



**URBAN GreenUP Legacy:** Lessons learnt on NBS implementation in the URBAN GreenUP cities

Handbook

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## Executive summary

*Raúl Sánchez Francés, Esther San José Carreras, Bárbara Díez Rodríguez*

“How much nature is enough in our cities? Let’s hope it’s never enough!”

This report is an overview of the URBAN GreenUP project and its impact on climate change challenges and how it dealt with governance, economic, social, health and environmental aspects in our cities. In this report, we want to summarize the results of the project, focusing on success stories, best practices and lessons learnt as legacy of the project and its contribution to the global knowledge generated on Nature-based Solutions implementation in urban areas.

With this handbook we want to guide policymakers, businesses, researchers, citizens, and other stakeholders on identifying urban challenges and selecting and implementing the best-suited Nature-based Solutions<sup>1</sup> (NbS) for their particular requirements.

Nature-based Solutions provide multiple ecosystem services that impact cities at multiple levels and scales. However, this wide variety of impacts makes the assessment of benefits more complicated.

Cities that include Nature-based Solutions in their plans as part of their urban strategy can achieve an integrated transforma-

tion and build a new relationship between nature and citizens.

Projects such as the URBAN GreenUP contribute to building evidence that promotes policies and strategies conducive to urban planning more conducive to the implementation of NbS instead of grey solutions or conventional green infrastructure.

Environment, governance, economy, society and health and well-being are the main areas to gather the impacts of the NbS in cities. The URBAN GreenUP project has been able to implement these solutions in its 3 Frontrunners cities, thus creating the necessary evidence to quantify the impact of NbS in urban environments. All this experience has been collected during the project and summarized in this publication.

In this handbook we will take a look at all the most relevant topics covered by the project, showing the background and the experiences through concrete examples. The reader will find success stories, lessons learned and practical advice.

Following this brief introduction to context and concepts, the remaining chapters are structured as follows:

**Chapter 1** provides an overview of the URBAN GreenUp project, paying attention on different aspects of the NbS implementation and identifies the complexity of this process. Later on, we drill down into the specific characteristics of some specific factors to highlight opportunities, knowledge gaps and

lesson learnt.

In **Chapter 2**, we address how the project has changed government practices, environmental factors and other socio-economical aspects, and its impact on climate change mitigation and adaptation.

**Chapter 3** summarizes the results of the project, focus on the success stories and as way of project legacy, from the perspective of both local government organisms and citizens.

**Chapter 4** gives an overview of the lessons learnt regarding management, monitoring and maintenance of NbS from the perspective of the cities that have participated in the project.

**Chapter 5** addresses the opportunities for replicability and up-scaling of the implemented interventions.

Finally, we provide a repository of resources and relevant scientific publications, and a list of useful online resources

Throughout this report, we analyse the project demo sites as case studies, as a source of good practice in order to inform the guidelines and recommendations on the NbS implementation.

# Introduction

*Bárbara Díez Rodríguez, Raúl Sánchez Francés, Esther San José Carreras*

## What are NbS and why do we need them?

Over the last decades, the frequency of extreme weather events has increased all over the world (IPCC, 2022)<sup>2</sup>. Human-induced climate change has resulted in new and significant urban challenges, such as high temperatures or poor air quality. With 68% of the world population predicted to live in urban spaces by 2050<sup>3</sup>, these challenges need to be urgently addressed. There is growing recognition and awareness that nature can help provide integrated and multifunctional solutions to many of these new challenges. As such, Nature-based Solutions (NbS) have become the focus of major policy initiatives.

While NbS are gaining momentum as an effective and sustainable way to solve environmental problems, they can also face several challenges during implementation. For example, NbS might encounter public resistance, because many people are not familiar with the concept or how they can be used to solve certain urban challenges, and therefore they might not agree with how public funding is being used. NbS implementation can also suffer from inadequate funding and institutional barriers, because they often require significant financial resources. This in turn leads to a lack of support by policymakers, businesses and other stakeholders, who may not be willing to take the necessary actions to implement them. In addition, NbS can

also encounter technical challenges, if they require specialized technical expertise, such as in ecological restoration or sustainable land management.

In this context, URBAN GreenUP is a EU funded project, that aimed at developing, applying and validating a methodology for re-naturing our cities through innovative NbS, introducing the new concept of Re-naturing Urban Plans (RUP). By collaborating with and involving different stakeholders including governments, businesses, and civil society, the project undertook these challenges to mitigate the effects of climate change, improve air quality and water management and increase the sustainability of our cities.

### What is the aim of this handbook?

This handbook is an overview of the URBAN GreenUp project and its impact on climate change challenges and how it dealt with governance, economic, social, health and environmental aspects in our cities. In it, we want to summarize the results of the project, focusing on success stories, best practices and lessons learnt. We wish to provide a practical guide on how to implement NbS that are adapted to local challenges and needs. Within the handbook, you will find advice and useful resources on NBS selection and implementation. Ultimately, this handbook is intended to serve as a guide for policymakers, businesses, researchers, citizens, and other stakeholders on how to identify urban challenges and select and implement the

best suited NbS for their particular requirements.

### Content of this handbook

Chapter 1 provides an overview of the URBAN GreenUp project. It explains basic concepts, and explains the main challenges, solutions and interventions implemented in Frontrunner Cities. It also describes how Follower Cities have been mentored by Frontrunner Cities to make the NbS interventions and plan implementation easier for them, and to facilitate the activities generated jointly by the project Network of Cities as part of the project replicability. In Chapter 2, we address how the project has changed government practices, environmental factors and other socio-economical aspects, and its impact on climate change mitigation and adaptation. A fundamental facet of the URBAN GreenUp project is how implemented NbS need to be tailored to the specific needs of each city. In Chapter 3, we summarize the results of the project, as way of project legacy, from the perspective of both local government organisms and citizens. Chapter 4 gives an overview of the management, monitoring and maintenance of NbS from the perspective of the cities that have participated in the project. Chapter 5 addresses the opportunities for replicability and up-scaling of the implemented interventions. Finally, we provide a repository of resources and relevant scientific publications, and a list of useful online resources



# 1. Overview of the URBAN GreenUP project

*Raúl Sánchez Francés*

The URBAN GreenUP project has brought together eight partner cities that have played a crucial role as witnesses to the implementation and evolution of NbS throughout the project. These cities have provided a wealth of knowledge and experience on the implementation of NbS from environmental, economic, and social perspectives, making them central to the project's success. Moreover, the URBAN GreenUP cities have introduced the renaturing plans developed by the project. To facilitate collaboration and knowledge sharing, the project's cities are divided into three groups: Front-runners, consisting of three European cities; Follower Cities, including two European and two non-European cities; and a Network of Cities.

### 1.1.1 Valladolid

Valladolid is a Spanish city with roughly 300,000 inhabitants. It is located in the Northwest part of Spain and in the region of Castilla and León (the biggest region in Europe). The city has a continental Mediterranean climate and is situated in a valley crossed by the Pisuerga and Esgueva rivers.

Within the framework of URBAN GreenUP, Valladolid has adopted the “Sustainable Urban Development Strategy” by expanding the connections between the city’s green areas. To achieve this, several interventions were implemented in the city. These interventions are grouped in four main categories.



Figure 1.1. Green façade on El Corte Inglés Building – Valladolid (Spain)

## RE-NATURING URBANIZATION

This category includes NbS interventions such as a new green cycle lane and re-naturing existing bike lanes, tree planting and creation of shade and cooling places, the installation of three green resting areas, or the creation of a carbon sink via the installation of urban woodland.

### PLANNED ACTIONS

- » New green cycle lane
- » Planting 1000 trees
- » Tree shady places
- » Green Resting Areas
- » Shade and cooling trees
- » Re-naturing parking trees
- » Urban Carbon Sink

## SINGULAR GREEN INFRASTRUCTURE

It includes innovative NbS such as the installation of three cycle-pedestrian green paths areas, the design and installation of different types of pollinator modules, the use of smart soils for various intervention.

### PLANNED ACTIONS

- » Cycle-pedestrian green paths
- » Smart soils as substrate
- » Natural pollinator's modules
- » Green Noise Barriers
- » Electro wetland roof
- » Green Covering Shelter
- » Green Roof
- » Green Shady Structures
- » Compacted pollinator's modules
- » Urban Garden Bio-Filter
- » Vertical mobile garden
- » Green Façade
- » Urban orchards
- » Community composting
- » Small-scale urban livestock

## WATER INTERVENTIONS

Water related interventions are included in this category. For example the installation of sustainable drainage systems (SUDs) to treat and manage water runoff affecting green bike lanes, re-naturing of parking and rain gardens, the installation of a floodable park to absorb flood water from the Esgueva River, the installation of green filter areas to improve water treatments and irrigation, a natural treatment plant or the replacement of asphalt parking pavements with green pavements to improve water infiltration.

### PLANNED ACTIONS

- » SUDs for green bike lane
- » Floodable Park
- » Parking Green Pavement
- » Rain gardens
- » SUDs for renaturing parking
- » Green filter area
- » Natural wastewater treatment Plan

## NON-TECHNICAL INTERVENTIONS

This category comprises actions that cover educational, engagement and awareness activities for citizens. It also includes activities to support the management of re-naturing processes and green projects developed by citizens.

### PLANNED ACTIONS

- » SUDs for green bike lane
- » Floodable Park
- » Parking Green Pavement
- » Rain gardens
- » SUDs for renaturing parking
- » Green filter area
- » Natural wastewater treatment Plan

## 1.1.2 Liverpool

Liverpool is a city in the United Kingdom with approximately 500,000 inhabitants. It is located in the Northwest part of the England, on the estuary of the River Mersey. It has a temperate maritime climate, with mild summers and cold winters.

Liverpool supports numerous initiatives aiming to develop and implement green infrastructures and renaturing urban plans. In this spirit, the city joined URBAN GreenUP by following the “Liverpool City Green Infrastructure Strategy”. The goal was to tackle specific urban problems, and improve the connectivity for pedestrians and cyclists between different parts of the city, improve the city centre environment, reduce flooding risks and improve biodiversity. The NbS interventions implemented are also grouped in four categories.



Figure 1.2. Green façade on Saint John's Building – Liverpool (The UK)

## RE-NATURING URBANIZATION

In the case of Liverpool, this category includes new green pedestrian and cycle travel routes and minor improvements in road crossings. It also includes the planting of shade and cooling trees and improved carbon capture by growing woody plants, such as shrubs and trees.

### PLANNED ACTIONS

- » Shade trees
- » Cooling trees
- » New pedestrian and cycleway Green route
- » Green travel route
- » Urban Carbon Sink
- » Road junction pedestrian improvements

## SINGULAR GREEN INFRASTRUCTURE

Implementation of solutions for improved soil functionality and biodiversity enhancement, the installation of pollinator spaces, walls and roofs; the construction of mobile and floating gardens that increase the city's green surface, and planting large urban trees and hedges that act as filters for urban pollutants.

### PLANNED ACTIONS

- » Enhanced nutrient managing and releasing soil (Biochar)
- » Pollinator walls vertical
- » Pollinator roofs
- » Green filter area
- » Mobile gardens
- » Pollinator verges
- » Freshwater ecosystem island

## WATER INTERVENTIONS

This category includes the implementation of sustainable drainage systems (SUDs), the reduction of flood risks and the improvement of water-quality via urban catchment forestry and culvert works for flood prevention or rain gardens to manage water runoff.

### PLANNED ACTIONS

- » Raingarden SuDS
- » Urban catchment forestry
- » Green pavement
- » Water retention ponds
- » Hard drainage (civils work for flood prevention)

## NON-TECHNICAL INTERVENTIONS

Like in the case of Valladolid, it includes interventions educational and outreach activities for citizens, and support activities for the implementation of the re-naturing processes and projects developed by citizens.

### PLANNED ACTIONS

- » Promotion of ecological reasoning
- » Wood allotments
- » GI for Education
- » Forest School
- » Engagement Portal for citizens
- » Green art/engagement
- » Forest church
- » Bio APP
- » GI for Physical Health
- » GI for mental health
- » Single window/desk for RUP deployment
- » Support to citizen project of NBS
- » City mentoring strategy

### 1.1.3 İzmir

İzmir is a Turkish city with roughly 4,000,000 inhabitants. Located in the west coast of Anatolia, it is the country's third most populous city. The local climate is Mediterranean, with long and hot summers and relatively mild winters.

With its large population and expanding urban areas, İzmir offered an opportunity to apply European re-naturing strategies to cities facing the challenges of the fast urbanizing world. The interventions focused mainly on creating green corridors and on decreasing the city's temperatures. More specifically, the following initiatives were implemented, grouped into the four categories already mentioned as part of the demonstrative structure of the project



Figure 1.3. Parklet on an İzmir street – İzmir (Turkey)

## RE-NATURING URBANIZATION

including as main NbS interventions the cycle and pedestrian route in the green corridor, tree planting and creation of arboreal areas and parks and the installation of urban woodland to act as a new carbon sink.

### PLANNED ACTIONS

- » Arboreal areas around Ege Park Green Car Park Area
- » Installation of Parklets
- » Planting trees
- » Urban Carbon Sink
- » Cycle and pedestrian route in new Green Corrido

## SINGULAR GREEN INFRASTRUCTURE

Like parklets, biochar production, the installation of several pollinator modules, the installation of green fences, the construction of green covering shelters and cool pavements or the construction of smart-climate greenhouses for educational purposes

### PLANNED ACTIONS

- » Green Car Park Covering Shelter
- » Cool pavement
- » Green Shady structures
- » Smart soil into green shady structures
- » Natural Pollinator's modules
- » Smart soil production in climate-smart urban farming precinct
- » Climate-smart greenhouses
- » Improving Overall Efficiency of urban waste water treatment by using by-products
- » Green fences
- » Establishment of fruit walls

## WATER INTERVENTIONS

Including interventions such as the installation of grassed swales and water retention ponds for water storage and filtering, the riverbank restoration and green pavements.

### PLANNED ACTIONS

- » Grassed swales and water retention ponds around Bio-boulevard
- » Culvert works for Peynircioğlu River
- » Green pavements for Peynircioğlu River

## NON-TECHNICAL INTERVENTIONS

Like in the case of Valladolid, it includes interventions educational and outreach activities for citizens, and support activities for the implementation of the re-naturing processes and projects developed by citizens.

### PLANNED ACTIONS

- » The Bio-boulevard
- » Education for the Food-smart future of İzmir
- » Urban Farming Educative-participate Activities, Learning for Producers
- » Municipality Enabled Urban Farming
- » The support for Women Cooperative community Agriculture
- » Bio-Blitz events and open platform education
- » Industrial Heritage Route Along the İzmir urban Green Corridor (IUGC)
- » Promotion of Ecological reasoning and intelligent
- » İzmir bio-diversity Atlas via citizen participation through ICT enabled smart phone tools
- » Engagement portal for citizens
- » Single window/desk for RUP deployment
- » Support to citizen project of NBS
- » City mentoring Strategy

## 1.2.1 Ludwigsburg



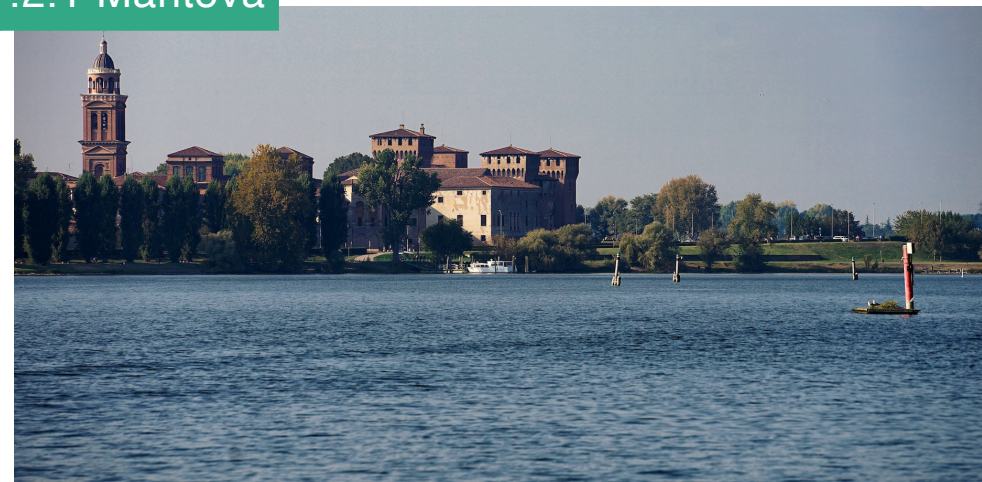
Ludwigsburg is a medium-sized town (93,000 inhabitants) in Baden-Württemberg, north of Stuttgart, famous for its baroque palaces. The municipality's activities are based on the "integrated city development" concept with strategic objectives in 11 areas.

Building on its Integrated Urban Development Strategy, Ludwigsburg developed a municipal energy and climate protection concept in 2010, followed by a strategic concept for climate adaptation in 2016.

In the coming years Ludwigsburg will put into effect the climate adaptation concept with the implementation of several NbS. The City of Ludwigsburg, as a follower City in URBAN GreenUP, was therefore really interested in the experience achieved by the Front Runner Cities during the demonstration activities.

Ludwigsburg will also share its experiences in this field. Indeed, Ludwigsburg has already implemented several NbS, which include the renaturation of a part of the bank of the Neckar river and the "Green Living Room": 140 m<sup>2</sup> of vertical green space on top of the town hall's underground car park. The green walls actively contribute to improve the recreational quality of the place and its micro climate and help sustain the local diversity of flora and fauna.

## 1.2.1 Mantova



Mantova is a city in Northern Italy with 50,000 inhabitants. The city is the main city of the province of Mantova, one of Lombardy's most extended provinces. In 2007, Mantova's centro storico (old town) and Sabbioneta were declared by UNESCO to be a World Heritage Site. Mantova's historic power and influence under the Gonzaga family has made it one of the main artistic, cultural and especially musical hubs of Northern Italy.

Mantova is surrounded on three sides by three artificial lakes (called "Upper", "Middle", and "Lower" Lakes, respectively), created during the 12th century, as a defence system for the city.

The area and its surroundings are significant not only from a naturalistic perspective but also from an anthropological and historical standpoint. Research has highlighted a number of human settlements dated, without interruption, from Neolithic times (5th–4th millennium BC) to the Bronze Age (2nd–1st millennium BC) and the Gallic phases (2nd–1st centuries BC), and ended with Roman residential settlements which could be traced to the 3rd century AD.

In its role of "follower city", Mantova committed to proactively seek advice, expertise, assistance, capacity building and mentoring from the front-runner cities and to develop a sustainable urban plan that systemically replicates, embeds and integrates the demonstrated NbS 'customized' to Mantova's context.



### 1.2.3 Medellín



Medellín, with its 2,500,000 inhabitants, is the second largest city in Colombia. It has particular characteristics due to its geographical location, surrounded by mountains and crossed by the Aburrá River, where the expansion space of the city is limited and generates challenges such as the protection of local ecosystems and the creation of public spaces.

According to a recent study, each inhabitant in Medellín has only 3.6 m<sup>2</sup> of public space like parks, squares and green areas. This is far below the World Health Organization's recommended standard of 10-15 square meters per person, indicating a significant deficit of public space in the city. As a consequence, and to improve the well-being and enjoyment of the community, the city needs to provide larger, high-quality public spaces for its citizens.

The city is settled in the Aburrá River basin, a network which has in Medellín more than 4,000 streams. Thus, the management of the water resources and the protection of local ecosystems is fundamental to prevent risk situations due to climate change and the variability that affects the city's population.

Medellín has five protected natural areas, covering a total of 168.81 km<sup>2</sup>, that offer shelter to wildlife, including some endemic species that fall under different threat categories. Furthermore, the city has important projects that aim to increase green areas, such as the planting of 800,000 trees, 30 Green Corridors and the "More Forests for Medellín" projects. These types of projects are focused on controlling the effects of climate change and variability, the heat island effects and the upgrade of ecosystem services.

Their involvement in URBAN GreenUP was expected to boost the efficiency of the initiatives undertaken by the city.

### 1.2.4 Quy Nhơn



Quy Nhơn is a coastal city in the Binh Dinh Province in Vietnam. It covers an area of 284 km<sup>2</sup> and has a population of 660,000 inhabitants.

The city has a long coastal line and a 5,000 ha lagoon, and it is located in the downstream area of two rivers. The city seriously suffers from storms, flooding and beach erosion. Quy Nhơn has therefore launched initiatives aiming to protect the local mangrove forest, which reduces the impact of natural hazards thus enhancing the livelihood of the area. This strategy is based largely on the involvement of the local population. Their participation in URBAN GreenUP will provide additional support to the activities organised in the city.

## 1.3 The Network of Cities

The URBAN GreenUP Network of Cities was created to foster transferability and to maximise the replication potential of the NbS that have been implemented in the Front-runner cities

Comprising 25 cities with a high potential for replication and a keen interest in exchanging experiences with the URBAN GreenUP cities, the network serves as a platform for sharing knowledge, best practices, challenges, and lessons learned. Cities in the network have benefited from participation in the project, including opportunities for exchanging experiences with the Front-runner and Follower cities, as well as participation in study tours and workshops



## South America



## Europe



- |                         |                         |
|-------------------------|-------------------------|
| 1. Maipu                | 14. Póvoa de Varzim     |
| 2. Independencia        | 15. Vila Franca de Xira |
| 3. São Paulo            | 16. Bragança            |
| 4. Vitória              | 17. Murcia              |
| 5. Umeå                 | 18. Santa Pola          |
| 6. Tampere              | 19. Hammam Lif          |
| 7. Oslo                 | 20. Monterosso Almo     |
| 8. Aalborg              | 21. Bari                |
| 9. Kladno               | 22. Ioannina            |
| 10. Lviv                | 23. Thessaloniki        |
| 11. Hegyvidék           | 24. Kifissia            |
| 12. Castelfranco Veneto | 25. Athienou            |
| 13. Esposende           | 26. Praia               |

Figure 1.4. Location of the Network of cities.

Within the framework of the URBAN GreenUP project, the Network of cities was invited to participate in many global engagement and dissemination activities, such as:

### REPLICATION WEBINARS

These webinars aimed to foster transferability of knowledge and disseminating best practices between the project's Front-runner cities and Follower cities.

### TECHNICAL WEBINARS

These webinars aimed to foster technical replicability between the URBAN GreenUP partners and the 25 external cities composing the network. The webinars also intended to promote the cities engagement in NbS activities, both with the project cities and among the external cities, and promote the exchange of knowledge and experiences.

### JOINT MAILING LIST

A joint mailing list has been created to keep external cities engaged and to network with potential new cities and relevant actors, such as associations, to spread news about project activities

### LINK WITH OTHER NBS PROJECTS

Several interactions with other NbS projects have taken place, leading not only to share and disseminate project outputs, but also to proactive mutual engagement through participation in specific events



Figure 1.5. Representatives from cities (Followers and Network of Cities) during the International Conference organized by the URBAN GreenUP project in Valladolid, March 2023

## 2. Impact

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NbS have assumed an increasingly important role in urban planning. Given their relevant potential in enhancing natural capital at different scales and in providing several ES. Despite the increasing appeal of NbS, cities are still lacking capacity in the identification of policies and measures for fostering such solutions. In fact, the variety of impacts and relevant stakeholders make it difficult to provide an assessment of benefits. It is necessary to identify flexible schemes that allow engaging different stakeholders in light of their social, economic, and cultural diversity. Moreover, an overall and integrated assessment of all the impacts generated by NbS is needed to fully compute the benefits related to the environmental, economic, and social dimensions. NBS impact assessment is a prerequisite for the definition of effective policies and measures to implement NbS at the urban scale.

This chapter analyses the main impacts produced by the NBS and how the URBAN GreenUP project has planned the actions according to these impacts.

## 2.1 Environment

The Commission defines NbS as “Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.” Environmental benefits are therefore one of the 3 benefits provided by solutions in nature, even within the urban environment.

This section will look at the environmental impacts of NBS, and in particular, we will look at some of the experiences within the URBAN GreenUP project.

### 2.1.1 Water



Figure 2.1. Culvert works for Peynircioğlu River – İzmir (Turkey)

NbS are presented as a real alternative to climate emergencies, mainly on water management and risks derived from climate change (floods, run-off water, drought) and Ecosystem Services (ES) affected. Water NbS have the ability to regulate water flows more cost-effectively than the traditional grey solutions.

URBAN GreenUP Frontrunner cities have implemented several water NbS in the project, in order to address specific urban challenges related to climate change and water management. In this sense, the table below shows the classification of the Water management solutions applied in the URBAN GreenUP project.

WATER MANAGEMENT	
<b>FLOODING</b>	Pollinator’s modules, SUDs
<b>WATER SCARCITY</b>	Green resting areas; Hard drainage pavements, green boulevard, ...
<b>WATER QUALITY</b>	Natural wastewater treatment, Green filter area
<b>CIRCULAR ECONOMY</b>	Green resting areas, Natural wastewater treatment

Table 1. Classification of Water management NbS applied in the URBAN GreenUP project

In Valladolid, one of the solutions implemented not only helps to treat wastewater naturally, but is also able to produce energy during the process.

### SUCCESS STORIES | NBS TO IMPROVE WATER QUALITY

#### *Electrowetland in Valladolid*

The electrowetland is a NbS installed in Valladolid and designed by Leitat. It consists in a natural wastewater treatment system with two electrodes placed within the treatment bed that generates electricity from the oxidation of the organic matter by means of exoelectrogenic bacteria (Bioelectrochemical System, BES).

Low input sensors can be powered with the electricity produced by the wetland. The integration of BES in the system also allows increasing the efficiency of the water treatment.

This NbS has proven its effectiveness in wastewater treatment. In particular, COD and BOD5 were reduced by 85% and TSS decreased an average of 80%.



## 2.1.2 Air quality

**Air quality** is a major concern worldwide, particularly in urban areas, due to its direct consequences on human health, plants, animals and infrastructure. The emission of the traditional air quality pollutants (AQPs) either direct or indirectly as a result of atmospheric chemistry, affect the concentrations of several climate pollutants. At the same time, the increase of air temperature due to global warming affects the concentrations of the AQPs. Some AQPs, such as ozone (O<sub>3</sub>), are also GHGs. These interactions between them are complex and can both enhance and mitigate global warming. Accordingly, a large number of abatement measures are beneficial for mitigating both impacts; however, there are some measures that may be beneficial for mitigating climate change but increase emissions of the key urban air pollutants, or vice versa.

NbS have the potential to reduce summer temperature and improve air quality in a city. However, there are not many NbS designed to directly capture air pollutants from emission sources. The URBAN GreenUP project has studied the implementation of one of them: **Urban Garden Biofilter**. This NBS is composed by three main elements, the extractor system to extract the polluted air from underground car park, the plenum section to distribute the air under the Biofilter and the Biofilter itself to clean the air and metabolize pollutants. It is composed by several layers for support, pollutants absorption and protection and finally is covered by vegetation. The absorption/capture of air pollutants is made by the different layers and the metabolization of these pollutants is made by the soil microbiota and the vegetation. This NBS has been developed by CARTIF in a previous research project. Project results show that it can be captured most of NO<sub>x</sub> and PM (>90%, see Figure 2.2) from indoor air (pollutants concentration 0,5-1ppm).

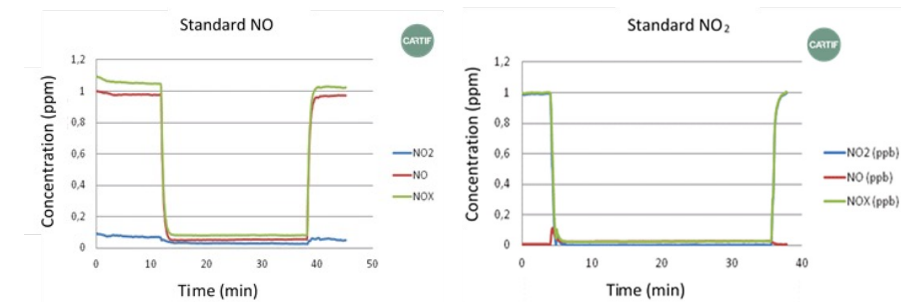


Figure 2.2. Laboratory results of the biofilter for NO and NO<sub>2</sub> removal

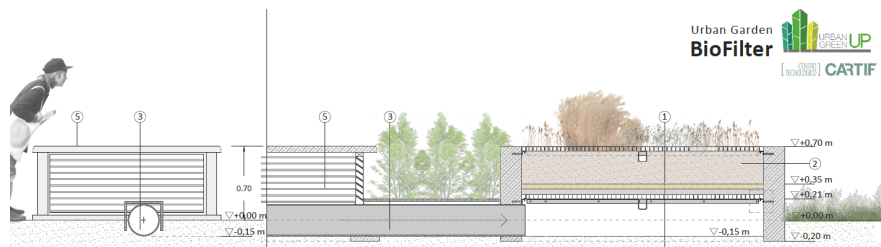


Figure 2.3. CARTIF. URBAN GreenUP Project. Biofilter cross section

This NBS can be adapted to existing car parks or tunnels or included in the design of new infrastructures. It can be created a new line for indoor air extraction and conduct it to the plenum zone. Then, the air will be cleaned by passing through the biofilter materials (see Figure 2.3). Due to the specific design of the biofilter layers, pressure drop of the filter is very low and simple extractor fan is used.

## SUCCESS STORIES | NBS TO IMPROVE AIR QUALITY

### Urban Garden Biofilter for air pollution

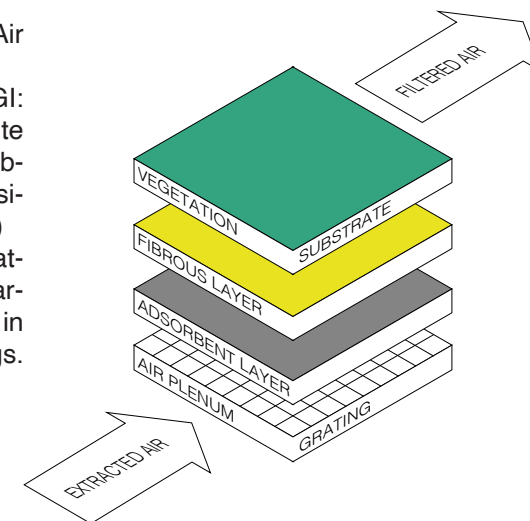
An Urban garden biofilter for capturing PM and NOx from underground car parks has been implemented in Valladolid. It is highly recommendable in the city centre where the air pollution is higher and with this NBS can easily capture outdoor pollutants from stationary sources such as underground car parks.



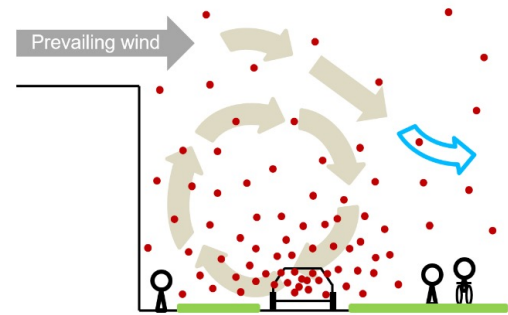
However, **green infrastructure (GI)** can be additionally used as one potential passive control system for air pollution in street canyons, yet optimum GI design is currently unclear. The Birmingham Institute of Forest Research has reviewed<sup>4</sup> the findings from previous research on GI in street canyons and assesses the suitability of different GI forms in terms of local air quality improvement with some clear messages:

- » The best way to improve urban air quality is to reduce emissions at source
- » Reducing exposure is a complementary means to improve public health outcomes
- » First Steps in Urban Air Quality
- » The role of strategic GI: dispersion to (re)distribute pollution and reduce public exposure (c.f. deposition to remove pollution)

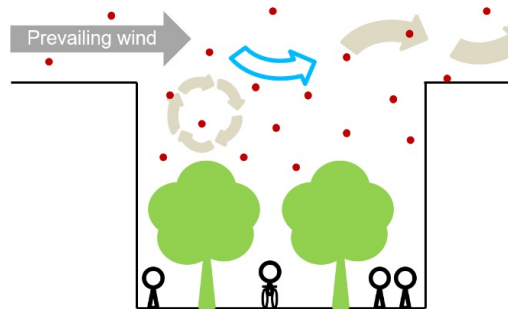
Additionally, they have created some infographics to clearly understand the role of GI in common urban street settings.



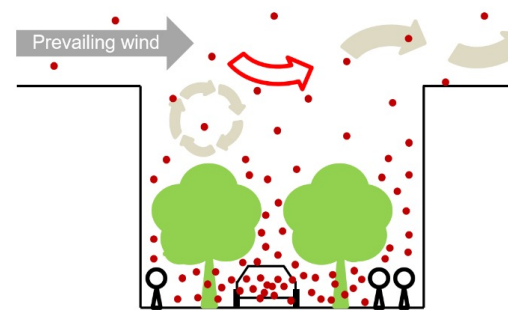




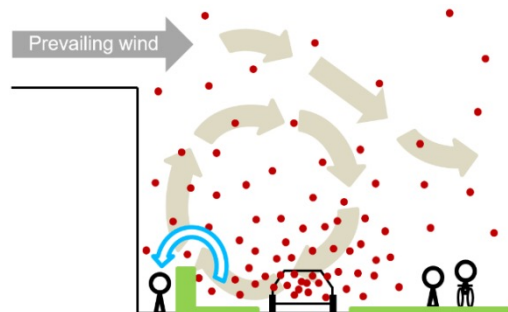
Green open spaces are vital to the dispersion of pollution (and likely take the place of additional sources of pollution)



Dense avenues of trees effectively protect quiet roads from the import of more polluted 'urban airshed' air aloft



Dense avenues of trees can trap pollution on busy roads and impede dilution by less polluted 'urban airshed' air aloft



Hedges as barriers provide effective (highly localised) protection by reducing concentrations in their immediate wake

## 2.1.3 Climate mitigation

On the other hand, even when, frequently, air quality issues are coupled with climate change mitigation policies, since many actions aimed at air quality improvement involve a concurrent reduction of greenhouse gas (GHG) emissions, such as the reduction of fossil fuel combustions, there are many other not. Additionally, it is needed to not to identify CO<sub>2</sub> as a pollutant affecting health directly. Thus, measures to improve urban air quality and mitigate climate change tend to be considered separately even though many pollutants affect both environmental impacts.

In this context, NBS for **climate mitigation** are seen primarily as those measures that conserve, restore or enhance “forests, wetlands, grasslands and agricultural lands” in order to either reduce CO<sub>2</sub> emissions or remove CO<sub>2</sub> from the atmosphere through specific measures such as “reforestation, forest conservation and management, agroforestry, cropland nutrient management, conservation agriculture, coastal wetland restoration, and peatland conservation and restoration” (Belamy & Osaka 2020: 98). In short, it is the capacity of NBS to sustain or enhance carbon storage and carbon sequestration that has to date attracted most interest<sup>5</sup>.

It is needed to identify the potential synergies and trade-offs for different kinds of NBS in contributing to sustainable development goals. Quite remarkable is the fact that urban blue areas can also contribute to climate mitigation (Table 2) as it was highlighted by their authors.

Within the most of the NBS implemented for the URBAN GreenUP project in Liverpool, İzmir and Valladolid, it is remarkable that the Interventions added to the carbon storage capacity within the cities in the vegetation and soils for the long term. The larger the area of the intervention, the greater the carbon storage. The three cities value positively the impact of their interventions on the indicators related with climate change mitigation. Some of the more relevant NBS in this sense are Urban carbon sink, Urban catchment forestry, shade trees, cooling trees, SuDs & Rain Garden, Pollinator verges and spaces, Pollinator walls/vertical, Pollinator roofs, Floating gardens and Green filter area.

NATURE-BASED SOLUTION	SCORE	VALUE (average) (kg carbon/m <sup>2</sup> )
<b>PARKS AND (SEMI)NATURAL URBAN GREEN AREAS</b>	<b>5</b>	32.6
<b>URBAN GREEN AREAS CONNECTED TO GREY INFRASTRUCTURE</b>	<b>4</b>	28.9
<b>BLUE AREAS</b>	<b>5</b>	36.1
<b>EXTERNAL BUILDING GREENS</b>	<b>2</b>	5.4
<b>ALLOTMENTS AND COMMUNITY GARDENS</b>	<b>4</b>	23.7
<b>GREEN AREAS FOR WATER MANAGEMENT</b>	<b>2</b>	12.5

Table 2. Relative contribution of NBS in different urban domains for carbon storage<sup>6</sup>

## 2.2 Governance

Governance by broad definition is the form of arrangement between stakeholders within a society to formulate mechanisms and organisations through which actors influence actions and outcomes. NBS projects are a form of intervention meant to bring positive impacts to the environment coping with climate change and anthropogenic development challenges, especially in urban areas. Thus, NbS can be classified to fall under a form of environmental governance<sup>7</sup>, which includes the actions of the state and, in addition, encompasses actors such as communities, businesses, and NGOs. Key to different forms of environmental governance are the political-economic relationships that institutions embody and how these relationships shape identities, actions, and outcomes.

Factors for mapping the governance models for NbS following Egusquiza et al.<sup>8</sup>,

» Ownership: NbS projects normally implemented on public land, but in a trend towards urban densification, NbS are also implemented on private land or business land (Liverpool, Valladolid both having this type of ownership) – Current tool and instrument including Public and Private partnership with agreement.

- » Scale: Object level, district, or Municipality level
- » Initiating actor: Private, Public, Community, Civil Society Organization, NGO, etc...
- » Implementation context: government-supported, participation, citizen engagement, funding mechanism.

Lesson learnt from NBS demonstrations from URBAN GreenUP:

- » Where NbS are placed onto third party land (e.g. green walls, pollinator terrace, tree planting), agreements should be put in place (as a form of co-management) to ensure that the external organisations take responsibility for the longer-term maintenance after the initial establishment period.
  - » A legal template document was developed for the Parr Street Green Wall installation (Liverpool) specifying ongoing maintenance would be the future responsibility of the building owner however the owner would allow future URBAN GreenUP research access for monitoring. This avoided additional maintenance costs for the city council and ensured that the NbS could continue to be studied and researched. In addition, the landowner is encouraged to maintain the green wall in a good condition because it now forms part of the landowner estate and reflects on the landowner’s business.

GOVERNANCE STYLE	HIERARCHIC	MARKET	NETWORK
<b>DEFINITION AND UNDERLYING RATIONALE</b>	The state provides laws and regulations for NBS to be implemented. The state chooses for citizens.	Market forces help bring together businesses to implement NBS effectively. <ul style="list-style-type: none"> <li>• The individual chooses for her-/himself</li> </ul>	NBS are identified through consultations and participation with a diverse set of groups and individuals. <ul style="list-style-type: none"> <li>• People choose based on consensus</li> </ul>
<b>KEY ACTOR(S)</b>	Government	Corporations, individuals	Nonstate – NGO, communities
<b>MEANS FOR ACHIEVING RESULTS</b>	Compliance, mandatory, binding	Competition, profit, self-interest, productivity, efficiency	Consensus, negotiated, voluntary
<b>POLICY TOOLS AND INSTRUMENTS</b>	Law, regulation, ban, fine, directive, penalty, fee, sanction	Trading schemes, credit, tax, incentive, promotion, award	Consultation, participation, co-creation, stakeholder engagement
<b>URBAN GREENUP DEMONSTRATION</b>	<p><b>Liverpool</b> SUDs tree planting schemes, pollinator planting, water retention ponds, raingarden, pop up forest, smart pollinator pillars, freshwater floating island.</p> <p><b>Valladolid</b> Cycle-pedestrian green paths, Rain gardens; Green roof; Green noise barriers; SUDs for re-naturing parking; Green Parking Pavements</p> <p><b>İzmir</b> Green corridor, culvert works, parklets, green shady areas around densely populated areas, agriculture center implementations</p>	<p><b>Liverpool</b> Liverpool ONE green wall which was a collaborative project and also formed a foundation for a wider proposed programme of environmental estate improvements.</p> <p><b>Valladolid</b> Private led implementation of Electrowetland in Valladolid. City Council signed a specific agreement for the construction, operation and maintenance of the NBS. El Corte Inglés retail have worked together to install a vertical garden on the department store in Calle Constitución.</p>	<p><b>Liverpool</b> The COVID-19 pandemic restricted opportunities for these types of projects, however. Local pollinator sites have the engagement of local communities in ongoing care and maintenance.</p> <p><b>Valladolid</b> “Sponsor a tree-pit initiative” was launched in a downtown street with the collaboration of the surrounding shops and residents.</p>

Table 3. Summary of Relevant NBS Governance Styles and Characteristics in URBAN GreenUP Project

» Collaborative governance (co-management) can be a suitable option for singular green NBS such as green walls, pollinator terrace, saltwater floating island in docks or NbS which are installed on land/water/park of private, college and/or third-party ownership. Collaborative management can sometimes include joint management by the building/land owner with the technical contractor.

» In Liverpool the green wall management at one site is split between staff from the business who undertake simple monthly checks and supplemented by technical specialist visits from the contractor. This hybrid approach can sometimes be cheaper for the business/land owner and has the benefit of engaging their business staff directly with the NbS.

» It is important to also recognize that, whilst some financial economies can be made by undertaking your own maintenance, specialist NbS such as green walls do require a high level of expertise for successful maintenance.

» Large NbS implementation like green corridor, SUDs, permeable pavement, etc should be led by State organization (to mobilize resources, long term technical management). Many of these large features are in the public realm and so would form part of the city council estate. As such the city council would want to be commissioning the work and partnering alongside the contractor for successful delivery. It is also worth noting that where NbS

help to alleviate key risks such as flooding the maintenance is very important and is possibly best carried out by the council or other appointed body so that it is regularly programmed and problems or issues are identified early and resolved.

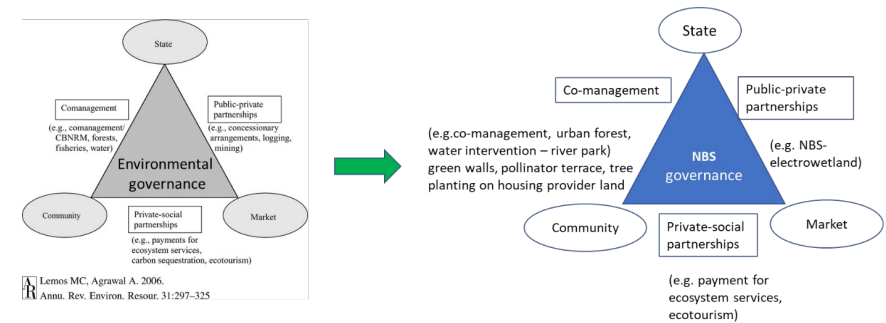


Figure 2.5. A schematic structure to classify strategies of environmental governance as they are founded upon the actions of three different social mechanisms and mapping of the NbS governance structure with specific examples from URBAN GreenUP project

## 2.3 Economy

Nature-based solutions (NbS) can provide various benefits to cities in terms of their economy, society, and environment. These benefits are known as Ecosystem Services (ES), which include things like clean air, clean water, and habitats for wildlife. Some of these services can be bought and sold in markets, but many others are considered public goods, meaning their value cannot be easily measured through prices. Economic valuation is a way to assess the hidden value of these services and the natural resources that provide them. It helps us understand the impact of human activities on ecosystems and the benefits we receive from them. Different approaches, such as the System of Environmental–Economic Accounting Central Framework and the Mapping and Assessment of Ecosystems and their Services, have been developed to measure ecosystem services at a national level. Another approach, called the Total Economic Value (TEV), considers the overall value generated by ecosystem services, including both their use and non-use value. Use-value refers to the benefits we get from directly or indirectly using nature, while non-use value includes the benefits we attribute to nature even without using it immediately. These frameworks help us understand the full range of benefits provided by nature and the importance of preserving natural capital for future generations.

The Total Economic Value (TEV) approach identifies three main ways to measure the value of ecosystem services (ES). The first approach looks at actual market transactions directly related to the ES being considered. The second approach considers parallel market transactions indirectly associated with the ES. The third approach involves creating hypothetical markets to gather information about the value of the ES. Based on these approaches, different methods of monetary valuation have been identified. These methods include direct market valuation, which uses data from real markets to estimate the value of the ES; revealed preferences, which look at individual choices in existing markets related to the use of natural resources; and stated preferences, which simulate market demand through surveys to assess the value of use and non-use of the ES. The choice of methodology depends on the specific ES being valued and its scale and scope, such as whether it is terrestrial or marine, rural or urban. Different factors, such as habitat, location, and socio-economic characteristics, influence how ES are provided and experienced. It's important to consider these factors when conducting economic valuation of ES at different scales. While various approaches are used to measure the economic value of ES, some methodologies may not be applicable at the urban level due to data limitations, difficulty in identifying impacts, or the absence of certain ES in urban areas.

Depending on the type of ES, there are multiple approaches available. For example, provisioning services can be valued

using three methodologies, regulating services with four methodologies, and cultural services with five methodologies. Each approach has its advantages and disadvantages. The pros include easily obtainable data for market price methods, simplicity and time-saving for replacement cost, damage cost avoided, and travel cost methods, flexibility for contingent valuation, and no requirement of prior knowledge from respondents for choice modelling. On the other hand, the cons include underestimation of ES value for market price and travel cost methods, the need for high-quality data for market price, replacement cost, and damage cost avoided methods, and potential bias issues in survey design for contingent valuation and choice modelling.

Throughout the URBAN GreenUP project, Liverpool Municipality promoted consultations with business and residential communities to gauge the added value that NBS interventions create.

## SUCCESS STORIES | NBS TO IMPROVE AIR QUALITY

### *Liverpool stakeholders' consultation*

Public responses to interventions were variable due to the diversity of locations, types, and approaches to investment in NBS undertaken. Although the portfolio of options embedded within the URBAN GreenUP delivery plan enabled the project team to target perceived NBS needs – that is, flood mitigation – it was difficult to align large-scale acknowledgments of the added value that they provide to society. Commentaries received from the URBAN GreenUP public surveys highlighted a growing awareness and appreciation of NBS, but these are not necessarily directly related to project interventions. While the most visible investments – for example, green walls and floating ecological islands – generated significant feedback, there has been a more limited reaction to investments that are “less visibly” “green” or “nature-based” (e.g. street lights with pollinators). Reactions to investment thus appear to be linked, at least in part, to visibility as well the location, with less commentary focusing on the added ecological value that NBS provide for urban landscapes. Such preconceptions need to be considered if urban greening projects are to stimulate community buy-in towards NBS interventions and encourage a sense of environmental stewardship.

The framework sets important goals and targets to make sure that biodiversity and its many benefits are taken into account in policies, regulations, planning, and development processes. It aims to integrate biodiversity considerations across all levels of government and sectors, especially those that have a significant impact on biodiversity. The framework emphasizes the importance of including biodiversity in policy-making and implementation, using natural capital accounting at all levels, including in urban areas. One of the targets of the framework encourages legal, administrative, or policy measures to support businesses, particularly large companies and financial institutions, in reducing negative



impacts on biodiversity, increasing positive impacts, minimizing biodiversity-related risks, and promoting sustainable production practices. The goal is to create a balance where economic activities align with the protection and enhancement of biodiversity, and in order to achieve it, several actions are required:

- » increasing total biodiversity-related international financial resources from developed countries, including official development assistance, and from countries that voluntarily assume obligations of developed country Parties, to developing countries;
- » significantly increasing domestic resource mobilization, facilitated by the preparation and implementation of national biodiversity finance plans or similar instruments according to national needs, priorities, and circumstances;
- » leveraging private finance, promoting blended finance, implementing strategies for raising new and additional resources, and encouraging the private sector to invest in biodiversity, including through impact funds and other instruments;
- » stimulating innovative schemes such as payment for ecosystem services, green bonds, biodiversity offsets and credits, and benefit-sharing mechanisms, with environmental and social safeguards;
- » optimizing co-benefits and synergies of finance targeting the biodiversity and climate crises;
- » enhancing the role of collective actions, including by indigenous peoples and local communities, Mother Earth-centric actions and non-market-based approaches including community-based natural resource management and civil society cooperation and solidarity aimed at the conservation of biodiversity;
- » enhancing the effectiveness, efficiency and transparency of resource provision and use;
- » innovative finance for nature is clearly envisioned as a very relevant instrument, involving several stakeholders, to invest in nature.

But public finance alone is not enough to support investments in nature-based solutions. Private finance also plays a crucial role, but governments need to create the right conditions to attract private investment. They can do this by implementing supportive regulations, incentives, and market structures. The World Economic Forum estimates that nature-positive policies could bring significant economic benefits and create millions of jobs. To finance biodiversity conservation, various innovative instruments are being used, such as payments for ecosystem services, blended finance, debt-for-nature swaps, carbon markets, and nature certificates. These instruments aim to unlock new financial resources and promote socially inclusive conservation efforts. Biodiversity-positive carbon credits and nature certificates are emerging instruments that link carbon reduction efforts with biodiversity conservation. Nature certificates represent claims for biodiversity conservation and cannot be used to offset negative impacts on biodiversity. These innovative financing approaches help contribute to nature-positive goals.

The financial instruments can be classified into two groups:

- » **ON-BUDGET:** instruments that are directly included in the municipal budget like municipal ‘green’ bonds or social impact bonds;
- » **OFF-BUDGET:** instruments for sustainable project financing channel funds with no direct impact on the municipal’s budget.

At the same time, a distinction between innovative and traditional financial instruments has been performed.

ON BUDGET	
Traditional	Innovative
Public transfers (European, national, regional)	Green and resilience bonds
Local taxation	Biodiversity-positive carbon credits
Loans	User charges
Development charges	Compensations
OFF BUDGET	
Traditional	Innovative
Project financing	Offset
Grants	Payment for ecosystem services
	BIDs
	Rotating funds
	Sponsorships
	Crowdfunding

Figure 2.6. Different financial instruments suitable for NBS implementation.

## 2.4 Society

Society is a determining factor to consider when designing NbS to achieve their optimal impact, especially in a city context. Considering society as part of the ecosystem, the services provided by the NbS can and should benefit citizens.

The NbS can impact in society mainly in two ways: through social justice and through social cohesion. Society can also benefit from the NbS in other aspects, such as health and well-being or economy, although these factors are considered in a separate section.

**Social justice** makes societies and economies function better and reduces poverty, inequalities and social tensions<sup>9</sup>. Social justice is an important consideration in NbS provision in many cities. However, successfully delivering NbS is usually positive, but not necessarily just or inclusive.

**Social cohesion** is also an important aspect that refers to the degree of existence of links between members of a social group. More specifically, it refers to the tendency of a group to be in unity as it works towards a goal or to satisfy the emotional needs of its members<sup>10</sup>.

It is important that NbS projects are selected and designed in ways that support both social justice and social cohesion. But

how can we make an impact on both factors through the NbS? The following table shows some of the important aspects to consider.

SOCIAL JUSTICE	SOCIAL COHESION
Ensure that NbS in cities are equally accessible or welcoming and benefits to all people.	Include elements that promote social cohesion, such as spaces for sport, play and food production.
Create a balanced map of NbS in the city, so that they are geographically accessible to all areas of the city.	Integrate the NbS into the urban landscape and locate them in highly visible public spaces, thus making them attractive places for passive leisure.
Ensure that NbS are adequately maintained in all areas of the city.	Creating spaces or features that contribute to the shared identity of a city, such as iconic parks and squares, or a particular street tree or flower that become associated with a city.
Ensure that processes for selection and design of NbS include everyone equally, and are all views for participants in these processes treated equally.	
NbS design and functioning may reflect the values and cultures of all people.	

Table 4. Improving social cohesion and social justice through NbS projects

Achieving social justice and improving cohesion is one of the challenges assessed within the URBAN GreenUP project and acted upon by the front-runner cities. Two examples of NbSs with a strong social component are shown on the next page.

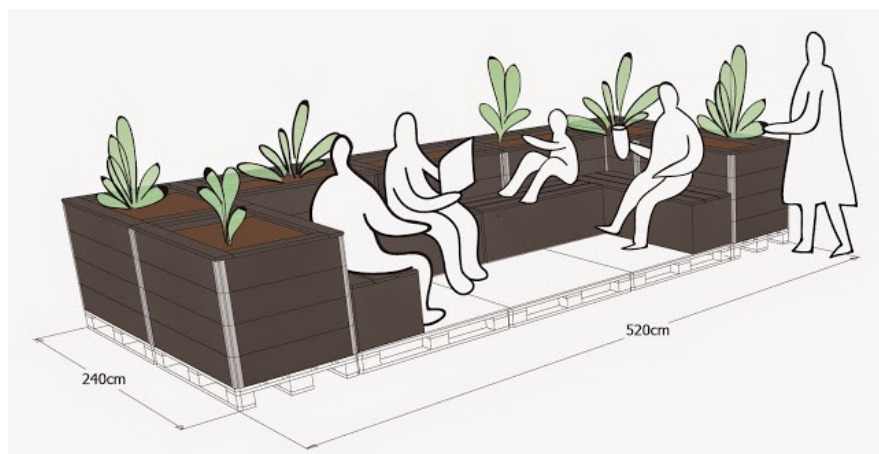


## SUCCESS STORIES | NBSS TO IMPROVE SOCIAL JUSTICE AND SOCIAL COHESION

### Parklets

#### CONCEPT

Parklet or pocket park provides opportunities for people to create small but important public spaces right in their own neighbourhoods. Parklet repurposes part of the street next to the sidewalk into a public space for people. It provides amenities like seating, planting, bicycle parking, and art. Parklets encourages non-motorized transportation.



#### IMPACTS

Parklets are safe, people-friendly environments that offer inviting café-style chairs and tables, benches, and trees and plants. These people places are designed to give residents extra space to walk, bike, dance, skate, sit, hang out with friends and meet their neighbours. Parklets extends community ties and creates public interaction opportunities among city residents.



### Green resting areas

#### CONCEPT

Green resting areas are green spaces projected for social passive recreation (resting, relaxation, observing nature, social contact). The development of green resting areas plays a central role in policies related to health, nature conservation and spatial planning.

#### IMPACTS

Studies have shown green resting areas increase social cohesion, building a solid community sense<sup>11</sup>. Studies in the Netherlands have concluded that the quantity and quality of greenery in a neighbourhood is associated with its social cohesion<sup>12</sup>.

### GREEN RESTING AREAS IN VALLADOLID

Three green resting areas have been implemented in Valladolid along the Green Corridor (SubDemo A).

Finding the suitable location especially in the city center (SubDemo B), with a lack of public space, is challenging.



## 2.5 Health and well-being

How have NbS contributed to psychological and physiological positive benefits?

The URBAN GreenUp project has deployed multiple nature-based solutions to create, extend or renew green and blue spaces in the three front-runner cities, from creating green bike and pedestrian routes to the installation of parks, shade and cooling trees, or several water-related interventions in drainage or rain gardens.

NbS do not only contribute to mitigate climate change by providing shade and evapotranspiration to reduce the heat island effect in cities, but the Urban vegetation also contributes to improve air quality by removing air pollutants and offer opportunities to improve the health of the citizens.

The modern urban lifestyle is associated with a certain degree of sedentarism and a base level of stress, which in turn generates non-communicable diseases and depression, which could be avoided in a healthier environment.

Urban forests and green spaces can improve the physical health of the citizens, promote mental well-being, encourage healthy behavior, such as social interaction and reduce their levels of stress, particularly of specific vulnerable groups such

as children or the elderly. There are multiple studies analyzing the impact of the physical environment as a determinant of the human health and wellbeing<sup>13</sup> and the possible benefits brought by nature-based solutions in terms of lower stress, faster recovery from psychological events, improved air quality, and increased level of physical activity<sup>14</sup>.

Air pollution is considered the greatest environmental risk to health for citizens living in cities, responsible for 4.2 million worldwide deaths per year<sup>15</sup>. It is estimated that every single growing tree absorbs between 10 to 40 kg of CO<sub>2</sub> per year (depending on several factors, such as the species, age of the tree, humidity, climate conditions, etc.) In the project, 8,200 trees were planted, which should remove an average of 205 tons of CO<sub>2</sub> per year.

The nature-based solutions deployed in the project also offer areas for physical activity and social interaction, which should increase the rate of physical activity of the citizens, which would have an even greater impact, as studies also suggest that physical activity in natural environments is more beneficial, and people enjoy it more<sup>16</sup>.

Although the links between the natural environment and multiple positive results for health are generally accepted and the association trend is generally positive, providing causal evidence between surrounding greenness and health (mental or physical) is a complex topic, and needs to be studied further.

Quantitatively measuring the positive impact of the interventions performed in the cities would require a long-term analysis with medical studies, which were outside the scope of the project. Furthermore, the COVID-19 pandemic took place during the project's duration, which would distort the results of the analysis, as it greatly altered the context of the project.

Most of the health/wellbeing data gathered during the project has been through surveys, which show a general improvement in the citizen's perception of wellbeing. Surveys conducted with elderly individuals in Valladolid indicate a slight improvement in their perception of well-being, with scores increasing from 3.6 to 3.75 on a scale of 0 to 5. Although the mobile application developed for Valladolid included the capacity to measure activity along the green corridor or NbS, the number of volunteers providing information was too low to reach any significant conclusion.

However, the general feedback from the citizens for the different NbS deployed in the front-runner cities has been mostly positive, and there is evidence to suggest that living in greener environments brings a range of physical, mental, and developmental benefits to the citizens. Nonetheless, there is not a defined common framework to evaluate these benefits that allows identifying the causal relationship between living in natural environments and health of the citizens, which would help identify the most effective NbSs from a health point of view.

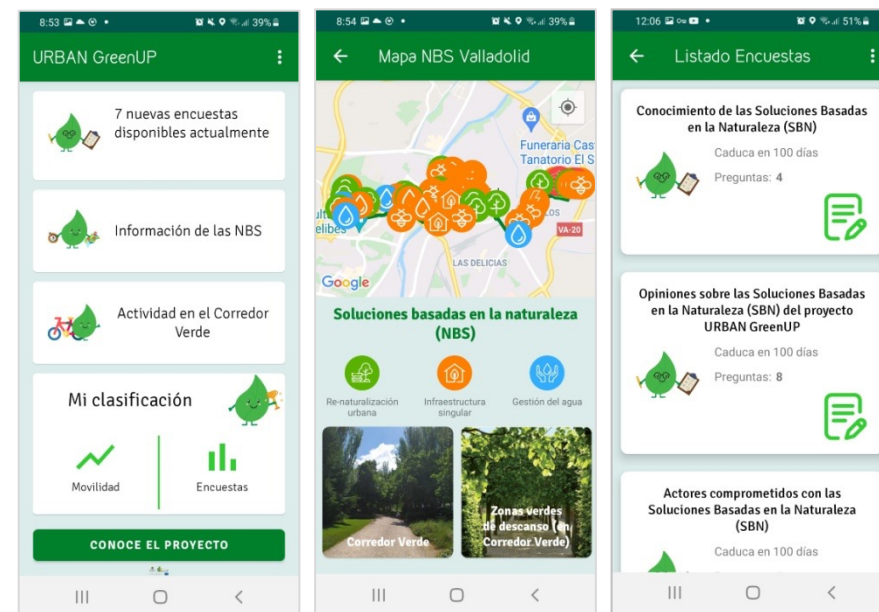


Figure 2.7. Mobile APP developed in Valladolid

### 3. Success stories

*Esther San José Carreras, Bárbara Díez Rodríguez, Raúl Sánchez Francés*

Cities are densely populated and land-intensive, which makes them more fragile to the threats posed by climate change. Citizens are most directly affected by the effects of climate change, and local authorities become the main retaining wall against this challenge. This is why local urban planners need new, more innovative and sustainable tools to address these challenges, as opposed to traditional urban planning, architecture and civil engineering.

Renaturing Urban Plans can be understood as biourbanism policies that incorporate NbS as a basic tool for action, implemented in a coordinated and planned manner. This type of integrated planning is capable of produce multifunctional impacts, improving air quality and reducing the load of greenhouse gases in the atmosphere, as well as improving people's quality of life by reducing exposure to polluting gases. On the other hand, it is possible to act on the water cycle in cities, being able to regulate runoff and infiltration of rainwater by relieving traditional drainage systems, and even to treat wastewater by generating water suitable for irrigation. Action can also be taken at the level of biodiversity, promoting ecological connectivity and preventing cities from becoming "grey islands" that are impassable to local animal species. Green corridors, pollinator modules, among other structures, will generate multiple associated

benefits and externalities.

By conceiving the city as an ecosystem, the foundations are laid for an economy based on environmental sustainability, natural resource management and ecological balance, in what we can call a green economy. This new economic concept assumes that a healthy and balanced city ecosystem translates into human well-being. To do this, it is necessary to determine the role of ecosystem services and natural resources in our cities in order to use them as efficiently as possible to meet the present and future needs of cities and their inhabitants.

However, this paradigm shift in the foundations of urban planning is a challenge in itself for local authorities, due to the degree of innovation of actions in the face of rigid legal and administrative channels. It also requires an effort on the part of citizens, whose engagement is key to the success of this transition

### 3.1 Perspective from local authorities

Despite the evident social, economic and environmental value of NbS, some cities are facing challenges in delivering NbS. In particular, many public authorities report difficulties in using public procurement to implement NbS projects. As part of the URBAN GreenUP project, front-runner and follower cities faced the challenges of implementing NbS in their territories, through public tendering processes or with their own means.

The figure below shows the pathways used by these cities to implement NbS within their Renaturing Urban Plans.

LOCAL AUTHORITY		PRIVATE OWNER III.
I. Public Procurement Process	II. Business as usual	
	Own resources	Frame-work contracts
IV. PUBLIC-PRIVATE COLLABORATION		

Figure 3.1. Methods for implementing NbS in the cities

But... How have the Front-runner cities of the URBAN GreenUP met this challenge? Here are some examples.

### 3.1.1 Public procurement process



A Public procurement process is followed to implement most of the NbS in the 3 front-runner cities. Public procurement is regulated as administrative contracts that are signed between public administration bodies and one or more economical contractors, whose objectives are the execution of construction works, to supply products or provide services.

However, it is not easy for local authorities to tackle an Renaturing Urban Plan as a whole. Given the complexity of the renaturation projects faced by the cities, they have opted to divide most of the works to be contracted out by lots.

#### SUCCESS STORIES | PUBLIC PROCUREMENT PROCESS

*İzmir – PP3. Includes the interventions within the boundaries of SUB DEMO C.*

In the case of İzmir, the Municipality decided to group the interventions in lots in term of sub demos. Below is an example of one of the lots tendered, corresponding to the actions included in one of its subdemos.



IAC2 - Planting 4800 trees.



IAC1 – Bicycle and pedestrian road



IAC5 - Urban Carbon Sink (Creation of new green areas with special species of plants which have a high-level carbon capture)



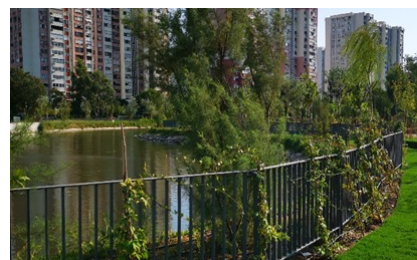
IAC7 – Culvert works on Peynircioğlu stream along 1.6 km



IAC13 - 96 m2 Fruit walls



IAC19 - Industrial heritage route



IAC12 - 1600 m2 green fence



IAC8 - Green pavement along Peynircioğlu stream

## 3.1.2 Private-public collaboration



Local authorities can also promote agreements with private entities to collaborate in the city's urban renaturation objectives. This is a good strategy to involve the different actors of the city in creating a better habitat for both the social and economic structure. These collaboration agreements have been a reality in the cities of Liverpool and Valladolid.

### SUCCESS STORIES | PRIVATE-PUBLIC COLLABORATION

#### *VALLADOLID - Implementation of the Green façade in El Corte Inglés building in Valladolid*

The green façade in Valladolid was fully installed in a private building that belongs to El Corte Inglés department stores. An agreement between the two entities was signed on May 2019, with the commitments agreed (co-responsibility, co-financing), which is a good example of public-private collaboration. The implementation works were divided in two sub-projects; with the first for El Corte Inglés, who are in charge of the works inside the building and the structural reinforcement of the building. This task is co-designed, executed and financed by El Corte Inglés. The second sub-project for the construction of the vegetable garden was executed through a process of public procurement. This part was financed by the European Commission through the URBAN GreenUP project, and the Valladolid City Council co-financing. This second project was undertaken by Singular Green, in coordination with El Corte Inglés architects. Finally, El Corte Inglés is in charge of the maintenance of the green façade.

### 11 TIPS TO MAKE YOUR RUP A SUCCESS STORY...

- 1 Public tendering processes can be slow and complex. Plan the implementation of NbS according to a schedule adapted to the duration of the processes, according to your local legislation but also on experience and real timing.
- 2 Plan carefully the annual financial plan for the RUP, to ensure budget execution within the same fiscal year or in a mid-term basis.
- 3 The technical project, procurement and construction are processes that are not independent from each other, but must be considered together.
- 4 Design and deliver skills don't always exist within the same company and tenders may need to reflect that. You may need a tender for the elaboration of the technical project and another tender for the construction/execution
- 5 Rely on the support of experts in each subject: technical, legal, procurement.
- 6 Count on a multidisciplinary team if possible within the same department, because depending on staff from other areas might mean delays.
- 7 Strengthen and promote the integration of NbS into local urban plans and investment plans to mitigate adverse impacts of environment and climate change.
- 8 Make tenders easier for companies. The full administrative content of tenders can drive potential bidders away. This can lead to lower quality bids, or fewer bids being received.
- 9 Tender scoring criteria must be clear, easy, numbered and preferably mathematically quantifiable. Seek for clarity on responses expected.
- 10 Allow time and resources for the unexpected. For example, a procurement challenge from an unsuccessful contractor and then new fire regulations were brought in that involved additional calculations, approvals and higher costs.
- 11 Unexpected circumstances lead to increases in the expenses. Manage the budget accurately.

## 3.2 Perspective from citizens

NbS are known as providers of ecosystem services, but there are other services of a more socio-cultural dimension that have a direct impact on citizens, such as well-being, health, social cohesion and increased ecological awareness, among others.

The society that forms part of the city is, therefore, a direct recipient of the benefits of the NbS, but at the same time, they are a key actor in the success of the RUP.

Indeed, the RUPs deployed in Front-runner cities have not been entirely free of discussion and in some cases, citizen rejection. A good strategy to follow is a participatory design in which citizens can be part of the conception of the NbS. This helps to increase the credibility of the actions and the involvement of citizens and other stakeholders from the beginning.

Since NbS go beyond traditional green infrastructures, a proper information campaign is needed to involve citizens in the benefits of installing these multifunctional solutions.

The awareness-raising, consciousness-raising and information actions (non-technical) carried out during the URBAN GreenUP project have been key to obtaining a good reception of the implementations.

An example of this is the programme of non-technical actions carried out in Liverpool in the framework of the URBAN GreenUP project. After there are some of the most representative actions carried out in Liverpool.



**SUCCESS STORIES | CITIZENS ENGAGEMENT**

*Non-technical actions in Liverpool*

**FOREST SCHOOL**

Forest School links NbS into the day to day work of schools. Forest School is an innovative, self-led learning approach adaptable for all age groups in a woodland setting, supported by a trained Forest School Leader.



In the Image: Mersey Forest - Forest School

**FOREST CHURCH**

The Forest School concept was extended in a unique trial to work across age groups with the community engaged within the local church.”



In the image: Forest Church at St. Michael's in the City.

**GREEN ART**

This is an initiative to bring together all the different stakeholders in the Baltic Corridor in a community arts project that helps to create ownership of the new green corridor and to celebrate the green interventions and improvements.



In the Image: Sparrow nests from twisted ducting

**GREEN INFRASTRUCTURE FOR PHYSICAL HEALTH**

This non-technical intervention uses strategic green infrastructure to encourage more physical activity, creating places where “Health is a Natural Choice”.



In the image: Gardening for Health, Liverpool

## 4. Lessons learnt

*Thami Croeser, Trinh Duc Tran*

As NbS implementation has grown, so too has the need to reflect on lessons learned from past experiences. Successful implementation of NbS requires careful planning, engagement, and collaboration across various stakeholders, including policymakers, researchers, practitioners, and communities. In this chapter, we reflect on lessons learned from the URBAN GreenUP project, drawing on the range of case studies and experiences from our front-runner and follower cities. We provide an overview of lessons learned from NbS implementation across different contexts, highlighting key challenges, success factors, and recommendations for future implementation.

### Focus on how you will procure the things you need efficiently

It is easy to underestimate the complexity of procurement processes, especially for goods and services that are new and unfamiliar. They can take a lot more time than expected; planning early to ensure you have the right processes in place can be rewarding. Be ready to invest significant time in specifications for tenders, and then managing contracts after procurement is finalised; because much of what you are doing is now, additional care in these areas is important to ensuring you deliver quality in a timely way. This applies both to large, challenging NbS implementation, and to seemingly 'simple' NbS where things can still go wrong if procurement is not managed with care.

### Bundling design and construction (and even maintenance) can be a win-win

It is possible to tender for contractors that combine design, construction and even maintenance services. Where NbS are unfamiliar, an experienced firm that delivers the entire project can be a useful way to ensure that designs are prepared carefully, and construction flows more smoothly from these designs. The contractor is incentivised to design realistically, and price construction appropriately. This can help avoid delays and variations to the contract. Where in-house maintenance capacity is not available, especially for more technical NbS, you may also consider including a few years of maintenance in your tender.

### Expect surprises (and budget for them)

Your NbS project will often be the first of its kind in your municipality, particularly for vertical and rooftop greening. Even if it isn't, many NbS remain unfamiliar and as such involve a level of uncertainty in their delivery. You will probably run into unexpected regulatory constraints for some of these, which are never a reason to give up – but can often require detailed negotiation and problem-solving. This can involve additional costs and time for project delivery. The Liverpool team offers some good examples from their experience:

*“Who knew that green walls would become classed as external cladding following the Grenfell Tower report and require addi-*

*tional specialist (and unbudgeted) fire regulation calculations? Or that a simple drainage connection in a quiet cul de sac required co-ordination of several services, two separate approvals and a road closure (each with an unexpected delay and additional cost)?”*

In addition to briefing executives on the likely uncertainties and surprises inherent to these works, it is also worth formally including a contingency of at least 10-20% in your project budget, while managing expectations around timeframes in the design and construction process.



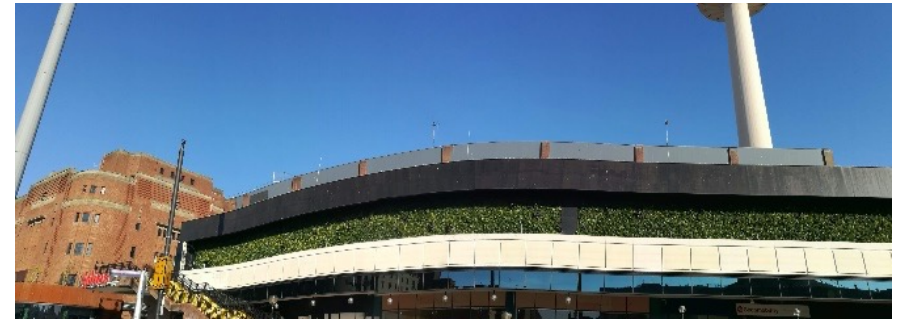
## LESSONS LEARNT | UNEXPECTED SURPRISES

### *Green Walls in Liverpool*

This type of NbS (green walls) were delayed during the project due to the new emerging guidelines following the Grenfell fire when green walls became recognised as building cladding. This resulted in the need for specialist fire regulation calculations and an application to Building Control.

### POLLINATOR GREEN WALL IN ST. GEORGE

The Pollinator Green Wall were installed along the façade of one the major shopping areas in the city centre, St Johns Shopping Centre. The wall will be 200m<sup>2</sup> and over 65m long, making it one of the longest green walls in the UK. The works finally ended in April 2020.



### POLLINATOR GREEN WALL IN THE BALTIC CORRIDOR

Liverpool also succeeded in installing a pollinator wall in the Baltic Corridor. This NbS was designed to raise awareness and attract curiosity, in addition to making a large visual improvement to the local street scene. In fact, the wall has become a landmark of the city, attracted lots of attention, featured in city publications and commercials and is also a favourite Instagram site. The wall was installed along the façade of an ordinary brick building that is currently used as a car park on Parr Street. The pollinator wall covers an area of approximately 132m<sup>2</sup> and the works finalised in May 2020.

## Use your successes to build interest and support

NbS successes are very visible. You may be approached by other professionals, even internationally, to share your stories. These can garner helpful contacts, and build support within your organisation for the NbS approach. You may also be approached by academia, as researchers recognise the valuable lessons and evidence your work has generated.

You can also expect to work closely with local residents and businesses on many NbS. This can be a valuable way of building trust and mutual understanding, easing future projects and helping guide decisions. You may even get interest from the business community in sponsoring additional works.

## LESSONS LEARNT | GROWING KNOWLEDGE

In addition to the provision of ecosystem services, NbS can also be an active part of knowledge generation and evaluation of different techniques to make the city and its environment more resilient to the challenges of climate change.

### CLIMATE-SMART GREENHOUSES IN İZMİR (TURKEY)

Climate smart greenhouse includes 3 production & demonstration parts and located in the eastern part of the Sasalı Natural Life Park. Studies are being done within the greenhouses to 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. 162 sqm of the area is used to demonstrate effects of changed climate condition on soils and plants. This part of greenhouse is being used for educative purposes for students and visitors of the natural life park to awareness on climate change. Another 162 sqm of the greenhouse there is a parabolic solar heating system and also use of solar energy for lightening. The rest part of the greenhouse is used for trying new techniques for agricultural production considering energy and water saving and having much more production per unit area.



## Things will change. Focus on achievable results, and work flexibly.

A lot of change can happen in the time it takes to deliver a large set of NbS. Elections may mean you have a new set of political leaders, who may in turn change the priorities or processes of your organisation. Other large construction projects will probably intersect with yours, sometimes in ways that you have not predicted. The COVID-19 pandemic ensured that our teams handled unprecedented levels of uncertainty. These changes can be difficult, but also can generate opportunities. As one project lead notes:

*“Things change all the time, more so over a long project and increasingly unexpectedly during a pandemic. Over the 5-6 years of the project the landscape and city changed; new buildings went up, politicians’ faces changed, public priorities and approval processes altered. Against this backdrop as we progressed to detailed site investigation work the initial scope of some projects changed and a few even became technically unviable.*

*The final raingarden was smaller than originally proposed but included additional features and importantly was the first in the city, providing a blueprint to build upon for others. The location of a water retention pond in a park had to be adjusted to accommodate a previously unmapped manhole but the redesign offered better opportunities for complimentary marginal and wildflower planting and the project has received many compli-*

*ments. Delays to other projects allowed more time to engage with community groups and key city landowners enabling us to deliver bigger and better projects in prime city locations”*

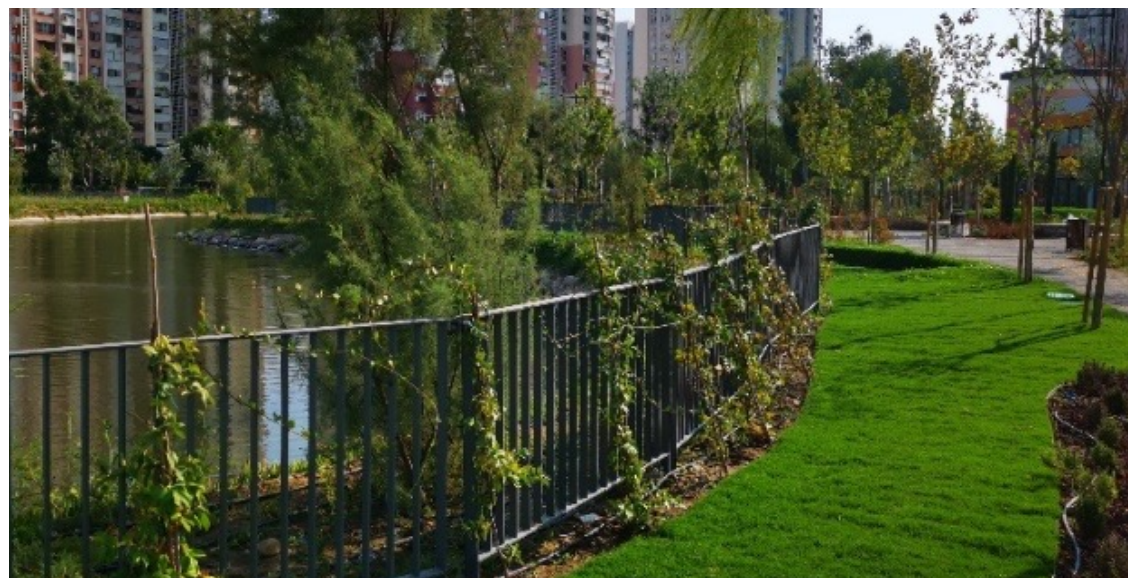
These results also highlight the value of conducting very thorough site investigations before committing to carrying out works at a given location.

### LESSONS LEARNT | COVID-19

COVID-19 has had a direct impact on the URBAN GreenUP project. The onset of the pandemic and the lockdown coincided with the development of the implementation works in some actions or with the beginning of the monitoring in others. In one way or another, cities have had to adapt to this situation in order to move the work forward.

### ACTIONS DELAYED IN İZMİR (TURKEY)

On Sub Demo C, deviations have occurred in case of the Urban Carbon Sink, Green pavements for Peynircioğlu River and Green Fences because, plant species materials and equipment needed for implementation could not delivered on site due to COVID epidemic. The problem was finally solved and the implementations finished in August 2020.



## Work across your organisation from early on

Delivering NbS is a multidisciplinary challenge, and will require the input of many teams in your organisation. Your direct team will often need guidance, permission or even resources from other teams. Some of these teams will have the power to slow you down or stop your projects if they are opposed to what you are doing – so they are important stakeholders! Bring these people into your early project discussions and help them understand that NbS are a whole-of-organisation effort – teams that may normally operate in other ‘silos’ are your collaborators, and should share the glory of delivering your project as well as responsibility for delivery at key stages. If you are engaging in planning of NbS delivery, such as in a strategy, including teams across the organisation can be valuable as a means of building trust and ownership. Don’t be afraid to ask for the support of your leadership and executives in building these bonds, and negotiating responsibilities as the project proceeds. To give an example of the extent of multidisciplinary work you need to do on an NbS project, our team in Valladolid offered their example, which included ten teams in total:

*“Over the course of URBAN GreenUP, the following departments of the Valladolid City Council have been involved: Innovation, Legal & Procurement, Urban Planning, Public Spaces department (including Roads), Environmental area, Water management, Parks and Gardens service, Real Estate and Public Participation.”*

## LESSONS LEARNT I UNDERSTANDING BARRIERS

The innovative character of the URBAN GreenUP actions means that sometimes the administrations have not had the necessary tools to generate a solid justification base that allows the legal viability of the proposed actions.

This is the case of this action in Valladolid, where the lack of specific regulation in the city and doubts as to how it would fit in terms of management and competences led the city council to cancel the action within the project.

### SMALL – SCALE URBAN LIVESTOCK (VALLADOLID, SPAIN)

The objective of the small-scale urban livestock was to improve the educational activities currently executed in the municipal orchards.

Numerous barriers were found, reflecting the extreme difficulty of implementing a chicken coop in an urban environment, the obligation to obtain a livestock exploitation permit from the competent Regional Authority (Junta de Castilla y León), in addition to the fact that there is no action protocol for chicken coops or for the management of live animals in Valladolid City Council. For these reasons, this intervention was finally cancelled.



## Specialist consultants can help your procurement process

NbS delivery will involve a lot of procurement, which is often unfamiliar to new NbS delivery teams. You can hire consultants to guide your procurement process, targeting groups with expertise in procuring and delivering capital works (particularly involving civil engineering and horticultural elements). They can help to articulate your requests in the right technical language and guide you on selecting the right contractor. They can also support with risk registers, pre-contract information and onsite contract management, dealing with issues before they become a problem and reducing your administration time.

An example of a very novel NbS that was difficult to procure was the ‘floating island’ in Liverpool:

*“External consultants helped to articulate the technical aspects required for procurement of the scheme and they provided expertise and onsite supervision (including authorising stages of contractor payment). This provided a level of reassurance for the delivery of a novel scheme.”*

## LESSONS LEARNT | TECHNICAL SUPPORT

The innovative nature of many of the actions proposed during the project means that the local councils have sometimes had to call on experts for specific consultations and technical advice. An example of this is the floating gardens installed in Liverpool.

### FLOATING GARDENS (LIVERPOOL, UK)

Floating gardens are self-contained ecological units, which can provide habitats for various aquatic and terrestrial species.

2 implementations finished in June 2020:

- » One larger 63m<sup>2</sup> floating ecosystem at Wapping Dock in a salt water environment
- » Another smaller 25m<sup>2</sup> freshwater floating ecosystem at Sefton Park lake.





## Don't forget maintenance!

Maintaining NbS will be different to other horticultural projects you may have delivered in past. It may involve access at heights (for green walls/roofs), complex irrigation systems, detailed monitoring, and/or ongoing community facilitation. These all require budget, and that budget probably isn't already there in your maintenance department – so you'll need to ensure your project allocates funding for maintenance. In many cases, these more technical maintenance tasks may also be challenging to the skillsets of your maintenance teams, and require additional training, equipment or the hiring of specialist staff or contractors. Talk to your maintenance department early to ensure this vital aspect of your project is well-planned and thoroughly documented.

## Tick every legal box that you can in advance

Implementing Nature-based Solutions will often involve many kinds of legal authorisations. It could be you need planning or heritage permits, access to water pipes, disability compliance, signoffs on drainage changes, or even an accord with firefighters or police to agree how access to a site might change. These permissions may come from local, state or national agencies, many of which will be less familiar with NbS than you are. Some will also not be supportive immediately and require extended negotiations. Try to meticulously audit your compliance needs well in advance, and initiate as many conversations as you can,

as early as you can. This will help reduce the risk of frustrating project delays and disruptions.

## LESSONS LEARNT | TECHNICAL ISSUES

Water interventions often have an added complexity, especially if they are located in existing watercourses. This case study analyses the causes of the abandonment of the planned flood park in the city of Valladolid.

### FLOODABLE PARK (VALLADOLID, SPAIN)

An extensive report prepared by the Duero River Basin Authority (topography, geology, hydraulic and hydrological studies) showed that the risk of flooding derived from the floodable park could outweigh the permissible. The results indicate that in the event that the flooded park is filled with water, due to the permeability of the terrain, it is very possible that the water affects the foundations of buildings built in the area. A possible solution would have been waterproofing the entire base of the park, which is technically and economically unviable. Since the Valladolid City Council could not find another location that could accommodate the flood park, it was decided to include this area in the Urban Carbon Sink.



### Involve your citizens early

NbS projects can attract a lot of interest from local residents and businesses. If citizens are not informed early, they can become frustrated when works disrupt their day-to-day lives. In many cases, you can involve your citizens in refining the design of the NbS you will roll out; including them helps build ownership of the final product, and in cases where your greening takes place on private property (e.g. green roofs and walls), the permission of citizens is in fact essential. “Town hall” style meetings are usually not the best way to get community input, so put some careful thought into what you will tell your citizens, what input you can allow them to have, and how you can ensure feedback is constructive and well-informed.

### Measure your success with a small set of carefully-chosen indicators

Data is very valuable in justifying future NbS, and understanding how well your NbS have worked. However, data collection must be planned in a way that it delivers you a set of really useful indicators that have a clear purpose. Think thoroughly about how you will use your data, and what it will tell you. For example, if you're concerned about heat, how can you meaningfully get insight into the amount of cooling that your NbS are delivering? What threshold of cooling represents a successful response to your identified heat risks?

Another key consideration in planning your monitoring program is also having a clear understanding of how you will collect, store and analyse your data. This should be simple and practical, and have a clear timeframe. You want to know what technology you will use, how you'll acquire it, how you'll process it and ideally how it'll be communicated too.

## 5. Replicability

*Thami Croeser, Trinh Duc Tran, Bárbara Díez Rodríguez, Raúl Sánchez Francés, Esther San José Carreras*

Replicating successful nature-based solutions (NbS) projects requires careful planning, collaboration, and long-term commitment. In this chapter, we explore eight essential tips for achieving successful replication of NBS initiatives. By following these eight tips, we can enhance the replication of NBS initiatives, fostering a more sustainable and resilient future for our cities.

**Develop a clear narrative explaining how you intend for your demo to scale up**

Even before your demonstrations are finished, you can already be preparing for replication, by telling a compelling story of how this is the first step, and how it leads to the next few steps. It can be easy to assume that a demonstration by itself is impressive enough that it will be replicated spontaneously, but this is rarely the case. Even with good data showing success, you still need systems in place for successful replication: plans, finances, skills, and a set of stakeholders that really believe in NbS and want more in their city. Your demonstration can help build this, but you need to explain how, and reflect seriously on whether your answer is convincing enough to kick off a decade or two more of investment. If the answer is 'no', that is OK – keep working on it until your story is convincing. Below you'll find some more tips to help you on your way.

### Celebrate your successes with leaders, colleagues, and the public. Build ownership.

You may feel like successful demonstration sites are all your hard work, but sharing the credit is a wise strategy for long-term success. The more your projects are ‘owned’ by the people that have power to help you replicate your success, the better. That means working both vertically and horizontally in your organisation! For example, you could invite your engineering and maintenance teams to partner with you to give a tour of the completed works that they helped you build. You might invite the people in procurement that helped you tender for the works, and the legal specialists that helped you form new agreements with private property owners. Most crucial is to celebrate with local residents, and local businesses – these are the people that speak to politicians. Invite your local leaders so they can not only ‘cut the ribbon’, but also see the enthusiasm that their constituents feel for nature-based solutions, and hear your stories of the potential for scaling up.

### Evaluate your trials and document your lessons (partner with academics and leaders)

A demonstration project is often the first time you do a new thing, and that can involve a lot of lessons – some of which are quite tough! We highly recommend you capture these lessons as you go, as well as at the end of the project. When all the greenery is in place it can be easy for people to forget how

many hurdles you got past to deliver the goods. Documenting challenges is a rare opportunity to reflect not only the issues you faced, but also their causes. This can be a moment to identify the systems, rules, roles and processes that made success difficult.

In some cases you may not be able to be directly critical of parts of your process, which is why involving academics in the action learning process is a good idea. They can also bring fresh perspectives on the problems you encounter. You should also seek executive input in the evaluation too; leaders that have helped evaluate a project, may support changes that make it easier to do next time.

### Write a plan, and link it to the major sustainability issues of your city

A demonstration can be done without a plan, but consistent annual rollout of NbS needs a plan to guide it. Your plan will need to show which problems you’re tackling (e.g. heat, flooding), which NbS you’ll be using, where they will go, how work will be divided through the organisation, and how it will be monitored. This can be a fairly technical exercise, but it’s also an opportunity to build support. You should work hard to co-develop a plan with your residents, as well as stakeholders in your organisation and other levels of government – including senior leaders. Urban GreenUP has generated many excellent resources<sup>17</sup> to help you prepare a plan for NBS in your city.

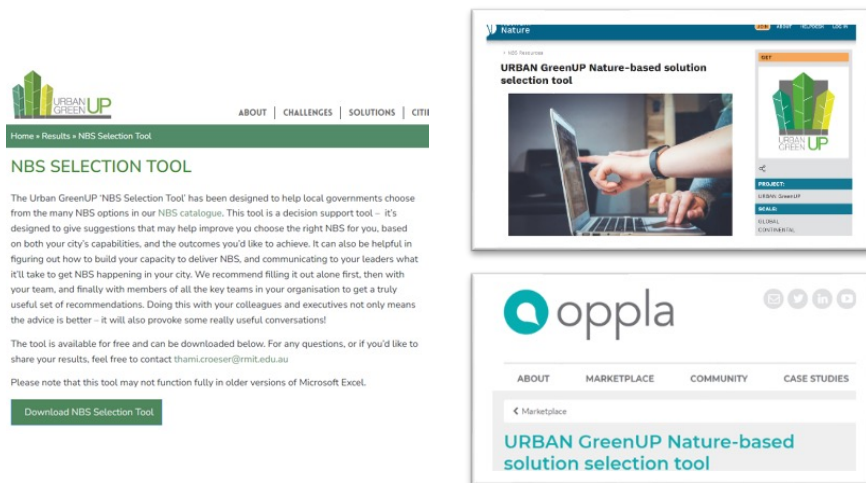


Figure 5.1. NBS selection tool hosted on the URBAN GreenUP project website and in the NETWORK NATURE and OPPLA repositories.

## Set up a financing framework

Grant funding is very helpful to get your first demonstration project up and running, but it can't sustain the years of work that most cities will need to do to in order to realise the true potential of nature-based solutions. This is why having a long-term plan with a good evidence base is important: you can show how much investment is needed to address issues like heatwaves or open space shortages, and argue for reliable budget allocations to enable that investment. This is especially important in ensuring ongoing maintenance of the living assets you have worked so hard to develop. EU projects have generated an array of excellent financing tools<sup>18</sup> that you can use to supplement your budgets.

## Fix the policy and legal barriers you identified

Don't fight the same battle twice, if you can avoid it!

You probably noticed how approval processes, legal requirements and procurement systems in your organisation are not well-designed for NbS delivery. The good news is, you can fix these, especially if you have been able to engage senior leaders in celebrations, evaluations and NbS planning. This may mean that it's a bit longer before you can start your replication activities, but it will also mean that you can work much more efficiently – with less uncertainty, negotiation and conflict – once your reform actions are complete.

## Plan training to cover skills gaps

So, you've successfully demonstrated a green roof, an electro-wetland, or maybe a pollinator wall. You had expert support in making this happen. Does your organisation have the skills to design and another one – and maintain it? If not, you may decide you are happy to keep working with contractors, but you might prefer to upskill your team too – this is especially key for maintenance. It may be that you need your civil engineers to understand how Tree SUDS work, or for your landscape architects to learn some new native species to support local pollinators and birds. Whatever your skill gap is, fixing it will make replication much smoother (and often more affordable).

## Get your leadership team on board

This theme has been woven through the seven tips before it, but we can't emphasise it enough. Involve them actively to build ownership, without demanding too much of their time. You and your team can upskill, and you can build connections to other teams, but ultimately you will also need executive and political support to upscale your NbS delivery. Senior leaders can change organisational policy and structure, negotiate with executives in organisations that you need to work with, and allocate budgets to support you. This is critical support, particularly once you move to a replication stage where you cannot rely on the initial funds and momentum of your demonstration.

## Conclusions

After 5 years of the URBAN GreenUP project, eight cities (three Frontrunner cities and five Follower cities) have been able to design and implement urban renaturation plans with the support of partners with multidisciplinary profiles. Working in a coordinated way, the final objective was to improve environmental, economic, social and governance aspects, and health and well-being of their citizens through the NbS, creating the necessary evidence for replication in other cities.

However, the road travelled has not been linear, it was not a “bed of roses”, and during this time, success stories have been achieved and many lessons learned have been collected on the NbS implementation process.

The NbS deployed in the three demonstrator cities have generated environmental impacts that have been measured and evaluated, demonstrating their effectiveness in addressing city challenges related to climate change. Nevertheless, besides technical environmental parameters, cities have faced the challenge of implementing Nature-based Solutions that go beyond business as usual, having to adapt to the governance of innovative solutions.

The NbS implemented in cities have brought about a major transformation perceived by all citizens. City councils have

been aware of the importance of communicating in an appropriate way and of involving society in the benefits beyond the aesthetic character of the NbS.

In conclusion, Nature-based Solutions are able to provide multiple benefits at various levels and scales. This means that cities that include NbS in their plans as part of their urban strategy can achieve an integrated transformation and a new relationship between nature and citizens.



## Repository of publications

During the project, URBAN GreenUP partners have capitalized on the project results to develop several scientific publications that have been published in international peer-reviewed journals. Papers produced cover several topics that are fundamental to foster NbS acceptance. Those topics and the related publications are listed in the next pages.

NBS IMPACT ASSESSMENT				
TITLE	JOURNAL/ EDITOR	PARTNER	TYPE	DATE
Spherical urban forest	WORLD CONGRESS ISWA 2019	CARTIF	Proceedings	07/2019
Evaluating the impact of nature-based solutions A handbook for practitioners	EC	CARTIF	Handbook	06/2021
Una experiencia de re-naturalización urbana: El proyecto URBAN GreenUP en Valladolid	Red Española de Ciudades por el Clima. Federación Española de Municipios y Provincias (FEMP)	Valladolid City Council	Chapter in book	03/2021
Novel Solutions or Rebranded Approaches: Evaluating the Use of Nature-Based Solutions (NBS) in Europe	Frontiers in Sustainable Cities	University of Liverpool	Paper	11/2020
Engineering Nature-Based Solutions (NBS) – Examining the Barriers to Effective Intervention	Engineering Sustainability	University of Liverpool	Proceedings	09/2022
Green Smart Cities: Living Healthily with Every Breath	IEEE	Ízmir Institute of Technology, BitNet	Paper	07/2019
Cities should respond to the biodiversity extinction crisis	Nature	RMIT	Paper	02/2021
Diagnosing delivery capabilities on a large international nature-based solutions project. Nature Urban Sustainability	npj Urban Sustain	RMIT,- CARTIF, University of Liverpool	Paper	07/2021

NBS ECONOMIC VALUATION				
TITLE	JOURNAL/ EDITOR	PARTNER	TYPE	DATE
Valuing Ecosystem Services at the Urban Level: A Critical Review	Sustainability	University of Bocconi	Paper	01/2021

NBS IMPLEMENTATION APPROACHES				
TITLE	JOURNAL/ EDITOR	PARTNER	TYPE	DATE
Methodology for Re-naturing Cities	National Congress on the Environment	Acciona, CARTIF	Proceedings	11/2018
Choosing the right nature-based solutions to meet diverse urban challenges	Urban forestry and urban greening	RMIT	Paper	10/2021

NBS BUSINESS MODELS AND FINANCIAL MECHANISMS				
TITLE	JOURNAL/ EDITOR	PARTNER	TYPE	DATE
State of the Art and Latest Advances in Exploring Business Models for Nature-Based Solutions	Sustainability	University of Bocconi	Paper	05/2021
From NBS to NBE	EC	University of Bocconi	White paper	06/2021

## Useful links

### NBS selection tool:

<https://www.urbangreenup.eu/resources/nbs-selection-tool/nbs-selection-tool.kl>

### Good practices kit:

<https://www.urbangreenup.eu/resources/good-practices-kit/good-practices-kit.kl>

### Info packs:

<https://www.urbangreenup.eu/resources/info-packs/info-packs.kl>

### NBS webinars:

<https://www.youtube.com/playlist?list=PLGUu2p9x4WZ-b1aN2gGMYWZxEzMTxzOn6H>

### Other webinars:

[https://www.youtube.com/playlist?list=PLGUu2p9x4WZY\\_c4E-fU09VcBFu\\_w9w6lz1](https://www.youtube.com/playlist?list=PLGUu2p9x4WZY_c4E-fU09VcBFu_w9w6lz1)

## Case studies:

### NetworkNature:

Valladolid: <https://networknature.eu/casestudy/29485>

Liverpool: <https://networknature.eu/casestudy/29484>

Ízmir: <https://networknature.eu/casestudy/29483>

### Oppla

Valladolid: <https://oppla.eu/casestudy/29485>

Liverpool: <https://oppla.eu/casestudy/29484>

Ízmir: <https://oppla.eu/casestudy/29483>

## Endnotes

1 The Commission defines NbS as “Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. ”NbS must therefore benefit biodiversity and support the delivery of a range of ecosystem services

2 <https://www.ipcc.ch/report/ar6/wg2/>

3 <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>

4 <https://www.cityoftrees.org.uk/sites/default/files/Dr%20James%20Levine%20-%20BIFoR%20UoB.pdf>

5 European Commission, Directorate-General for Research and Innovation, NbS for climate mitigation – Analysis of EU-funded projects, Publications Office of the European Union, 2020, <https://data.europa.eu/doi/10.2777/458136>

6 Source: Naturvation (2019a) NBS Navigator Technical Note: Carbon Storage Indicator, NATURVATION, November 2019. The scoring is designed to provide an indicator of the relative contribution of nature-based solution in each domain to the indicator (carbon storage), with five being a relatively very good contribution and 1 being a relatively very weak contribution.

7 Lemos, M.C. and Agrawal, A., 2006. Environmental governance. *Annu. Rev. Environ. Resour.*, 31, pp.297-325.

8 Egusquiza, A., Arana-Bollar, M., Sopelana, A. and Babí Almenar, J., 2021. Conceptual and Operational Integration of Governance, Financing, and Business Models for Urban NbS. *Sustainability*, 13(21), p.11931.

9 <https://www.un.org/en/observances/social-justice-day>

10 Carron, A. V., & Brawley, L. R. (2000). Cohesion: Conceptual and Measurement Issues. *Small Group Research*, 31(1), 89–106. <https://doi.org/10.1177/104649640003100105>

11 De Roo, M. (2011). The green city guidelines – Techniques for a healthy liveable city. Available at [www.thegreencity.com](http://www.thegreencity.com)

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14 Health and the natural environment: A review of evidence, policy, practice and opportunities for the future. European Centre for Environment and Human Health, University of Exeter Medical School, 2018. [https://ore.exeter.ac.uk/repository/bitstream/handle/10871/36923/Health%20and%20the%20Natural%20Environment\\_Full%20Report.pdf?sequence](https://ore.exeter.ac.uk/repository/bitstream/handle/10871/36923/Health%20and%20the%20Natural%20Environment_Full%20Report.pdf?sequence)

15 Ascenso A., Gama C., Roebeling P., Miranda A.I. HOW EFFECTIVE ARE NATURE-BASED

SOLUTIONS IN DIFFERENT ENVIRONMENTS? WIT Transactions on the Ecology and the Environment, vol 252, p 3-14 - DOI: 10.2495/AIR210011

16 Thompson Coon, J., et al., Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. Environ. Sci. Technol., 2011. 45: p. 1761.

17 <https://www.urbangreenup.eu/resources/>

18 <https://growgreenproject.eu/greencitiesframework/develop-financial-plan/>

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