routes surrounding Izmir Bay. This route has also public bike sharing system called “BISIM” with 30 stations, 300 bicycles and over 25 000 subscribers. Study area constitutes the northern part of the existing cycling routes. From Bostanlı Fisherman’s Wharf to Izmir Bird Paradise there are 16.5 km long existing cycling route mostly for recreation purposes. Within the frame of the sub-demo areas new cycling lanes will be added (5.5 km)

(Figure 4-15). This route will be designed as green cycling lane with SUD systems, resting areas and walking paths (Figure 4-16).

Figure 4-15: Routes of new (green, 5.5 km) and existing (orange, 16.5 km) cycling lanes

Figure 4-16: New green cycle lanes (with walking and resting areas)

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	LIST OF NBSs	Quantity
EKLIPSE Framework	City-Specific Environmental Problems	Green Route	Green cycle lane and re-naturing existing bike lane	22.5 km (5.5 new)
Urban Regeneration	Disconnectivity among urban green areas			

Table 4-23: Summary of new green cycle lanes

- ***Baseline Calculation***

Indicators **(social, economic, physical, environmental etc.)**	Metrics (a;b;c;d...) **from EKLIPSE & NBS Impact Table (or new metrics)**	Scale	Baseline Values
Environmental, Physical	Carbon Savings by cycling (kWh/y and t C/y saved.)	**N, D**	To be calculated in 2018
Social	Recreational (number of visitors, number of recreational activities)	**N, D**	26 700
Environmental, Physical	Increased drainage surface (m^2)	**D**	To be calculated in first period of 2018

Table 4-24: Metrics and baseline for new green cycle lane

4.3.2 Urban Carbon Sink: Planting Trees to maximize carbon sequestration around new green corridor

- ***Study Area in Brief***

Air pollution is one of the main problems of urban areas. Karşıyaka and Çiğli are not the exception of course. It has been experiencing air pollution especially in winter months owing to fossil fuels. Although natural gas has been used for the heating, unfortunately low-income neighbourhoods in the Karşıyaka and Çiğli districts still use fossil fuels. The air pollutant measurements illustrated that especially December, July and August in 2016 are the worst months in terms of air quality. The air pollutants measured in stations in Karşıyaka are CO, SO_2, PM10, NO_2, NO_x and NO. It is worth mentioning that the concentration of CO in the air was measured to be the highest in July, August, December and January in 2016 in the Karşıyaka district.

CHALLENGES & ENVIRONMENTAL PROBLEMS		**UrbanGreenUP Category**	**LIST OF NBSs**	**Quantity**
EKLIPSE Framework	**City-Specific Environmental Problems**	Arboreal Interventions	Urban Carbon Sink: Planting New Trees	400
Climate mitigation & adaptation, Air quality	Air pollution			

Table 4-25: Urban carbon sink: Planting trees to maximize carbon sequestration around new green corridor

- ***Baseline Calculation***

Indicators **(social, economic, physical, environmental etc.)**	Metrics (a;b;c;d...) **from EKLIPSE & NBS Impact Table (or new metrics)**	Scale	Baseline Values
Environmental, chemical	Carbon sequestration in vegetation	D	16.15 tones/year
Environmental, chemical	Pollutant's removed by vegetation (in leaves, stems and roots) (kg ha -1 year -1)	D	2.79 kg/ year
Environmental, physical	Increase in shadow surface (m2)	D	0

Table 4-26: Metrics and baseline for urban carbon sink: Planting trees to maximize carbon sequestration around new green corridor

Calculation of carbon sequestration

Tree and grassland cover were digitized from satellite images. The total tree cover was calculated and then based on methods employed by Tratalos et al. (2007)[79] a formula used by Nowak (1991) was employed: Tonnes of carbon sequestration acre−1 year−1 = (0.00335 x (% tree cover) x area) / 4046.85642.

Total carbon in shrub cover was determined by multiplying the total area of shrub cover with the maximum (1.4 carbon kg/m2 year) ratio for the estimation of carbon content of shrub cover biomass per unit area ([80];[81]).

Total carbon in herbaceous vegetation was determined by multiplying the total area of shrub cover with the minimum (0.6 carbon kg/m^2 year) ratio for the estimation of carbon content of herbaceous vegetation biomass per unit area[82].

Total carbon in urban agriculture was determined by multiplying the total area of agricultural land with the (0.06 carbon kg/m^2 year) for the estimation of carbon content of agricultural land[83].

Total carbon in coastal wetland was determined by multiplying the total area of wetland with the (130 carbon gr/m^2 year) for the estimation of carbon content of wetland[84].

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[79] Tratalos, J., Fuller, R. A., Warren, P. H., Davies, R. G., Gaston, K. J. 2007. Urban form, biodiversity potential and ecosystem services, Landscape and Urban Planning 83: 308-317

[80] Davies, Z.G., Edmondson, J.L., Heinemeyer, A., Leake, J.R., Gaston, K.J. 2011. Mapping an urban ecosystem service: quantifying above-ground carbon storage at a city-wide scale, Journal of Applied Ecology 48: 1125–1134. doi: 10.1111/j.1365-2664.2011.02021.x

[81] Townsend-Small, A. & Czimczik, C.I. (2010): Carbon sequestration and greenhouse gas emissions in urban turf. Geophysical Research Letters 37 (2). L02707

[82] Davies, Z.G., Edmondson, J.L., Heinemeyer, A., Leake, J.R., Gaston, K.J. 2011. Mapping an urban ecosystem service: quantifying above-ground carbon storage at a city-wide scale, Journal of Applied Ecology 48: 1125–1134. doi: 10.1111/j.1365-2664.2011.02021.x

[83] Vleeshouwers, L.M., Verhagen, A., 2002. Carbon emission and sequestration by agricultural land use: a model study for Europe. Glob. Chang. Biol. 8, 519–530

[84] Beaumont, N. J., Jones, L., Garbutt, A., Hansom, J. D., Toberman, M. 2014. The value of carbon sequestration and storage in coastal habitats, Estuarine, Coastal and Shelf Science 137:32-40

The carbon in lawn areas was defined by multiplying the total area of grass cover with the (0.9 carbon mg/ha year)[85].

The demo site is composed of trees and wetland vegetation. In total, 16.15 tons of carbon per year is stored and sequestrated in vegetation in the area.

Calculation of Air purification

Airborne particles and gas molecules can be deposited when they pass close to a surface. Most plants have a large surface area per unit volume that increases the probability of deposition compared to the smooth surfaces present in urban areas[86].
Air pollutant removal capacity of trees was estimated based on dry deposition that is considered as the rate of air pollutants removed from the atmosphere ([87];[88];[89]). Pollutants are removed on leaf surfaces primarily in two ways: through leaf stomata uptake of gaseous pollutants and leaf interception of particulate matter[90]. 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 re-suspension of intercepted particles from the leaf surfaces through wind action[91]. 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) were not included in the calculation.

The pollutant flux (Fi) is calculated as the product of the deposition velocity (Vd) and the concentration of air pollutant i (Ci), Eq. (3):

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

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[85] Bandaranayake, W., Y.L. Quian, W.J. Parton, D.S. Ojima, and R.F. Follet. 2003. Estimation of soil organic carbon changes in turfgrass systems using the CENTURY model. Agron. J. 95:558-563

[86] Roupsard, P., Amielh, M., Maro, D., Coppalle, A., Branger, H. 2013. “Measurement in a wind tunnel of dry deposition velocities of submicron aerosol with associated turbulence onto rough and smooth urban surfaces”, Journal of Aerosol Science, 55,12-24

[87] Lovett, G.M. (1994), “Atmospheric deposition of nutrients and pollutants in North America: an ecological perspective”, Ecological Application, 4, 629-650

[88] McPherson, E.G., Scott, K.I., Simpson, J.R. (1998), “Estimating cost effectiveness of residential yard trees for improving air quality in Sacramento, California, using existing models”, Atmospheric Environment, 32, 75-84

[89] Scott, K. I., J. R. Simpson, and E. G. McPherson. 1998. Air pollutant uptake by Sacramento's urban forest. J. Arboriculture. 24:224-234

[90] Nowak, D.J., Crane, D.E., Stevens, J.C. (2006), “Air pollution removal by urban trees and shrubs in the United States”, Urban Forestry and Urban Greening, 4, 115-123

[91] Selmi, W., Weber, C., Riviere, E., Blonda, N., Mehdi, L., Nowak, D.J. 2016). “Air pollution removal by trees in public green spaces in Strasbourg city France”, Urban Forestry & Urban Greening, 17, 192-201

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. (4):

$$F_{it} = F_i \times A \times T \tag{4}$$

The amount of air pollutants removed by trees (F) could be quantified by Eq.(5);

$$F = \sum_{i=1}^{3} F_{it} \tag{5}$$

In the demo site, pollutants removed by vegetation are calculated separately as 0,6 kg/year SO_2, 2,11 kg/year PM 10 and 0,03 kg/year NO_2. It was found that 2,79 kg/year pollutants are removed in total.

4.3.3 Green pavement for renaturing Peynircioğlu Stream

- ***Study Area in Brief***

The Peynircioğlu Stream that flows in a south-north direction through high-rise apartments in Mavişehir Mass Housing Area in Karşıyaka is completely covered in concrete. Thus, the proposed river corridor is now an open space with little or no vegetation except some very sparse seasonal herbaceous plants. Some parts of the stream course are filled with seawater because of the elevation difference. The river functions like an open concrete drainage channel. It does not attract any human activities let alone urban wildlife in its current state (Figure 4-17).

Figure 4-17: Peynircioğlu River towards İzmir Bay (Original, 2017)

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	LIST OF NBSs	Quantity
EKLIPSE Framework	**City-Specific Environmental Problems**	Green Pavements	Green pedestrian road pavements	7200 m2
Green Space Management	Disconnectivity among urban green areas			

Table 4-27: Summary of green pavement for renaturing Peynircioğlu Stream

- ***Baseline Calculation***

Indicators **(social, economic, physical, environmental etc.)**	Metrics (a;b;c;d...) **from EKLIPSE & NBS Impact Table (or new metrics)**	Scale	Baseline Values
Environmental, Water Management	Absorption capacity of green surfaces	**D**	To be calculated in first period of 2018
	Increased drainage surface (m2)	**D**	To be calculated in first period of 2018

Table 4-28: Metrics and baseline for green pavement for renaturing Peynircioğlu Stream

4.3.4 Green fences/vertical alongside Peynircioğlu Stream

- ***Study Area in Brief***

Green fences will be placed alongside Peynircioğlu Stream to allow development of new green areas and hence rising bio-diversity. Existing metal fences that create problems in using Peynircioğlu Stream efficiently will be replaced with green fences (Figure 4-18).

Figure 4-18: Peynircioğlu Stream towards Halkpark (Original, 2017)

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	LIST OF NBSs	Quantity
EKLIPSE Framework	**City-Specific Environmental Problems**	Vertical GI	Green fences/green walls (along Peynircioğlu Stream)	1600 m2
Green space management/Increasing urban biodiversity	Loss of biodiversity and lack of sufficient green spaces			

Table 4-29: Summary of green fences/vertical alongside Peynircioğlu Stream

- ***Baseline Calculation***

Indicators **(social, economic, physical, environmental etc.)**	Metrics (a;b;c;d...) **from EKLIPSE & NBS Impact Table (or new metrics)**	Scale	Baseline Values
Environmental & Biological	Pollutant's removed by vegetation (in leaves, stems and roots)	D	283,55 gr/year
Environmental & Biological	Pollinator species increase (before and after green walls)	D	Observations will start in April, 2018
Environmental & Biological	Carbon sequestration in vegetation	D	6,09 kg/year

Table 4-30: Metrics and baseline for green fences/vertical alongside Peynircioğlu Stream

Baseline for pollutants removed by vegetation (in leaves, stems and roots)

Pollutants removed by vegetation are calculated separately as 90,47 kg/year SO_2, 186,39 kg/year PM 10 and 6,69 kg/year NO_2. It was found that 283,55 kg/year pollutants are removed in total.

Calculation of pollinator species

The method is composed of setting up sample areas and observing and recording pollinating insects visiting the plants in 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 by 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-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.

Baseline for pollinator species

As time is limited for establishing baselines in the project, it was not possible to make observations for a period of time for pollinator species in the study area. Since there are no pervious bio-diversity observations or studies on demo site and its surroundings, the observations will start for baseline data in April, 2018.

Calculation of carbon sequestration

It is mentioned above at the section 4.3.2 about the methodology of calculation of carbon sequestration. The methodology is the same but the baseline result is different and it can be seen as following.

Baseline for carbon sequestration in vegetation

The demo site is composed of trees and wetland vegetation. In total, 6.09 kg/year of carbon is stored and sequestrated in vegetation in the area.

Figure 4-19: Green fences

4.3.5 Grassed swales and water retentions ponds (Bio-Boulevard)

- ***Study Area in Brief***

Bio-boulevard, as a unique section of new green corridor, is located at the Sasalı Natural Life Park extension area and within the boundaries of Çiğli District. It will be an interface between Sasalı Natural Life Park and Sasalı Urban Forest (Figure 4-20).

Bio-Boulevard is considered as an educational path to learn about urban bio-diversity, climate change effects and storm water management. It consists of vegetated native landscape of grassed swales and water retention ponds that hold water for a specific period of time. Benefits of green species on the Boulevard include storm water harvesting for landscape and species health, and surface water and aquifer recharge. Bio-Boulevard is also holding significant educative value with carefully selected species and markings. The increased participative nature of these activities via multiple bio-blitz events, regular visits by schools and institutions will allow for an urban-nature relationship to be enhanced.

Bio-boulevard will include grassed swales, water retention ponds, and pollinator modules and fruit walls to attract public’s attention to biodiversity issues.

Figure 4-20: Location of Bio-Boulevard (next to Sasalı Natural Life Park)

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	LIST OF NBSs	Quantity
EKLIPSE Framework	City-Specific Environmental Problems	SUDs	Grassed swales and water retentions ponds around Bio-Boulevard	1 450 m2
Water Management	Flood risk and sustainable runoff retention			

Table 4-31: Summary for grassed swales and water retentions ponds (Bio-Boulevard)

- ***Baseline Calculation***

Indicators **(social, economic, physical, environmental etc.)**	Metrics (a;b;c;d...) **from EKLIPSE & NBS Impact Table (or new metrics)**	Scale	Baseline Values
Environmental & Biological	Pollinator species increase	D	To be calculated in spring of 2018
Environmental & Biological	Urban green spaces per capita	U	91.75 m2/people
Environmental & Biological	Distribution of public green spaces/total surface per capita	U	2.73 m2/people
Environmental & Biological	Accessibility: connectivity, distribution, configuration and diversity of green space	U, N	Given in the text
Physical	Runoff volume calculation	D	To be calculated in spring of 2018
Physical	Peak runoff rate calculation	D	To be calculated in spring of 2018
Environmental	Water quality assessment (Total suspended solids (TSS) concentration analysis)	D	To be calculated in spring of 2018

Table 4-32: Metrics and baseline for grassed swales and water retentions ponds (Bio-Boulevard)

Calculation of pollinator species

It is mentioned above at the section 4.3.2 about the methodology of calculation of pollinator species

Baseline for pollinator species

It is mentioned above at the section 4.3.2 about the baseline of pollinator species.

Baseline for urban green and public green spaces/total surface per capita

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 in the UDZ of the Çiğli district. Baseline value for green spaces per capita is 91.75 m^2/people.

Public green spaces in the Çiğli UDZ are dominated by urban parks, play grounds, sport facilities, and cemeteries. Baseline value for public green space per capita is calculated to be 2.73 m^2/people.

Calculation of distribution, configuration and connectivity of green spaces

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 were calculated at the class level by using FRAGSTATS 3.4 with a cell size of 1 m[92].
CA equals the total area, and it defines the extent of the landscape. NP (NP≥1) is the total number of patches within a specified patch type. It measures subdivision or fragmentation of the patch type ([93];[94]). Percentage of landscape quantifies the percentage of each patch type in the landscape. When PLAND approaches zero, patch class becomes increasingly rare in the landscape and when it approaches 100, the entire landscape consists of a single patch type. AREA_MN is simply the average size of patches of particular land cover types (class types) or across the entire landscape (landscape level). It is a measure of subdivision of the class or landscape. GYRATE_AM provides an analyst with a measurement of correlation length. Large values of GYRATE_AM indicate more connected (less subdivided) landscapes[95]. CONNECT (Connectance index) is defined by the number of functional joinings between patches of the corresponding patch type, where each pair of patches is either connected or not connected based on a user-specified distance criterion. The connectance index is reported as a percentage of the maximum possible connectance given the number of patches. CONNECT equals zero when

[92] McGarigal K. & Marks, B.J. (2003). FRAGSTATS. Spatial Pattern Analysis Program for Quantifying Landscapes Structure. Version 3.4 Oregon State University, Corvallis
[93] Forman, R. T. T. (1997). Land mosaics: the ecology of landscapes and regions. Cambridge, UK: Cambridge University Press
[94] McGarigal K. & Marks, B.J. (2003). FRAGSTATS. Spatial Pattern Analysis Program for Quantifying Landscapes Structure. Version 3.4 Oregon State University, Corvallis
[95] Botequilha Leitao, Ä., Miller, J., Ahern, J., & McGarigal, K. 2006. Measuring landscapes: A planner's handbook (p. 118). Washington: Island Pres

either the focal class consists of a single patch or none of the patches of the focal class are "connected". It equals 100 when every patch of the focal class is "connected" [96].

Baselines for connectivity, distribution, configuration and diversity of green space

Diversity of green space:

Open and green spaces cover 47.41 % of the Çiğli UDZ. Green spaces were classified as natural and managed urban green spaces (Table 4-33).

Type of green spaces	% cover
Parks	1.17
Gardens	4.65
Wetlands	7.84
Open spaces	10.04
Cemetery	0.19
Native vegetation	9.16
Agriculture	12.27
Other (roadside vegetation, canals)	2.09

Table 4-33: Diversity of green spaces in Çiğli UDZ

Agricultural land is the dominant land cover type in Çiğli. They are mostly located around Sasalı Neighbourhood. Open spaces take second place and they are represented by vacant lands with little or no vegetation cover in the built-up area. Native vegetation patches represented by phrygana and shrub vegetation (Mediterranean shrubland) cover 9.16 % of Çiğli UDZ. They are mostly located on the Northern peripheries of the existing built-up area. Wetlands that cover 7.84 % of the area are abundant in the form of coastal marshes on south of the development zone.

Gardens refer to the apartment yards (mostly multiple story tall buildings) and single-family house gardens, gardens of public and government buildings, such as schoolyards, hospital gardens and commercial centres and Atatürk Industrial zone. Parks on the other hand occupy just 1.17% of the area which almost equal to almost one third of gardens.

Connectivity, distribution and configuration of green spaces

The Çiğli UDZ shows a different urban development pattern than Karşıyaka. Karşıyaka has a very dense and compact urban core. While Çiğli has a densely urbanized core on the East, which is physically connected to Karşıyaka, on the west it shows a suburban growth pattern or satellite pattern (Table 4-34).

[96] McGarigal K. & Marks, B.J. (2003). FRAGSTATS. Spatial Pattern Analysis Program for Quantifying Landscapes Structure. Version 3.4 Oregon State University, Corvallis

	CA	NP	PLAND (%)	AREA_MN	GYRATE_AM	CONNECT
Neighbourhood						
Built-up	451.35	6.00	78.07	75.22	1,405.76	26.66
Green spaces	1,607.03	80.00	21.92	20.08	1,603.28	23.54
City						
Built-up	1,980.54	18.00	52.29	110.03	2,557.33	16.33
Green spaces	1,785.07	1,500.00	47.41	1.19	352.22	2.16

Table 4-34: Landscape metrics values of the Çiğli UDZ[97]

Number of patch value of green areas is high both in neighbourhood and city level. Mean patch size values are very low. This means that green areas are composed of small patches (Table 8). Urban pattern map shows that green areas are unevenly distributed throughout the study area (see Table 4-33).

GYRATE_AM is used for interpretation of the physical connectedness of the landscape. Compare to built-up, low values indicate that green areas in Çiğli are subdivided (Table 4-34).

The connectivity values of green spaces in neighbourhood and city scales are 10.44 and 2.16, respectively. This indicates that urbanization decreased the connectivity between green areas in the study area.

Calculation of runoff volume

NRCS method which assumes that, for a rainfall storm event, the ratio of actual retention of soil after runoff begins to the potential maximum retention of soil is equal to the ratio of direct runoff to rainfall, will be used to calculate the runoff volume of the demo site. NRCS Runoff equation is[98]:

$$Q = \frac{(P - 0{,}2\,S)^2}{(P + 0{,}8\,S)} \tag{1}$$

Where:

Q = runoff depth (mm)
P= precipitation (mm)

[97] There are no units such as m, m^2, m^3 etc. for these metrics. The values given in the table are the results from those specific metrics which have their own scales.

[98] USDA, 1999. SCS Runoff Equation, Engineering Hydrology Training Series Module 205, https://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/training/SCS-runoff-equation.pdf

S= the potential of maximum retention of soil

$$S = \frac{25400}{CN} - 254 \tag{2}$$

CN= curve number

$$Q_v = Q.A \tag{3}$$

Q_v= Runoff volume (m^3)
A= Area (m^2)

Baseline for runoff volume calculation

To be calculated.

Calculation of for peak runoff rate

The Rational Method will be used to calculate the peak surface runoff rate for design of storm water management structures. Values for the runoff coefficient, drainage area, time of concentration and design return period are needed for the calculation.

The equation of the Rational Method is:

$$q = kCiA \tag{1}$$

Where:

q=peak surface runoff rate (m3/s)
k= Conversion factor equal to 0.00278
C= runoff coefficient
i= storm of intensity (m/hr)
A=drainage area (ha)

Baseline for peak runoff rate calculation

To be calculated.

Baseline for water quality assessment

Total suspended solids (TSS) concentration analysis will be done after the implementation of grassed swales and water retention ponds around bio-boulevard in means of water quality monitoring. TSS samples will be collected from inlets and outlets of the structures.

Figure 4-21: Grassed swales and water retention ponds

4.3.6 Natural pollinator modules (Bio-Boulevard)

- ***Study Area in Brief***

Natural pollinator modules will be a part of Bio-Boulevard (see 4.3.5).

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	LIST OF NBSs	Quantity
EKLIPSE Framework	**City-Specific Environmental Problems**	Pollinator	Natural pollinator modules	50 units
Green Space Management	Loss of Biodiversity			

Table 4-35: Summary for natural pollinator modules

- ***Baseline Calculation***

Indicators **(social, economic, physical, environmental etc.)**	Metrics (a;b;c;d...) **from EKLIPSE & NBS Impact Table (or new metrics)**	Scale	Baseline Values
Environmental & Biological	Pollinator species increase	D	To be calculated in first period of 2018

Table 4-36: Metrics and baseline for natural pollinator modules

Calculation of pollinator species

It is mentioned above at the section 4.3.2 about the methodology of calculation of pollinator species

Baseline for pollinator species

It is mentioned above at the section 4.3.2 about the baseline of pollinator species.

4.3.7 Fruit walls (Bio-Boulevard)

- ***Study Area in Brief***

Fruit walls will be a part of Bio-Boulevard (see 4.3.5).

CHALLENGES & ENVIRONMENTAL PROBLEMS		UrbanGreenUP Category	LIST OF NBSs	Quantity
EKLIPSE Framework	City-Specific Environmental Problems	Vertical GI	Fruit walls (around Bio-boulevard)	4 units
Green space management/increasing urban biodiversity	Loss of biodiversity			

Table 4-37: Summary for fruit walls

- ***Baseline Calculation***

Indicators **(social, economic, physical, environmental etc.)**	Metrics (a;b;c;d...) **from EKLIPSE & NBS Impact Table (or new metrics)**	Scale	Baseline Values
Environmental & Biological	Pollinator species increase (before and after fruits walls)	D	To be calculated in first period of 2018

Table 4-38: Metrics and baseline for fruit walls

Baseline for pollinator species (for Fruit Wall)

It is mentioned above at the section 4.3.2 about the baseline of pollinator species. For fruit wall same conditions are exist for initial situation.

Figure 4-22 Fruit walls

4.4 Non-technical Interventions

Non-technical interventions support NBSs aiming bio-diversity raising education activities and contributing to socio-economic dimensions of local environment. List of the proposed non-technical interventions as follows:

- Community meeting facility and market stalls for agricultural cooperatives
- Urban farming educational activities
- Municipality-enabled urban farming (community supported and collaborated with women cooperatives)
- Bio-blitz event for Sasalı Region
- Bio-boulevard’s educational path

4.4.1 Community meeting facility for climate-smart urban farming

This special educative and communication programs will simulate the future of the city under the negative impacts of "climate change", will allow for a significant educative aspect for the citizens (especially students). This open-air "laboratory of the future" demonstrating the effects of increased temperatures, decreased and irregular rainfall and soil chemistry changes on those bio-species which people in İzmir recognize from their daily lives, will impact greatly the green consciousness of the citizens.

And also, the strong producer presence will be around the climate-smart urban farming precinct through community facilities, producers’ stalls, women cooperatives and local government enabled urban farming activities that greatly increase and enhance the interfaces urbanites have with the natural world and urban farming practice.

“Laboratory of the Future" and "Community Agriculture and Producers Stalls" will allow gender sensitive producer cooperatives. The impacted citizens will be the additional **500 000 people** visiting the Natural Life Park bringing that area's total to over **1 500 000 citizens**.

Building planned greenhouses has some specific parts inside; those parts will be used to showed different aspects of climate changes and continuously agricultural production under changing climate condition. Designing of the parts needs to multidisciplinary works to get detail baseline values and quantifying some metrics. Since time is limited for establishing baselines in the project, it was not possible to make detail designed metrics for a period of the time.

4.4.2 Urban Farming Education Activities

Urban farming education activities will also be a part of climate-smart urban farming precinct that is located in Sasalı Natural Life Park. This educational activity will be done within the frame of social farming and community-supported agricultural practices.

Izmir Metropolitan Municipality has vocational school called “Meslek Fabrikası” aiming education of unemployed adults in Izmir region. The Municipality is now preparing a local green infrastructure strategy which aims to develop more green jobs in the city using the “Meslek Fabrikası”. At the moment, there are courses about aquaculture and hydroponics at Meslek

Fabrikası. Therefore, climate-smart urban farming precinct will be a perfect test-bed of new practices about urban farming (Figure 4-23).

Figure 4-23: Representation of new urban farming practices in climate-smart urban farming precinct

4.4.3 Bio-blitz Event for Sasalı Region (Çiğli District)

A bioblitz is an event that focuses on finding and identifying as many species as possible in a specific area over a short period of time. A bioblitz may involve community members, volunteers as well as scientists (Figure 4-24).

Possible volunteers of bio-blitz event in cases of Australia and Canada between 300 and 700 people. It is expected that high level of contribution to this event in İzmir thanks to active environmentalists. Doğa Derneği and İZKUŞ are NGOs specifically interested in this region and there are approximately 200 volunteers helping to collect data about birds in Delta.

In Izmir, nature activists counting birds regularly like bio-blitz event every year. Bio-blitz here in this project will be a starting point and awareness raising activity for nature consciousness. There are small scale experiments by project team about botany and archeology in order to prepare bio-blitz event within the project. In these experiments project team used mobile apps and, in the end, there will be a part of bio-atlas Izmir which is developed by Izmir Metropolitan Municipality and universities in the city.

Figure 4-24: Representation of Bio-Blitz event

4.4.4 Municipality-enabled urban farming (collaborated with women cooperatives)

Izmir Metropolitan Municipality supports collaborative good practice agricultural production by means of agricultural cooperatives and buy products like ornamental flowers for city's streets and parks. The next step will be implementation of green procurement rules for local production which is climate sensitive. Therefore, The Municipality supports local economy and production capability that help low impact development in which the internal migration has dramatically reduced and quality of life in peripheral regions has enormously been risen. Climate-smart urban farming area will be an excellent opportunity to develop an interface between peripheral regions and central part of the Izmir in support of local agricultural production.

Here, women cooperatives are important due to the population decrease and aging in peripheral regions. Activities of women cooperatives in these precincts will bring more recognition and confidence in the sustainable production of food in the near future of the region (Table 4-39).

No	Women Cooperative	Members
1	Cumaovası Kadın Derneği - Menderes	47
2	S.S. Bayındır Tarımsal Kalkınma Koop.	98
3	S.S. Bergama Kadın Girişimi Üretim ve İşletme Koop.	14
4	S.S. Bornova Kadın Girişimi Üretim ve İşletme Koop.	52
5	S.S. Çeşme Kadın Girişimi Üretim ve İşletme Koop.	70
6	S.S. Kargönül Kadın Girişimi Üretim ve İşletme Koop.	7
7	S.S. Kavacık Kadın Girişimi Üretim ve İşletme Koop.	20
8	S.S. Seferihisar Kadın Girişimi Üretim ve İşletme Koop.	85

No	Women Cooperative	Members
9	S.S. Tire Kadın Girişimi Üretim ve İşletme Koop.	New
10	S.S. Urla Kadın Girişimi Üretim ve İşletme Koop.	138

Table 4-39: Number of Women Cooperatives in Izmir

4.4.5 Bio-boulevard's Educational Path

The Bio-Boulevard will serve as an educational path to learn about urban bio-diversity, climate change effects and storm water management. Bio-Boulevard consists of vegetated native landscape of swales and channels that hold water for a specific period of time. Benefits of green species on the Boulevard include storm water harvesting for landscape and species health, and surface water and aquifer recharge. Bio-Boulevard is part of Izmir's new urban green corridor to reduce reliance on conventional grey infrastructure systems, thereby reducing cumulative urban heat island effects, and increasing bio-diversity and filtration of ground/air pollutants. The bio-boulevard also holds significant educative value with carefully selected species and markings (Figure 4-25).

Figure 4-25: Representation of Bio-boulevard

5 Conclusions

Urban Green Up Project aims at developing, applying and validating a methodology for Renaturing Urban Plans to mitigate the effects of climate change, improve air quality and water management and increase the sustainability of our cities through innovative nature-based solutions. To this end, the project has large scale demonstration sites in Izmir as the front-runner city together with Valladolid and Liverpool.

The Report has detailed several of the more critical aspects of the Urban Green Up project, namely the tools with which the success of the project will be measured against and the technique with which the measurements are scientifically benchmarked. The so-called Key Performance Indicators (KPI's) in this type of projects, has been developed and elaborated by the EU EKLIPSE project, specifically for the purpose with which it has been used, for extensive utilization in Urban Green UP. The process of KPI's selection as well as categorization and logic of Ecoservices evaluation frameworks has been included in the Report.

The sub-demos of the Urban Green Up implementations in the city of Izmir are the major part of the Report. Izmir is a fast-growing city and the city is still expanding thorough its periphery in where most agriculturally important and naturally fragile land. Therefore, those three sub-demos spatially integrated each other and creates a set of solutions from dense urban areas to more rural and natural parts of the city within the frame of urban-nature continuum. These have been explained in detail and scope, including their locations and exact dimensions of realization after which a state-of-the-art explanation has been given, using the latest available baseline KPI's selection methods and metrics. The implementations involve largely quantitatively identifiable implementations as well as largely non-technical impacts which are also subject to quantification. These have also been mostly covered by KPI definitions.

Given the plethora of limitations, barriers and constrictions on the transformation of modern cities to renatured urban forms, an attempt has been made to categorize this field with location specific references. In the report, legal, socio-cultural, organizational and financial aspects of challenges and limitations of Izmir are given. For Izmir case, sectoral and silo approaches due to organizational thickness looks one of the major problems in the implementations of NBSs. Another limitation is the uneven distribution of urban nature throughout the city. This is the part of lack of green continuity as ecosystem driver in the city's spatial development plans.

The report has also detailed technical explanations of baseline situation regarding to sub-demo sites ranging from heat island abatement to new green corridor formation. For the non-technical part initiatives involved more citizen engagement and provide the link between urban and rural areas by means of several core activities, meeting points and events. Those non-technical interventions are major part of metropolitan municipality's strategic direction of local development. Therefore, there will be starting point to enhance collaborative agricultural practices and nature preservation efforts in coming years.

Izmir, as a front-runner city, has unique natural resources in danger in the face of rapid urbanisation and thoughtless exploitation of precious urban lands for the sake of mass consumption society. Therefore, demo sites have been carefully selected to provide NBSs in every segment of urban development in order to create urban-nature continuum. Detailed planning of NBSs in selected demo sites and careful monitoring of applications with KPIs will be the real basis of implementation. This can be followed in report D4.3 and D4.4 in the Izmir case.