NATURE-BASED SOLUTIONS FOR MEDITERRANEAN CITIES

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Plan Bleu

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CREDITS

The images that illustrate the projects come from public sources. The cover image has been produced using Dall-e artificial intelligence.

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DISCLAIMER

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Introduction

Plan Bleu is one of the six Regional Activity Centres of the United Nations Environment Program's Mediterranean Action Plan (UNEP/MAP). These six regional centers are commissioned by the twenty-two Contracting Parties to the Barcelona Convention, and are responsible for the implementation of the Convention's seven Protocols. In this framework, Plan Bleu acts as an observatory of the environment and sustainable development in the Mediterranean, notably by producing out thematic, systemic and strategic foresight analyses that aim to enlighten stakeholders and decision-makers on key environmental risks and levers for sustainable development in the region.

Plan Bleu launched this analysis of NbS in Mediterranean urban areas as part of its biannual work program, in an effort to promote the implementation of and advocate for Nature-based Solutions (NbS) as a key means to increase the resilience of Mediterranean coastal zones. This report thus aims to showcase and capitalize on selected case studies of Mediterranean NbS projects and European programs.

NbS concerns several of the Barcelona Convention's different Protocols. In particular, direct links can be established between NbS and the Convention's Integrated Coastal Zone Management (ICZM) Protocol, which provides a legal framework for the integrated management of the Mediterranean coastal zone. Measures include efforts to protect specific coastal ecosystems (e.g., coastal wetlands and estuaries, coastal forests and dunes, marine habitats…), as well as actions to ensure the sustainable use of the coastal zone, notably by ensuring that coastal and marine economies are adapted to the specificities and carrying capacity of Mediterranean coastal zones. The capacity of NbS to increase and support biodiversity is also key to the implementation of the Specially Protected Areas and Biological Diversity Protocol. Finally, more indirect links can be established between NbS and the Convention's Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources. Indeed, NbS can support coastal zones' capacity to prevent pollutants, such as untreated wastewater, from reaching the sea.

Table 1. MSSD Objectives and links to the United Nations Sustainable Development Goals

MSSD Objectives	SDGs		
1. Ensuring sustainable development in marine and coastal areas			14 LIFE BELOW WATER
2. Promoting resource management, food production and food security through sustainable forms of rural development	2 ZERO HUNGER	15 LIFE ON LAND	6 CLEAN WATER AND SANITATION
3. Planning and managing sustainable Mediterranean cities		11 SUSTAINABLE CITIES AND COMMUNITIES	7 AFFORDABLE AND CLEAN ENERGY
4. Addressing climate change as a priority			13 CLIMATE ACTION
5. Transition towards a green and blue economy	8 DECENT WORK AND ECONOMIC GROWTH	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	12 RESPONSIBLE CONSUMPTION AND PRODUCTION
6. Improving governance in support of sustainable development		16 PEACE, JUSTICE AND STRONG INSTITUTIONS	17 PARTNERSHIPS FOR THE GOALS

Source: UNEP/MAP, 2024), https://www.unep.org/unepmap/what-we-do/mediterranean-strategy-sustainable-development-mssd

WHAT ARE NATURE-BASED SOLUTIONS?

The International Union for the Conservation of Nature (IUCN), the originator of the concept, defines NbS as actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.

According to the European Commission, NbS "help society face environmental, economic and social challenges in a sustainable way" and is economically profitable. NbS do not reject new technologies but, on the contrary, innovate by favoring the active participation of citizens in both the design and the management of their cities.

Many of the most advanced management techniques of the relationship between societies and the planet are NbS. Nevertheless, these NbS do not have to be a set of new environmental techniques. Throughout its history and even before, humanity has found ways to adapt natural processes to satisfy its needs, guaranteeing the preservation of the processes that provided those resources in a closed cycle. Therefore, NbS could be technically defined as follows: the mechanisms that facilitate the harmonization between social processes and ecological processes through their connection, joint functioning and mutual adaptation.

The core idea of the NbS concept is that the preservation of natural processes is not a cost for the economy and the development of societies, but quite the opposite. When the principle of sustainability was raised by the United Nations in 1987 with the famous Brundtland Report, a good part of developing countries stated that the protection of nature, and even the rational use of resources that the report proposed, were a drag on its socioeconomic development. Thus, a completely wrong narrative began to be woven that opposed socioeconomic development to sustainability.

This narrative gave rise to proposals that emphasized this opposition, such as the financial compensation of productive processes that generate negative environmental impacts, e.g. “paying for polluting”. However, this approach can only offer a partial, temporary and monetary solution, while waiting for the socio-ecological transformation towards sustainable societies.

NbS emphasize that the sustainable management of resources and the environment is not a burden on the economy, but is precisely an indispensable production of so-called environmental services, which can be found in all sectors of the economy and are essential for any society’s functioning.

This conceptual framework therefore refutes the idea that nature is a cost. On the contrary, it emphasizes its value, including in economic and market terms. Moreover, this departure from the extractivist industrial vision must be accompanied by at least one essential governance mechanism: respect for both human societies and nature, that crystallizes into a vision of more just societies and a preserved environment, capable of hosting the greatest possible biodiversity.

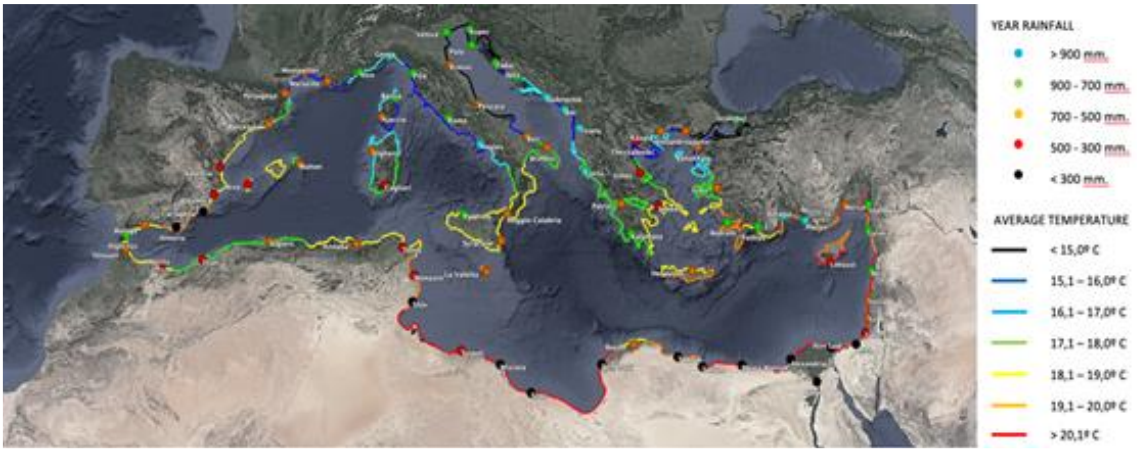
WHAT ARE THE MEDITERRANEAN CITIES?

It is common to speak of the Mediterranean region as a sort of entity, which is undoubtedly true from a geographical point of view. Here, we will consider case studies in the Mediterranean basin and, more specifically, in its urban or peri-urban coastal areas. Several other characteristics lend a certain unity to the Mediterranean, and are analyzed below.

Climate

One of the commonly cited characteristics of the region is its climate and bioclimatic characteristics. While it is true that most of the Mediterranean presents a warm climate with dry and hot summers, we also find other more continental climates in the north, and desert in the south. Nonetheless, the Mediterranean basin is warming faster than the global average, and is a climate change “hotspot” (MedECC, 2022). Other regional climate parameters, such as lack of precipitation, drought periods, water scarcity are also above global average annual values.

Figure 1. Map of average annual precipitation and temperatures of the cities and coasts of the Mediterranean



Source: Own work, using Google Earth Base

The average temperature along Mediterranean coasts typically hovers around 18ºC. However, this area exhibits considerable variability, with some cities experiencing annual averages below 14ºC and numerous others surpassing 20ºC. During the summer months, temperatures often approach an average of 30ºC.

Regarding precipitations, the Mediterranean coasts generally receive more than 600 millimeters per year. Nevertheless, this calculation includes extreme variations, from cities like Port Said, receiving less than 100 millimeters, to places such as Tirana, where annual precipitation exceeds 1000 millimeters. Precipitation patterns are notably erratic and intermittent, especially during warmer seasons, leading to significant evapotranspiration and dry conditions. The region is also prone to droughts and episodes of heavy rainfall every few years.

These environmental extremes are exacerbated by climate change predictions, which foresee a worsening of these conditions. This situation underscores the importance of NbS for managing extreme weather events and increasing resilience to withstand their impacts in the Mediterranean.

Urbanization

Urbanization is a distinctive characteristic of the Mediterranean, with urbanization rates surpassing the global average, except in the Western Balkans. This trend is even more pronounced along the coastlines: night maps reveal over sixty urban areas with population densities exceeding half a million, including 25 cities of more than one million residents. These urban centers account for a total of nearly 150 million people, representing two-thirds of the total coastal population of the Mediterranean, which continues to grow.

Figure 2. Night map with size of the agglomerations

Source: Own work, produced using a satellite image

Inequality

The issue of inequality is also pivotal, given its global relevance and specific impacts within the Mediterranean. Among its 22 coastal countries, France, Italy, and Spain alone generate two-thirds of the region's Gross Domestic Product, despite counting only one-third of its population. The Human Development Index in these countries ranges from high to moderate. However, inequality is also rising internally within these countries, particularly in urban areas, reaching concerning levels.

Table 2. Human Development Index scores of Mediterranean countries

HUMAN DEVELOPMENT INDEX

Country	HDI (2021)	world position	Country	HDI (2021)	world position	Country	HDI (2021)	world position
Monaco	1.104	0*	Greece	0.887	33	Tunisia	0.731	97
Israel	0.919	22	Croatia	0.858	40	Libya	0.718	104
Malta	0.918	23	Turkey	0.838	48	Palestine	0.715	106
Slovenia	0.918	23	Montenegro	0.832	49	Lebanon	0.706	112
Spain	0.905	27	Albania	0.796	67	Morocco	0.683	123
France	0.903	28	Bosnia and Herzegovina	0.78	74	Syria	0.577	150
Cyprus	0.896	29	Algeria	0.745	91	World	0.732	-
Italy	0.895	30	Egypt	0.731	97	* Out of the UN general list.		

Source: Human Development Report 2023-24: Breaking the gridlock: Reimagining cooperation in a polarized world. United Nations Development Programme.

This analysis highlights the necessity of tailoring NbS to the distinct environmental and social contexts of each area, especially through international cooperation. For NbS to be genuinely effective and replicable, they must be designed based on an understanding that the most vulnerable groups always have the greatest needs. This document will pay special attention to case studies of NbS aimed at assisting disadvantaged populations, including those affected by forced displacement, to whom NbS can offer vital, albeit mostly temporary, solutions.

Methodology

This document aims to illustrate the advantages and different implementation techniques of NbS in the Mediterranean by analyzing a series of case studies that seem particularly relevant due to the challenges that they address.

To select the case studies, distribution criteria were applied to various key themes. Cases addressing water issues have been prioritized, as water is a particularly critical resource in the Mediterranean. An effort to maintain a certain geographical balance between the sub-regions of the Mediterranean basin was made.

Each case study follows the same structure. It begins with general information, such as the location and implementation of the NbS, and the **Type of action**. This category includes executed projects, but also other types of actions (Diagnostic studies, Strategies, Plans and Programmes, implementation specificities, etc.). This is followed by a description of the context of the NbS, and a **Description** section.

Each Description contains an assessment of the **Ecological Services** targeted by each NbS case study. Environmental services refer to the qualitative functions of natural assets of land, water and air assets, including related ecosystems and their biota. There are three basic types of environmental services: disposal services (the functions of the natural environment as an absorptive sink for residuals), productive services (the economic functions natural resource inputs and spaces for human production and consumption), and consumer or consumption services (provide for the physiological and recreational needs of human beings).

Ecological Services contain two sub-categories: those benefits that seek to improve the environment, and those that pursue a direct positive impact on urban societies.

Environmental Benefits

1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

Social Benefits

1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

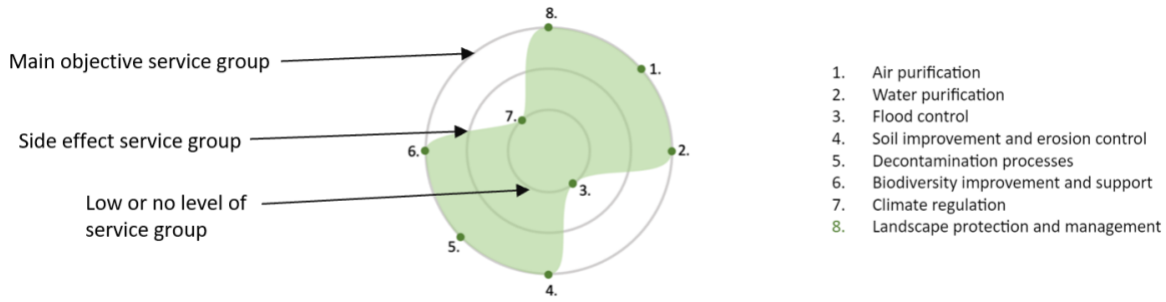
These benefits are evaluated against the overall targets pursued in an effort to describe their real performance. This step is important when evaluating NbS, since it is not always easy to evaluate their actual performance. Indeed, evaluation mechanisms may not have been implemented or even proposed, or may present potential defects.

What is more, it is crucial to adopt a holistic approach when assessing the impacts of an NbS. Even though a given solution may have positive benefits at one level, it may have negative knock-on effects at another. Moreover, the impacts of NbS may be limited when they fail to spread and take root in society and policy-making, or when they are limited in time and lack continuity.

But it is also true that once NbS solutions reach a certain stability, i.e. when planted vegetation has grown and adapted to the site and when populations have grown accustomed to using and maintaining them, NbS tend to improve their results over time. This aspect is almost never included in the impact evaluations that are usually carried out shortly after NbS are implemented.

In the following case study section, the extent to which the above benefits have been obtained or not are discussed, using diagrams that rank the NbS benefits on a three-level scale: firstly, the service group is not pursued only or to a small extent; secondly, the service group is a relevant side effect of the main objective or the main action and thirdly, the service group is pursued as the main objective of the action.

Figure 3. Environmental Benefits diagram – example

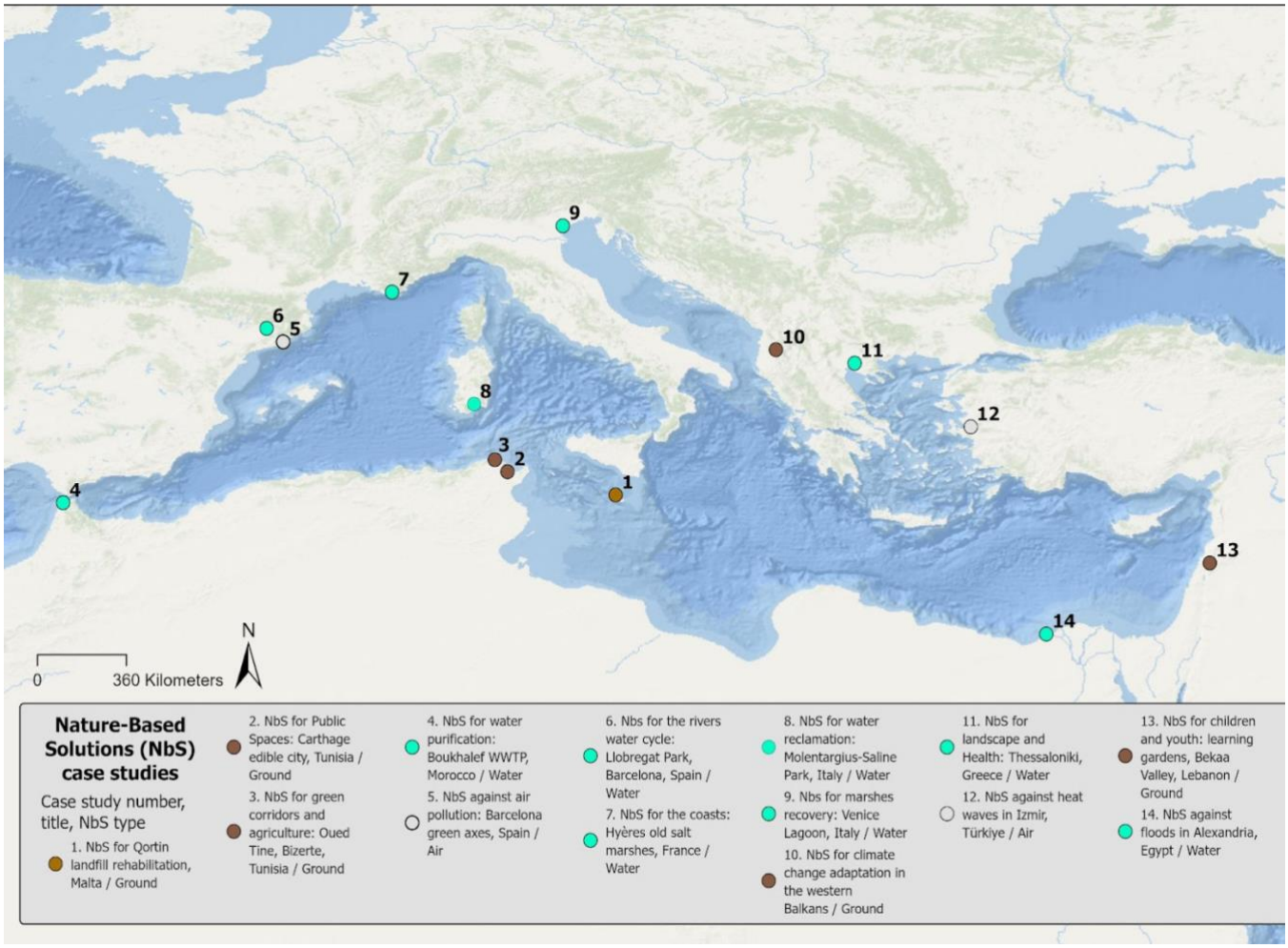


The **Lessons Learnt and Policy Recommendations** section then analyzes the most relevant insights provided by the NbS, with specific focus on the governance aspects of the implementation process, thereby providing recommendations for policy makers to implement NbS in Mediterranean cities.

Finally, some references are provided in the **To know more…** section. In all of the case studies, technical expressions are highlighted in green and are defined in the **Glossary** at the end of this report. Finally, the **Conclusions** aim to inform and facilitate decision-making on NbS with strategic recommendations.

Case studies

Figure 4. Geographical distribution of the selected NbS case studies



Source: Plan Bleu 2024, map created using ArCGIS software

NBS FOR LANDFILL REHABILITATION: QORTIN LANDFILL, MALTA

Source: Authors, using Google Earth Base

GEOGRAPHICAL LOCATION
Gozo, Malta

IMPLEMENTATION PERIOD
2007-2013

TYPE
Implemented Project

PARTICIPATING ENTITIES:
- Environment and Resources Authority of Malta
- WasteServ Malta Ltd
- European Agricultural Fund for Rural Development (EAFRD) (75% financing entity)

FIELDS OF ACTION:
- Human health
- Water security
- Environmental degradation and biodiversity loss

LOCATION
Peri-Urban (surface: 49.000 m²)

BUDGET
€ 3.250.000,00

The control and recovery of landfills is essential to prevent the release of a wide spectrum of high-risk contaminants into the environment, such as leachate that can contaminate groundwater or the sea, threatening water resources, or waste that can be dragged to the sea by rainfall. Landfills near the sea can contribute to the dumping of plastics that pollute beaches and form "Garbage Islands", which already exist in the Mediterranean. They also contribute to the concentration of dangerous microplastics in the sea, from where it reaches the human food chain and can generate serious diseases. That is why it is important to treat landfills that still do not comply with the EU waste and landfill legislation, representing a serious risk for human health and the environment.

Context

The Qortin landfill in Gozo Island, Malta, was initially functioning as an uncontrolled landfill from 1968 to 2004, affecting an area of 49,000 m² and comprising around 0.6 million tons of waste (33% municipal/commercial, 39% construction and demolition and 28% industrial waste). In addition to concerns over potential impacts on human health and the environment through landfill fires, landfill gas production and emissions of leachate, Qortin landfill was not compliant with the engineering requirements of the European Union Landfill Directive. These issues not only affected the immediate vicinity of the landfill, but also disturbed neighboring areas. Victoria, the capital of the island, is located less than 3 km away, while Xagħra and Marsalforn are even closer, bringing the total population living in the vicinity of the landfill to more than 12,000 people.

Description

The rehabilitation and restoration of the Qortin landfill were achieved by the:

- installation of engineered capping to improve control of gas emissions and reduce rainfall infiltration (and thus leachate production);
- control of surface water run-off using a drainage system with attenuation ponds;
- placement of subsoil and topsoil;
- restoration planting;
- ongoing maintenance and irrigation.

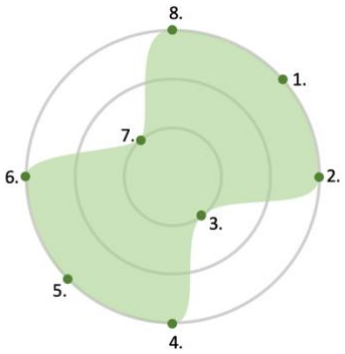
Thus, when the landfill was closed in 2004, measures were taken to install an aerial emissions control system which was completed in 2008. Following this, the landfill was sealed off by means of a subsoil and topsoil, and around 23,000 shrubs were planted to restore this area to its natural habitat. A water reservoir was also built to harvest rainwater to be used for irrigation purposes.

In the final phase of this project, the site was made safe for the public to access. This was achieved through the installation of safety railings, gates and fences that were built around the gas manifolds. Qortin has been transformed from a landfill into an open space for families to enjoy the surrounding views of Ramla l-Ħamra bay. A parking area and a dog park were also created. This project thus involved the permanent closure of a non-engineered landfill and achieved the following results:

- an improvement in the control of gas emissions;
- a reduction in rainfall infiltration and leachate production;
- control of surface water run-off using a drainage system with attenuation ponds;
- restoration planting using indigenous Maltese species;
- improved visual impact;
- reduced odor generation.

Ecological services

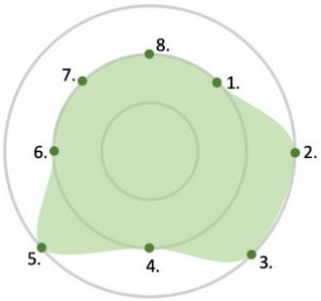
Environmental Benefits



1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

The landfill containment actions control the pollution of groundwater by leachate and should prevent plastics from reaching the sea, thereby protecting both marine and terrestrial waters (2 and 5). In addition, methane emissions generated by decomposition are controlled, avoiding greenhouse gas emissions (1). Improvements to the soil are achieved with vegetation cover and by retaining runoff (4). The selection of native species from the typical Mediterranean maquis of the island, mainly composed of shrubs, should also facilitate the regeneration of the potential fauna and flora of the area, establishing a landscape that can adapt to local climate change impacts (6 and 8).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

The rehabilitation project has allowed the development of a new settlement between the landfill and the sea, and has drastically reduced the impact on the surrounding population. Therefore, we can say that it is an investment that protects the well-being and health of the population (3), and it is an exceptionally effective investment in terms of territorial development (2). European funding provided by the EU Interreg COCOON project also allowed the company managing waste in Malta to reach a very good level of problem resolution and to strengthen other lines of sustainable waste management (5). Finally, as the landfill space has become accessible thanks to restoration efforts, the installed recreational areas have improved the walking possibilities for local populations (7).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

Tourism is one of the fields for which environmental recovery is most evidently productive. Malta has managed, in part thanks to the qualification of its tourist offer, to achieve a great boost for its economy, which lies in direct relationship with the improvement of the environmental conditions of the archipelago.

Therefore, one should consider operations aimed at improving the environment not only as investments aimed at improving the quality of life of the population and biodiversity, but also as business opportunities for the economy.

TO KNOW MORE…

- Consortium for a Coherent European Landfill Management Strategy (COCOON, Interreg Europe): https://projects2014-2020.interregeurope.eu/cocoon/
- Qortin Landfill Rehabilitation in Gozo: https://www.interregeurope.eu/good-practices/qortin-landfill-rehabilitation-in-gozo
- Wasteserv Malta - Creating resources from waste: https://www.wsm.com.mt/en/home

NBS FOR LOCAL FOOD SYSTEMS: CARTHAGE EDIBLE CITY, TUNISIA

Source: Edicitiesnet Project

GEOGRAPHICAL LOCATION
Carthage, Tunis Governorate, Tunis

IMPLEMENTATION PERIOD
September 2019- February 2024
(Edicitnet Horizon 2020 Project)

TYPE
Pilot Test

PARTICIPATING ENTITIES:
- Carthage Municipality
- Association Tunisienne de Développement Durable: La Recherche en Action (REACT).
- Société Bel Fer.
- EdiCitNet Horizon 2020 financial instrument of the European Union, with Carthage as a member city

FIELDS OF ACTION:
- Economic and social development
- Food Security
- Environmental degradation and biodiversity loss

LOCATION
Urban

BUDGET
€ 158.156,26

Few objectives seem less debatable than that of eating well: producing food sustainably, consuming healthy food and ensuring that everyone can eat enough and properly. That is why all links in the food system value chain must be reviewed in depth to strive for more sustainable food production and fairer access to healthy food. More efficient and proximity-based food systems are needed, while it is also necessary to transform consumption habits to adapt them to the production capacities of sustainable agriculture. These are difficult goals. Cities are far from achieving such objectives and need important systemic innovation changes to achieve them. In the absence of action, the threat of system collapse is very real.

Context

The archaeological site of Carthage was added to UNESCO's World Heritage List in 1979. The Carthage of Antiquity was founded by the Phoenicians in the 9th century BC. Established in 1919, modern Carthage is located about 15 km to the east-northeast of Tunis, and counts around 26,000, mostly wealthier residents. wealthier residents. Carthage Palace, the Tunisian presidential palace, is located on the coast. Over the past years, Carthage has benefited from the implementation of an integrated effort to improve the city's food system.

Description

The term ***Edible City Solutions*** (ECS) designates a kind of NbS. It encompasses all sustainable forms of food production, distribution and consumption in urban areas, ranging from urban community gardens and beekeeping to vertical farming and high-tech indoor agriculture, culinary events and meals, and the use of locally-grown products in restaurants. The implementation of ECS is recognized as a catalyst for stimulating local economies, enhancing economic development, boosting tourism, and creating employment opportunities, especially for unemployed individuals and informal workers. By using urban landscapes for food production, these solutions contribute to making cities more sustainable, livable, and healthy. Globally, a diverse range of initiatives under the Edible Cities movement is flourishing. These initiatives, through their various products, activities, and services, empower local communities to tackle social issues via inclusive and participatory approaches, while also fostering the creation of new green businesses, job opportunities, and enhancing local economic growth and social cohesion.

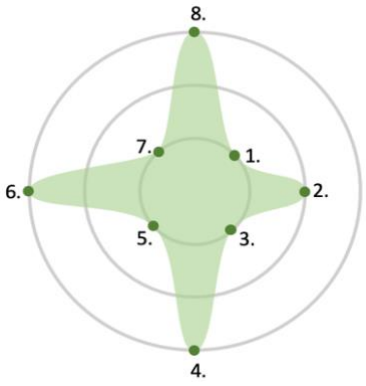
EdiCitNet, a key player in this movement, focuses on maximizing the benefits of ECS at the local level and promoting their replication worldwide through the establishment of an open and participatory network of cities. This network thus empowers urban populations with a unified methodology to explore, adapt, plan, and implement ECS tailored to their unique urban settings.

In this context, an innovative Edible City Strategy (ECS) was formulated to integrate urban agriculture into Carthage's development. Various actions were taken, including the construction of the Amilcar Garden. This garden of over 3000 m² is composed of 5 orchard-vegetable gardens, designed according to the principles of ***permaculture***. The *Societé Bel Fer* carried out a series of awareness-raising actions, notably to build the capacity of the targeted stakeholders in the city. Moreover, the *Association la Recherche en Action* focused on integrating ECS into urban master plans by developing ECS strategies that are adapted to specific climatic, social, and cultural contexts. This involved integrating aspects linked to water and biodiversity into the plans, engaging in co-creation meetings with key stakeholders, and establishing the project's Carthage city team which was responsible for raising awareness, building capacity, disseminating information, and ensuring the sustainability of EdiCitNet's achievements.

To ensure the success of these initiatives, EdiCitNet strives to bridge knowledge gaps in the effective implementation of ECS, and transform them into sustainable, innovative business models. This knowledge is available in a globally accessible knowledge base and methodology, which supports the evidence-based and sustainable integration of ECS into long-term urban planning.

Ecological services

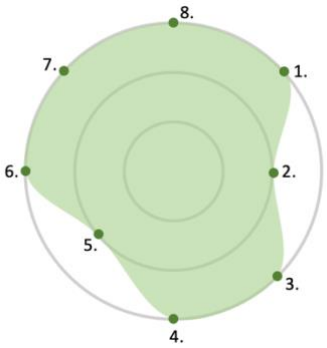
Environmental Benefits



1. Air purification
2. Water purification
3. Flood Control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

Although the overall goal of the project is to engage in research on a global transition of society towards a more sustainable, healthy, and fair food systems, the specific actions carried out in Carthage have a more limited effect if we only consider the gardens that have been built. In this sense, the most remarkable results consist in the improvement of soils thanks to the permaculture techniques employed (4), attracting and reinforcing the action of pollinators (6), and the improvement of the urban landscape (8).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

Although it was deployed on a small scale, the project provides a wide spectrum of social benefits. It sought to generate employment (1), emphasized the health benefits of adequate and fair nutrition (3 and 6) and also improved the aesthetic and recreational value of the city, potentially increasing its touristic value (7). Finally, the awareness-raising actions carried out, as well as the studies regarding the reinforcement of food policy networks, guarantee an important educational and scientific value (8).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

Some basic systems of contemporary societies, such as the food system, need to be reconfigured. However, due to its scale and complexity, it is challenging to introduce systemic changes into the global food system. These actions must not only target its material base, but also connect change agents to accelerate the urgent innovations that are needed.

Therefore, collaboration among the agents of administration, research, production, and social activism who encourage innovation in the food sector (or any sector) is crucial. By building a network of agents that promotes change and encourages the exchange of information and resources, as well as collaboration between them, we can accelerate the transition towards a more sustainable, healthy, and fair food system.

TO KNOW MORE…

- Edible City Network: https://www.edicitnet.com/green-cities/
- European Union - Edible Cities Network - Integrating Edible City Solutions for social resilient and sustainable productive cities: https://cordis.europa.eu/project/id/776665
- Productive Urban Landscapes: https://blogs.brighton.ac.uk/pulr/tag/carthage/
- Edible City Network - Documentation of Edible City Solutions in Follower Cities: https://www.researchgate.net/publication/370155450_EdiCitNet_-_Documentation_of_Edible_City_Solutions_in_Follower_Cities

NBS FOR GREEN CORRIDORS AND AGRICULTURE: OUED TINE, TUNISIA

Source: Association Avenir des Jeunes, PPIOSCAN Project

GEOGRAPHICAL LOCATION
Bizerte and Manouba Governorates, Tunisia

IMPLEMENTATION PERIOD
2016-2022 (PPI-OSCAN Program)

TYPE:
Pilot Project

PARTICIPATING ENTITIES:
- Association les Amis de Capte Tunisie (organization)
- International Union for Conservation of Nature and Natural Resources (organization and financer)
- Swiss Embassy in Tunisia, Sotipapier, Tunisian Association of Environmental Agriculture (ATAE), MAVA Fondation pour la Nature, Fonds Français pour l'Environnement Mondial, Chinese Man Records (co-financers)

FIELDS OF ACTION:
- Climate change mitigation and adaptation
- Environmental degradation and biodiversity loss
- Food security
- Economic and social development

LOCATION
Hinterland (surface: 55 km²)

BUDGET
€ 51.444 € (164.620 TND)

Industrial agriculture and the use of chemical products for farming can have a significant impact on ecosystems and can compromise agricultural production levels in the medium term, thereby increasing its vulnerability to climate change. It is therefore crucial for agriculture to adopt more sustainable techniques. Indeed, this shift in environmental management and agricultural production is necessary to secure and improve food production and preserve ecosystems, thus achieving greater sustainability and resilience to climate change.

Context

Les Amis de Capte association, based in Bizerte, supports farmers in the Oued Tine area to reforest green corridors and transition to agriculture through the IUCN PPI-OSCAN project (Small Initiatives Program for Civil Society Organizations in North Africa).

The Oued Tine area includes three villages (Edkhila, Gousset el Bey, and Sidi Abdel Basset) located on the borders of the Governorates of Manouba and Bizerte in northern Tunisia. The bioclimatic zone is upper semi-arid, with a relief characterized by a diverse landscape crossed by a hydrographic network, with the Medjerda River acting as the central collector. The local community, predominantly dependent on agriculture, consists of around 200 people, including 20 farmers and their families as well as 10 young people working as forest workers. Additionally, there are 90 pupils in two primary schools in the villages concerned, who are involved in awareness-raising activities implemented by the PPI-OSCAN project. The location of these crops, about 50 km by road from both Bizerte and the capital Tunisia, means that they can act as a local food source for these cities, thereby improving these urban areas' food security and resilience.

This territory includes two distinct eco-zones: the plain area, crossed by the Oued Tine with hydromorphic soils presenting high levels of salinity, and the hillsides, which are subject to wind and water erosion and have limestone soils. Agriculture is the primary source of income in the area.

Description

The creation of a dam upstream led to changes in one of the few wetlands in the region, which is under threat due to the constant deterioration of natural forests, soils, waters, and environmental resources. In the case of Oued Tine, the key action is the preservation and reinforcement of ***green corridors*** and the promotion of agroforestry. To respond to this threat, the project strives to create a harmonious balance between farming productivity and environmental stewardship by integrating trees into agricultural landscapes. Several initiatives were implemented:

- Plantation of threatened and endangered trees such as thuja cypress trees or carob, reinforcing or creating ***green corridors***.
- Promoting ***agroforestry practices*** to improve ecosystems, biodiversity, and resilience of Tunisian agro-food systems.
- Installation of orchards (olive trees, carob trees) organised with mixed hedges.
- Water and soil conservation through tree planting, mulching techniques and irrigation pods.
- Creating an environmental club with the pupils of Gousset El Bey primary school and distributing an educational game among the younger pupils to raise environmental awareness.
- Development of solidarity with and among farmers.

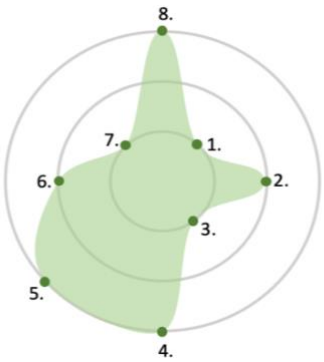
Green corridors are ecological structures that connect different biotopes and ensure the flow of species among them. This is essential for preserving and enhancing biodiversity, and can reinforce the resilience of agricultural systems. Such corridors support biological interactions and restore the community flows of species (seasonal migrations, genetic connectivity etc.) which are vital for their survival, but are also essential for maintaining animal and plant biodiversity, since they allow species to move and perpetuate themselves.

The network of green corridors also allows for the establishment of an agroforestry mosaic that increases the performance of agricultural operations, which are able to reduce or even eliminate the use of chemical fertilizers, since the forested areas provide organic matter and humidity to the crops. Agroforestry systems seek to increase the availability of resources, while simultaneously enhancing the sustainability of cropping systems. In terms of reforestation, the project employs diverse strategies such as planting endangered trees like the carob or cypress, establishing orchards with olive and carob trees, and creating mixed hedges.

At the community level, the program tries to improve the population's perception of the importance of biodiversity and its state of degradation, increase beneficial interactions between farmers and stakeholders and facilitate the adoption of good environmental and agronomic practices by farmers and their families, while paying special attention to the younger generation by creating an environmental club and distributing an educational game to raise their environmental awareness. The benefits rendered have been tested with a collaborative tool to support community involvement and cohesion.

Ecological services

Environmental Benefits



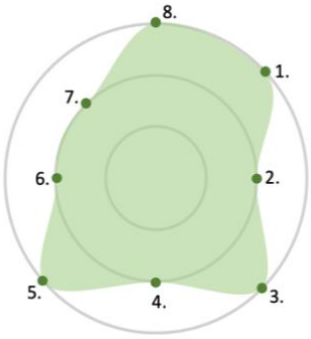
1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

The project's primary focus within the environmental sphere encompasses diverse initiatives geared towards cultivating a heightened awareness of biodiversity, promoting sustainable agricultural practices, and bolstering the resilience of local farms. A key aim is to transform the community's perception of biodiversity and its ongoing degradation, fostering a collective commitment to conservation (6).

In its pursuit of sustainable practices, the project aims to facilitate the widespread adoption of environmentally-friendly and agronomically-sound approaches among farmers and their families. By imparting knowledge and practical tools, the project seeks to empower the community to implement practices that preserve the environment and contribute to the long-term health of agricultural systems.

The project's commitment to conservation extends to collaborative efforts and innovative tools for monitoring and measuring benefits. By fostering collaboration between farmers and stakeholders, the project aims to create a network that conserves natural resources, particularly water, and ensures the sustained success of environmentally-conscious agricultural practices. This multifaceted approach underscores the project's dedication to fostering a resilient and sustainable environment for current and future generations (8).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

From a social perspective, there were other projects in the area engaging the community, and this was one of the reasons why this area of intervention was prioritized. The project is located in a rural hinterland, where most of the population engages in agricultural activities. The residents face escalating financial instability resulting from numerous factors with a strong climate dimension, including soil degradation, water and soil contamination, salinization, and increasingly threatened biodiversity.

To combat the identified challenges, the project introduces strategies that foster ecological sustainability and uplift the community's socio-economic fabric. A pivotal focus lies in reintroducing fruit, forest, and fodder tree plantations to bolster family income (1 and 3). By advocating for the cultivation of resilient plants capable of withstanding environmental stressors, the project endeavors to optimize the utilization of marginal soils (2).

In addition to these agricultural initiatives, the project recognizes the imperative of knowledge dissemination within the community (8). It seeks to enhance the understanding of the local environment, emphasizing its fragility and illuminating its untapped economic potential. This educational facet is designed to equip community members with the insights needed to make informed decisions on sustainable agricultural practices, fortifying their resilience against environmental challenges. The project ensures the link with induced socio-economic impacts that are beneficial for a community with low resilience. Indeed, thanks to inclusive governance mechanisms, the level of involvement of local stakeholders is maximized. In essence, the social dimensions of the project are intricately woven into the fabric of addressing the unique challenges faced by the rural population. The proposed solutions contribute to ecological rejuvenation and empower farmers to navigate towards a more sustainable and resilient future.

LESSONS LEARNT AND POLICY RECOMMENDATIONS

The project understands well how community engagement is crucial to achieving long-lasting solutions that consolidate beyond a specific project. The project demonstrated that the community's willingness to participate in all parts of the intervention is solid and responsive, leading to successful results. Indeed, creating interactions between the socioeconomic and governance aspects is crucial for the community to understand that its engagement is the only guarantee to achieve root results for the people.

It might be worthwhile to assess to what extent this successful approach is sustainable in the long run. The initiatives carried out in this project resulted from a boost achieved through international cooperation through the PPI-OSCAN project. It is necessary to ensure that the project's results are embedded in the community and the overarching reality of the Tunisian green corridors. National and local authorities might need other similar initiatives before they integrate the approach in order to scale it up at the national level with similar results.

Therefore, it is key to promote the integration of all the stakeholders concerned, which strengthens the interactions between socio-economic and governance aspects by making it easier to understand the institutional commitment to a reforestation project.

TO KNOW MORE…

- IUCN - Planning and delivering NbS in Mediterranean cities: https://portals.iucn.org/library/sites/library/files/documents/2021-036-En.pdf
- Corridors Caroubier: https://explorer.land/x/project/corridors_oued_tine/partners
- Mobilization Plan for relevant parties: https://www.cepf.net/sites/default/files/stakeholder-engagement-plan-111446.pdf
- 5 NbS used by North African civil society for forest restoration:https://www.ppioscan.org/5-solutions-fondees-sur-la-nature-utilisees-par-la-societe-civile-nord-africaine-pour-restaurer-ses-forets/#:~:text=Les%20Corridors%20Environnementaux%20à%20Oued%20Tine%20(Bizerte)&text=En%20effet%2C%20les%20corridors%20environnementaux,déplacer%20et%20de%20se%20perpétuer

NBS FOR WASTEWATER TREATMENT AND REUSE: BOUKHALEF WWTP, MOROCCO

Source: Amendis

GEOGRAPHICAL LOCATION
Tangier, Tangier-Tetouan-Al Hoceima Region, Morocco

IMPLEMENTATION PERIOD
2015-2020

TYPE:
Implemented Project

PARTICIPATING ENTITIES:
- Municipality of Tangier
- Ministry of Interior
- Water Authority
- River Basin Agency (ABH)
- Agency for the Promotion and Economic and Social Development of the Northern Prefectures of the Kingdom (APDN)
- Regional Council of Tangier-Tetouan-Al Hoceima
- Amendis (delegated management company)

FIELDS OF ACTION:
- Water security
- Climate change mitigation and adaptation
- Economic and social development

LOCATION
Peri-Urban (surface: 3 km²)

BUDGET
€ 5.600.000

Inadequate infrastructure for sustainable water cycle management is a major threat to cities. This is particularly evident in Northern Africa's water-stressed regions, where the overexploitation of water resources leads to the contamination and depletion of water resources, compounding a precarious future in a context of increasing water demand and more frequent droughts. NbS are key to enhancing water use efficiency, protecting water resources, both at the quantitative and qualitative levels.

Context

Tangier, a city located at the convergence of the Atlantic and the Mediterranean, falls within the watershed of the Tangier-Tetouan-Al Hoceima region in northern Morocco. This region, encompassing both the Atlantic and Mediterranean coasts, covers an area of 15,090 km² and has a population of 3.8 million inhabitants (2024), 60% of which is urban. It is the rainiest area in the country, largely due to the proximity of the Atlas Mountains and the

microclimate of the Strait of Gibraltar, which enhance precipitation and the collection of runoff water. For instance, Tetouan receives about 650 liters/m² annually, while Tangier reaches 750 liters/m², despite both cities experiencing long, hot, and dry summers. However, the increase in population and water consumption poses a risk of overexploiting the area's water resources. Therefore, integrating mechanisms to improve the efficiency of the urban water cycle is of utmost importance.

Description

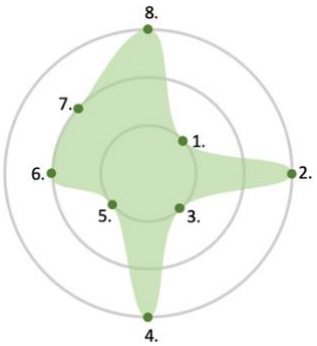
The Boukhalef Wastewater Treatment Plant (WWTP) started operations in 2015 with a capacity of 10,700 m³/day. This capacity has grown to 42,700 m³/day after expansion works. The plant treats the water to a tertiary level and the recycled water it produces is used to irrigate golf courses and municipal green spaces.

The project was carried out in three phases:

- The first phase began in 2015 with the commissioning of the Boukhalef WWTP, the laying of an 8 km distribution network and the installation of a 120 liters per second (l/s) pumping station to irrigate an area of 110 ha of green spaces at the Qatari Diar Golf Course.
- The second phase, which started in 2019, saw the expansion of the reuse network toward the center of Tangier to irrigate municipal green spaces and the Tangier Golf Royal. In addition, two storage tanks with a total capacity of 6,000 m³ and a capacity discharge station of 120 l/s were constructed. A second tertiary treatment plant was also established, and 21.5 km of distribution network was laid. The target of this phase was the irrigation of 141 ha. To date, 115 ha, including 70 ha for the Royal Golf Tangier located in Tangier and Gzenaya municipalities, are irrigated with recycled water from the plant.
- The third phase increased the capacity of the Boukhalef WWTP to 42,700 m³/day and expanded the irrigation area to 150 additional ha across the rest of the city. Construction work for this expansion is in the final phase, and a study to extend the transport and distribution network is almost complete.

Ecological services

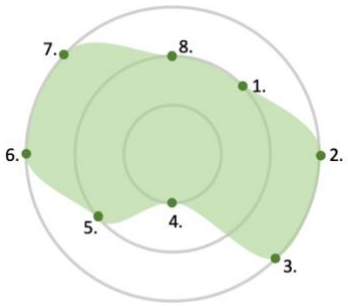
Environmental Benefits



1. Air purification
2. Water purification
3. Flood Control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

Apart from the obvious contributions in terms of water reclamation (2), the project provides other values such as soil improvements thanks to the plantations of irrigated areas (4) and guarantees the management of managed landscapes (8) in an environment in which that the planting of herbaceous plants is not as contradictory as in other parts of Morocco.

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

Currently, the reuse system has not generated much employment in the long term, although Amendis considers it likely that this will change. In terms of the design and implementation of the wastewater treatment plant and reuse system, jobs have been created for companies engaged in construction work, but Amendis are not able to provide data on this (1). In terms of tourism, Tangier is one of the cities most visited by recreational and seaside tourists in Morocco (7). Wastewater treatment and reuse of the recycled water makes it possible to improve the attractiveness of the city through the expansion of green spaces and at the golf courses that benefit from the project. The collection and processing of wastewater has greatly improved the local environment compared to the pre-project situation and reuse is having a very positive impact in terms of reducing groundwater and other water uses (6), saving 3 million m³/year (2 and 3).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

The management model for the use of recycled water from the Boukhalef WWTP for golf courses and green spaces operates within a partnership framework, in conjunction with other municipalities including Fnideq, Tetouan and M'diq in the north of Morocco.

A formal agreement establishes the partnership and cooperation between the signatory parties, by defining their roles and responsibilities, in particular with regards to the financing, implementation and monitoring of projects and their achievements, as well as monitoring the quality of treated wastewater.

- The water basin agency provides financial support and permits for water reuse, motivated by the incentives for cost savings through wastewater recycling and compliance to the law.
- The Municipality of Tangier provides the land and financial contribution for the construction of the wastewater treatment plant.
- The Ministry of the Interior, the Water Authority and the Northern Development Agency (APDN) invest the capital expenditure (CAPEX).
- Amendis, a private entity, manages necessary works and installations, ensures the consistency of the quality of the treated wastewater intended for reuse, covers the operating expenses (OPEX) and maintenance and delivers recycled water to end-users at USD 0.27/m³.
- A monitoring committee monitors compliance with the terms of the partnership contract and the overall operation of the treatment and reuse system.

The successful implementation of NbS requires a good governance design, which can be achieved through partnerships that facilitate collaboration among stakeholders without compromising control.

Therefore, it is crucial to establish collaborative relationships among all agents involved to address the challenges of implementing innovative systems compliant with regulations, and to face other difficulties in the development of NbS.

The project's reports recall that, compared to agrarian recovery (i.e. land sharing or redistribution), this reuse model is viable because it involves a logic of remuneration with solvent users, which irrefutably contributes to cost recovery. However, it is important to remember that the association between powerful economic

agents can facilitate the stability of the project, but can also contribute to an increase in inequalities if these associations do not work to achieve and disseminate the benefits that are obtained for society at large.

Thus, NbS incorporation projects that bring together economically powerful stakeholders in developing countries must consider from the design phase which advantages they must provide to society as a whole to guarantee their growth possibilities. Without providing benefits to the entire population, social problems may arise, which can threaten the continuity and possibilities of scaling up the projects.

TO KNOW MORE…

- Boukhalef wastewater treatment plant and Tangier green space and golf course water reuse: https://www.iwmi.cgiar.org/Publications/Books/PDF/water_reuse_in_the_middle_east_and_north_africa-a_sourcebook-case_study-2.pdf
- The United Nations World Water Development Report 2018: NbS for water https://unesdoc.unesco.org/ark:/48223/pf0000261424
- Managing Urban Water Scarcity in Morocco: https://documents1.worldbank.org/curated/fr/820871516882762722/pdf/122698-WP-v2-PUBLIC-anneces-to-sections-2-to-4.pdf
- Video: The steps of wastewater treatment: https://youtu.be/raO7bjIMuQw

NBS AGAINST AIR POLLUTION: BARCELONA GREEN AXES, SPAIN

Source: own production

GEOGRAPHICAL LOCATION
Barcelona, Catalonia, Spain

IMPLEMENTATION PERIOD
May 2022-September 2023 (1st phase)

TYPE:
Implemented Project

PARTICIPATING ENTITIES:
- Barcelona Municipality (Promoting Entity)
- Neighborhood associations
- Associations for health, associations against air pollution, primary school parent associations

FIELDS OF ACTION:
- Human Health
- Climate change mitigation and adaptation
- Economic and social development

LOCATION
Urban (surface: 150.000 m²)

BUDGET
€52,700,000

Private mobility has become a significant issue in Mediterranean cities due to several factors, with air pollution being one of the primary concerns. In 2022, over 310,000 people died prematurely due to causes related to air pollution in Europe, particularly in urban areas. An important share of this pollution originates from private mobility, though the proportion could be much higher in urban areas. Furthermore, car traffic in cities also entails problems such as high levels of noise pollution, water pollution, degradation of the urban landscape and an increase in the heat island effect. Generally speaking, car traffic generates an unbalanced distribution of public space, with a minority group of car drivers occupying much more space and producing a far greater share of greenhouse gasses than the rest of the urban traffic sector. Given this situation, it is possible to reduce the space allocated to private vehicles to reduce the volume of traffic and therefore use these spaces to improve the landscape and environmental quality of the city.

Context

In Spain, deaths from air pollution are ten times higher than deaths from traffic accidents. Additionally, due to its high density, Barcelona is the European city with the highest number of cars per square kilometer, often exceeding the maximum limits set by EU regulations. Such levels of air pollution can affect the health of the urban population. Some scientific studies point out that high pollution levels provoke a significant number of premature deaths as well as other problems such as lower levels of educational achievement in schoolchildren. Indeed, Barcelona City Council commissioned epidemiological studies from prestigious institutions that estimated premature deaths due to air pollution at more than 800 per year, while other studies confirmed the slower intellectual development of schoolchildren subjected to high levels of noise and pollution.

Barcelona counts 1.7 million inhabitants within a metropolitan region of about 5.5 million. But the Municipality of Barcelona, which spans less than 100 km², has the particularity of presenting a very high urban density, only surpassed by Paris in Europe. This density has the consequence that the level of green spaces in the city is low, barely 5 m² per inhabitant on average, which in the case of dense areas of the city can fall below 1m² per inhabitant.

In a central area of the city that suffers from high car traffic levels, high air pollution, and a lack of green spaces, the Green Axes Project addresses these three problems by subtracting urban space dedicated to traffic to create more green spaces. This strategy can reduce the number of circulating cars and improve the experience of pedestrians by reducing air and noise pollution. It also delivers other critical environmental services, such as improving the water cycle, reducing the risk of flooding, and reducing the urban heat island effect.

Description

Green Infrastructures are not only made up of the natural systems preserved in metropolitan areas, nor are they limited to large parks and tree-lined avenues in cities. Green infrastructures must provide guaranteed access in a reasonably short time for the entire population, while allowing for the penetration of ecological flows throughout the urban fabric. Barcelona's metropolitan area is not conducive to traffic flows (in and out) for the surrounding neighborhoods. And among all of them, the Eixample neighborhood stands out, due to a very high density of population, activities and circulation of private vehicles, while its provision of public parks is very low.

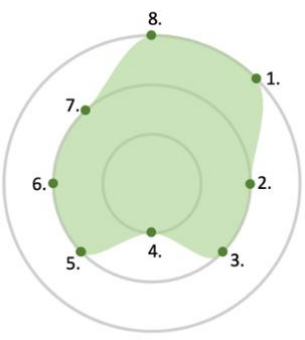
Figure 5. Space dedicated to road traffic in the existing city

Figure 6.Reduction proposal for the 2030 horizon.

Source: Barcelona Municipality. Public document

The Green Axes project is part of an ambitious Barcelona city council plan for the whole city called “Super-Blocks”, which aims to increase the number of pedestrian streets in the city. This does not simply mean closing access to traffic, but rather transforming the spaces to bring them closer to the environmental standards offered by parks and gardens. By collaborating with local associations and citizens, traffic areas are transformed to accommodate living and circulation areas for pedestrians and to create spaces for vegetation, natural water infiltration and urban biodiversityEcological services

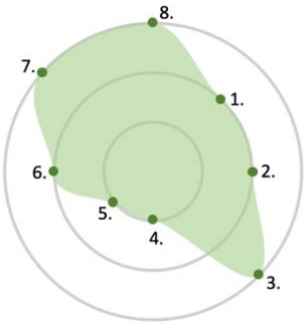
Environmental Benefits



1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

At the environmental level, the Green Axes project's main objective is to reduce traffic, thereby improving air quality and reducing noise levels in a high-density urban area (1). The technique used is to discourage the use of private vehicles by reducing the space that they can use to circulate in order to achieve the ***evaporating traffic*** effect. Therefore, it is not a matter of cars simply passing through another place. The aim is to ensure that some of the private vehicle drivers using these spaces decide to use other, much less polluting modes of transport such as public transport. The other major argument of the project is the improvement of the urban landscape and its environmental performance (8) through the reinforcement of urban vegetation and the implementation of ***Sustainable Drainage Systems***. However, the latter have not been very productive, due to the lack of space and the limitations that arise from building in a very dense and active urban area. notably the numerous regulations that must be strictly met, in matters such as emergency vehicle access, protection of underground pipelines, etc.

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

Barcelona is a city with a very high supply of commerce and services, including tourism. It has been shown that the expansion of pedestrian spaces in commercial and service areas stimulates the economy by attracting investment and generating employment, although this can also generate gentrification and excessive touristification. For this reason, the project proposes elements designed to ensure the access to the new pedestrian spaces at no cost for all citizens and visitors. In the traffic-free streets, pocket parks have been created as living and social spaces. However, these elements also suffered from the lack of space and the technical constraints of working in a built-up urban environment. On the other hand, increasing walkable spaces in the city (3) and nurturing the urban landscape by introducing vegetation is not only city beautification (7), but has generated a broader social discussion on the actions to be taken against air pollution. In itself, this is an educational advance that has changed the narrative, putting air quality at the center of the political discussion (8).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

Throughout the very lively discussions around this project, the reduction of space dedicated to private traffic and the inconveniences generated for drivers became the central issue. These consequences have repeatedly been questioned from a technical and scientific angle, which left aside several of the project's key benefits: the unquestionable landscape improvement of public space, the implementation of essential systems for the sustainability of the urban metabolism, and the improvement of the quality of life of citizens. For this reason, although Barcelonians who use private vehicles for their daily mobility barely constitute 20% of the population, the Green Axes and the Super-Blocks Plan were put on hold when the municipal government team changed in September 2023. However, the social and international success of the project illustrated the fact that the culture of public space usage in the city has changed.

Thus, it must be considered that NbS, which can have a truly transformative effect on their surrounding socio-ecosystems, must be accompanied by well-designed public consultation and communication plans that are capable of reaching and involving the entire local population that may be affected. To do so, it is crucial to highlight the direct and verifiable benefits perceived by citizens.

TO KNOW MORE…

- European Environment Agency - "The number of premature deaths due to air pollution continues to decrease in the EU but efforts must be redoubled to eliminate toxic substances from the environment" (in Spanish): https://www.eea.europa.eu/es/highlights/el-numero-de-muertes-prematuras#:~:text=En%20la%20UE%20se%20producen,salud%20de%20la%20población%20europea.
- Information on Barcelona's Green Axes (in Spanish): https://ajuntament.barcelona.cat/superilles/es/

NBS FOR RIVERS: LLOBREGAT PARK, SPAIN

Source: Barcelona Metropolitan Area. Public document.

GEOGRAPHICAL LOCATION
Barcelona Metropolitan Area, Catalonia, Spain

IMPLEMENTATION PERIOD
May 2007-2024

TYPE
Implemented Project

PARTICIPATING ENTITIES:
- Barcelona Metropolitan Area (Promoting Entity)
- Catalan Water Agency
- Metropolitan municipalities
- European Union FEDER Funds
- Metropolis Institute (Research Center)

BUDGET
€40,000,000

FIELDS OF ACTION:
- Water security
- Environmental degradation and biodiversity loss
- Climate change mitigation and adaptation
- Economic and social development

LOCATION
Peri-Urban (surface: 10 km²)

Mediterranean coasts present high population densities and receive relatively low rainfall, with hot and dry summers. As a result, water has always been a precious resource in most Mediterranean coasts, although it is often over-exploited or contaminated, leading to a reduction in available resources coupled with an ongoing rise in demand. This makes access to clean water a particularly crucial challenge for urban areas in general, and large cities in particular. NbS can significantly help in improving water balance and achieving a more sustainable water cycle, while preserving biodiversity and facilitating citizens' enjoyment of water landscapes.

Context

The metropolitan region of Barcelona, with its more than 5.5 million inhabitants, is located in a relatively small river basin, with the main river, the Llobregat River, presenting an average flow of about 20 m³/s. This flow is insufficient to meet the needs of the region's population, industry, and agriculture. Traditionally, this deficit has been solved by consuming groundwater and channeling water from neighboring, less populated basins, which still suffer from water losses in their ecosystems and agricultural areas. This dependence becomes particularly problematic during the frequent periods of drought that have occurred every seven years over the last century, leading to bitter controversies. In the early 1970s, 70% of the water consumed by the 3 million inhabitants of the central area of the Barcelona metropolis came from 100 km further north, and there were even plans to bring water from the Rhône River in France, located more than 400 km away. However, this unsustainable solution was eventually abandoned. Instead, the

Llobregat River was equipped with a series of facilities to improve the water cycle and reduce dependency on other basins and groundwater.

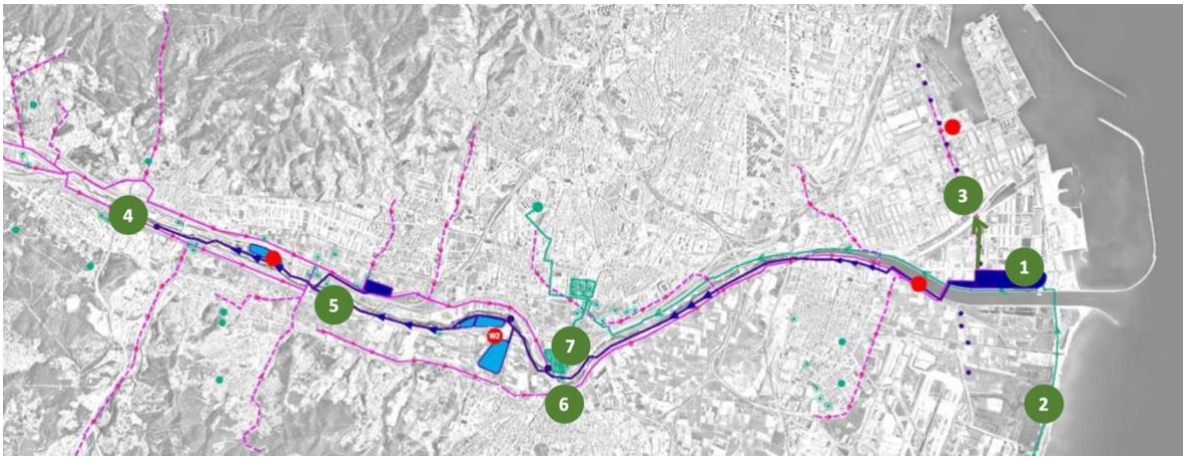
Description

The Llobregat River is the main water source for metropolitan agriculture and plays a crucial role in providing drinking water to the several million inhabitants of the central metropolitan region, as one of its largest water treatment plants draws its water from it. As a Mediterranean river, it is subject to significant fluctuations in its flow, making it necessary to ensure maximum efficiency in its water cycle. To achieve this, the regenerated waters produced by the wastewater treatment plant located near its mouth (1) are not discharged into the sea, but can be reused for a variety of purposes.

They can be:

- pumped upstream, more than 15 km along the river, where they are returned to its course (4), so as to reinforce the ecological flow and to be captured by the water treatment plant (7) for incorporation into the supply network.
- injected under pressure into the subsoil to create a barrier against saltwater intrusion into the groundwater (3).
- used to irrigate the river's floodplain at various points, or to recharge the aquifer through different infiltration ponds.
- used to irrigate agricultural areas, after undergoing additional treatment to reduce their salinity through reverse electrolysis (6).

In case of drought, fresh water produced by a desalination plant built on the coast (2) can be added.

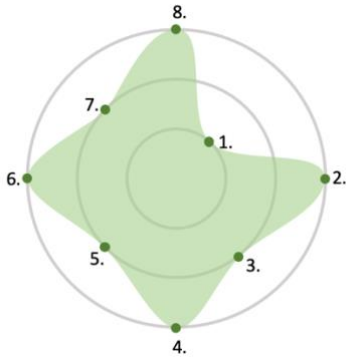


Strategic Plan for the Water Cycle in the Llobregat Metropolitan Park (Source: Authors)

This regenerated water recirculation system is mostly composed of engineering solutions with a high level of technology. However, taking into account that the Llobregat is a protected river and agricultural space that functions as a metropolitan park, this circuit allows a whole series of NbS to reinforce the environmental and social benefits of this river, which had greatly been altered by infrastructure development in the past.

Ecological services

Environmental Benefits



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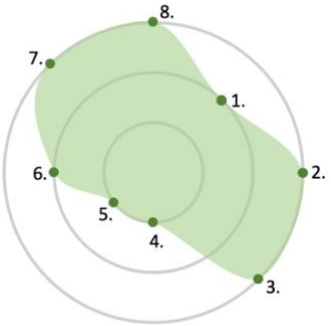
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

Widespread improvements in the water cycle, as well as morphological improvements in the river itself, have directly resulted in improved water quality (2). Stabilization measures for slopes and other potentially unstable elements, carried out wherever possible using bioengineering methods, have improved soil quality and reduced erosion. The enhancement of native species through the planting of more than 4000 riverside trees, shrubs, and hydroseeding has contributed to the improvement of biodiversity in the area, as demonstrated by bird counts (6), and has facilitated the recovery of a Mediterranean fluvial landscape that is managed in such a way that it can adapt to ongoing external impacts (8).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban Resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

From the social point of view, the improvement of water resources stands out thanks to facilities that simultaneously form the landscape of the Llobregat River Park, which currently receives more than three million visits a year (2, 3 and 7). Its presence within the metropolitan urban continuum is also an opportunity for local schools to use it as an educational space (8).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

Large metropolitan projects must know how to combine and optimize the distribution of different ecosystem services, so that each intervention offers maximum performance in the greatest number of fields possible. That is why it is important to remember that NbS are not usually designed based on a single parameter, but are related to the valorisation of various environmental services, such as water infiltration and retention, carbon fixation capacity, biodiversity of fauna and flora. Moreover, as the NbS interventions mature, their capacity to ensure these objectives usually increases over time, as well as the capacity of the system, if well managed, to receive increasing numbers of visitors.

In the case of the Llobregat River, these different results were evaluated in depth through the LIFE UrbanGreeningPlans project, developed from 2021-2023, once most of the NbS actions had already been carried out for some time. The evaluation of the Llobregat River area revealed a growing improvement in performance, year after year, in the production of ecosystem services.

When evaluating the beneficial impacts of NbS, it is therefore important to bear in mind that NbS will usually perform better over time in most cases. Also, good management of NbS will lead to greater efficiency, making it possible to direct NbS towards the production of a desired ecosystem service. For this reason, NBS monitoring and maintenance are both essential and cost-effective.

TO KNOW MORE…

- Llobregat River: https://www.amb.cat/s/web/territori/espai-public/espais-fluvials/parc-riu-llobregat.html
- Europarc Federation - LIFE UrbanGreeningPlans: https://www.europarc.org/library/project-archive/life-urbangreeningplans/

NBS FOR COASTS: HYÈRES OLD SALT MARSHES, FRANCE

Source: Life Adapto Project

GEOGRAPHICAL LOCATION
Hyères, Provence-Alpes-Côte d'Azur, France

IMPLEMENTATION PERIOD
2017-2021 (Adapto EU Project)

TYPE:
Implemented Project

PARTICIPATING ENTITIES:

- Conservatoire du littoral - Délégation Provence-Alpes-Côte d'Azur (Promoting Entity)
- European Union Life Program (Financing Entity of Adapto)
- BRGM
- Water agencies
- Fondation de France
- Fondation Total
- Other entities: ENSP, MNHN, UNCPIE, UBO, ULCO, EPHE, ULR.

BUDGET
€840,000.00

FIELDS OF ACTION:

- Climate change mitigation and adaptation
- Disaster risk reduction
- Environmental degradation and biodiversity loss

LOCATION
Peri-Urban (Surface: 363.86 ha)

Climate change represents an obvious threat to the stability of coastlines and their ecosystems, notably due to sea level rise and the increase in the frequency and intensity of extreme weather events. Both processes can have catastrophic effects on coastal populations, ecosystems, business and goods. Compared to expensive and impactful grey solutions that employ rigid and inert defenses to protect coastal zones against these impacts, NbS can assist coastal systems to recover their natural balance, at much lower cost.

Context

The City of Hyères was one of the pioneers of maritime spa tourism in Europe at the beginning of the 19th century, and is still located in an area that counts several centers of tourist interest. However, its economy also has a relevant flower and wine production sector. Today, it is a city of 55,000 inhabitants that is part of the Métropole Toulon Provence Méditerranée, a French group of municipalities with almost 450,000 inhabitants in a territory of 360 km² with 200 km of coastline.

The Old Salt Mines of Hyères (*Vieux Salins d'Hyères)* is an anthropogenic landscape of coastal pools and canals dedicated to salt production by evaporation. In the 13th century, it was one of the leading salt producers in the Mediterranean and extended its activities well into the 20th century. In 1967, under the ownership of the *Salins du*

Midi salt company, salt production stopped intermittently, before coming to a complete end in 1995. The "Conservatoire du Littoral", a public entity under the jurisdiction of the Ministry for Ecological Transition and Territorial Cohesion of France, acquired the entire industrial complex six years later. Following a series of studies and the drafting of a management plan for the area, two European-funded projects were launched in 2017: Adapto and Marittimo, which aimed to improve the sustainability and resilience of this section of the coast.

Description

The renovation of the Vieux Salines is a conclusive example of flexible coastline management in a coastal area that has been degraded by the protective riprap breakwaters of the industrial salt facilities. Removing them has reestablished the natural balance of the coastal zone, which turned out to be much more resilient in the face of storms and even potential sea level rise. The protection offered by the riprap used by the salt flats to fix the coastline presented several problems:

- As structures that functioned thanks to the rocks' hardness and very low porosity, they were in fact very exposed and vulnerable to catastrophic collapses caused by storms and erosive processes.
- The rockery system reduced the complexity of the coastal ecotone, reducing its biodiversity to a minimum.
- Their rigid resistance to the sea's erosive force concentrated the sea energy on the unprotected areas nearby, leading to further erosion and ecological degradation.
- Their appearance as industrial docks degraded the landscape on an aesthetic level, and made it difficult for the population to enjoy the sea.

Once the rock defense was removed, several steps were taken to re-establish the coast's sedimentary and ecological balance.

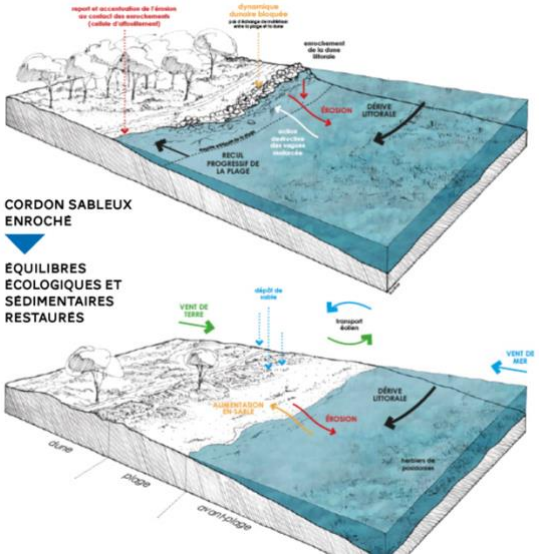
- 3,200 m³ of sand was integrated to create an adequate dune structure, fixated by planting native species that will attract other endemic species.
- The coastal pine forest was cleared to reduce shading and facilitate the arrival of onshore winds, which provide sediments and organic matter that sustain the dunal plant community. The dune system thus acts as a sand reserve bank against storms and erosive waves.
- The preservation and reinforcement of submerged *Posidonia* meadows, which are plants that support submerged sand slopes just as grass does on a mountain, is ensured. *Posidonia* can maintain a rich ecosystem of aquatic species and act as a major carbon sink. However, it is very sensitive to water pollution, so it must be monitored.

Rockeries removal

Beach regeneration

Source: Life Adapto Project

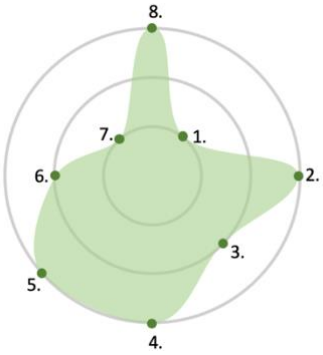
The resulting system is called flexible because it is subject to fluctuations in beach width and, for example, can lose ground after a storm. However, when more extended time frames are considered and provided that the design and monitoring work well, such beaches progressively grow in the mid-term. Since the beginning of these interventions, the beaches have widened by 5- 10 meters. Although it requires some monitoring, this type of coastal stabilization favorises biodiversity and is much cheaper than engineering solutions. It can thus be used for coastal stabilization in general, and not just to create beaches.



Source: Life Adapto Project

Ecological services

Environmental Benefits



1. Air purification
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4. Soil improvement and erosion control
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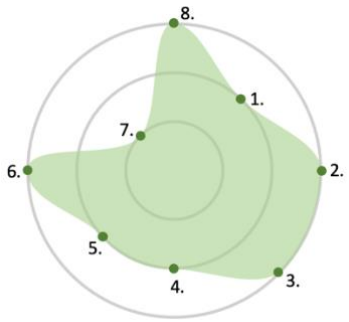
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

One of the virtues of the *Posidonia* meadows is the fixation of many pollutants (which, if present in excess, can kill them). For this reason, the project also obtains the effect of improving water quality (2). But the main objective of this project is to improve soils and combat coastal erosion by reestablishing a coastal ecosystem (4). This technique also protects elements like coastal paths from flooding (3). As demonstrated by monitoring, the effects of improving biodiversity have also been evident, especially in the case of birdlife (5). Landscape recovery is also apparent, thanks to the removal of the rockeries (6) and the recovery of the natural beaches (8).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

The monitoring study presents the savings achieved as spectacular: the project's execution amounted to €840,000, coupled with expected maintenance costs of around €700,000 over 30 years. On the other hand, using conventional engineering techniques to protect the coast would cost a minimum of €2,400,000, with maintenance costs of at least €3,100,000. In this sense, this NbS is an excellent investment (2) that has freed up resources for improving coastal paths, providing the municipality with an excellent scenic route (3 and 6). Paradoxically, the population was mainly against the project to remove the rockery. However, it has since been proven through opinion studies that after the completion of the project, a slight majority of people (54%) had become in favor. Apart from the apparent results, this change is due to campaigns to explain the project to schools and the population in general, which were carried out while the works progressed. Environmental education and birdwatching actions have been carried out thanks to the collaboration of 50 volunteers who became "beach guardians," which helped to raise people's awareness of the value of the new natural spaces (3 and 8).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

As early as the 1960's, there were reports of the success of ecosystem restoration compared to the use of ***gray engineering*** solutions. However, it is usual for the general population to believe that the solutions offered by gray engineering are safer. Technicians and politicians also frequently believe that inert and mechanical engineering solutions are more reliable than solutions that depend on the stability of an ecosystem. However, for this type of project, it is clear that this is not the case, as the higher engineering maintenance costs demonstrate. One of the main barriers to NbS is the culture of control over nature in which we still live. The abstract and geometric lines of gray engineering seem to have a greater persuasive effect on society, since they are easier to understand and are pervasive in our highly engineered contemporary world. That is why environmental education and popular involvement in the implementation of NbS are essential to correct these cognitive biases.

Therefore, we must insist on the advantages that NbS offer not only through education and dissemination of the results of the actions, but also through the involvement of stakeholders from the world of ecology and environmental education.

TO KNOW MORE…

- Old salt marshes of Hyères (in French): https://www.lifeadapto.eu/vieux-salins-d-hyeres.html
- Social perception of the old salt marshes of Hyères (in French): https://www.lifeadapto.eu/media/7702/VieuxSalins_RapportPerceptionSociale_2022_UE.pdf
- Interreg Italie-France Maritime 2021-2027 (french version): https://interreg-marittimo.eu/fr/programme

NBS FOR WATER RECLAMATION: MOLENTARGIUS-SALINE PARK, ITALY

Source: Molentargius Saline Natural Park

GEOGRAPHICAL LOCATION
Cagliari-Quartu Sant'Elena, Sardinia, Italy

IMPLEMENTATION PERIOD
Construction in 2005

TYPE
Implemented Project

PARTICIPATING ENTITIES:
- Consorzio Parco Naturale Regionale Molentargius Saline (Promoting entity)
- Environmental Ministry of Italy (Financing entity)

FIELDS OF ACTION:
- Water security
- Environmental degradation and biodiversity loss
- Economic and social development

LOCATION
Urban (surface: 370.000 m² in a 5,5 km² protected park)

BUDGET
€ 62.000.000 (whole park, 1988)

Enhancing the quality of water used by humans is a critical concern for the Mediterranean basin. In a region with variable and relatively low rainfall, water purification is an essential issue to protect water resources and support a healthy water cycle. If a groundwater table becomes contaminated, it can take centuries to be used again. Constructed wetlands are considered a successful tool to treat wastewater: their success is mainly assessed by observing the rate of pollution reduction achieved. Constructed wetlands can also contribute to the conservation of ecosystem services. Among the many ecosystem services provided, the protection of the subterranean waters, the biodiversity of constructed wetlands and the leisure opportunities offered by these landscapes are especially relevant.

Context

The metropolitan city of Cagliari includes 17 municipalities totalling about 450,000 inhabitants, distributed along the coast of the Gulf of Cagliari in southern Sardinia. In the densest area of the agglomeration and between the two largest municipalities, Cagliari and Quartu Sant'Elena, an extensive protected park covers several water landscapes. Since the abandonment of salt extraction activities in 1985, the Molentargius wetland area has undergone a process of redevelopment and transformation into what is now one of the richest sites for birdlife in Sardinia, recently emerging as the most important nesting site for flamingoes in the Mediterranean. In addition to hosting a great variety of habitats and species, the park still retains traces of its past such as the fascinating early 1900s buildings of the Salt City and its industrial machinery. It also comprises a marsh area that is specially designed to naturally purify water.

Description

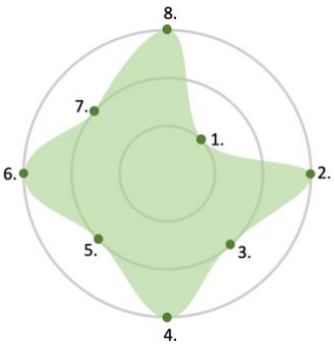
The *EcoSistema Filtro* (ESF, EcoSystem Filter) is a wastewater treatment wetland constructed in 2004 in the Molentargius-Saline Nature Reserve, which was established in 1999. The ESF was financed by the Italian Ministry of Environment, as part of the Molentargius reserve's protection plan. The ESF is located between the Bellarosa Maggiore pond, the first evaporation basin of the salt pans, and the Bellarosa Minore. It has a total surface area of 37 hectares, a total surface area of the basins of about 28 hectares, an average width of about 200 meters, and a length of about 1900 meters.

The water purification process occurs thanks to the protracted contact between water, plants, and litter, which, in turn, provides a growth substrate for the adherent microbial flora, which is responsible for a significant part of the purification process. To ensure efficiency, the active surface, namely the reed bed area, must occupy the maximum possible surface with very dense coverage. The ESF has a "filter" function, reducing the concentration of certain pollutants in the water it receives through various naturally occurring ecological processes. Aquatic plants play a dual role by directly refining water into their tissues through assimilation, and by indirectly providing a suitable environment for microorganisms that transform pollutants and reduce their concentration. The ESF provides secondary treatment to effluents from the Is Arena Depuration Plant in Cagliari. Following treatment, the ESF supplies purified and bio-chemically balanced water to restored freshwater ponds in the nature reserve.

The proximity of the reserve to the two cities nearby provides an ideal opportunity for easily accessible educational and recreational activities. The park dedicates educational walking tours devoted to the topic of constructed wetland purification processes and the importance of wastewater reuse, and offers recreational activities such as birdwatching. Ecologists visit the site to monitor and tag birds, while some of the reserve's research activities are open to the public, with small groups invited to assist biologists and naturalists. Though publicly accessible, the wetland is carefully managed by limiting volunteer numbers and human contact as needed in order to protect the habitat. The Sustainability and Environmental Educational Centre of Molentargius (CEAS) introduces visitors to the ESF and provides educational materials and event facilities to the general public.

Ecological services

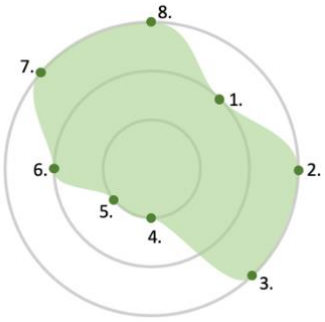
Environmental Benefits



1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

Constructed wetlands are considered a tool for reclaiming water. Their success is therefore primarily evaluated by observing pollution reduction (2 and 4). Floristic surveys conducted annually after the construction of the artificial ecosystem in 2004 revealed changes in the composition of vascular flora over time. The flora of the ESF accounted for 54% of the entire regional park's flora, while exotic species represented 12% and endemic taxa of conservation interest represented 6%. Comparing data over the years, an increase in species richness was thus observed, with an increase in endemic species, species of conservation interest, and exotic species (6). Once endemics appeared, they remained part of the flora, showing good persistence in the artificial wetland. Included in a natural park, but surrounded by an expanding and rapidly growing urban environment, this artificial ecosystem provides multiple benefits by preserving and enhancing biodiversity. This is particularly relevant considering that biodiversity can act as a driver of sustainable development in urban areas where most of the world's population lives and comes into direct contact with nature (6 and 8).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

The inclusion of a protected natural park in a metropolitan area is an interesting reinforcement of the environmental quality of this urban area (2) and undoubtedly improved citizens' wellbeing. Indeed, various studies affirm that this has a direct positive effect on both the physical and mental health of the population (3). It also results in an improvement of the urban landscape (7), which presents opportunities for tourism (7) and environmental education in schools (8).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

Since the establishment of the Molentargius-Saline Park in 1999, the park has undergone various commendable developments. These include the establishment of a Center for Environmental Education, the creation of educational footpaths, biking trails, and waterways, and the restoration of historic buildings linked to salt production traditions. Furthermore, measures have been implemented to prevent fires, hunting, fishing, and waste dumping, with projects aimed at recovering damaged environments and reducing wastewater pollution, among which the ESF stands out. Planning has also involved bordering municipalities and environmental associations.

Despite these accomplishments, the park must overcome significant challenges due to funding limitations and conflicts with illegal housing and intensive agriculture. Furthermore, the ongoing development of tourist facilities along the bordering beach will likely continue, causing soil erosion and coastline recession. Balancing ecotourism with conservation remains a concern, as seen in other wetlands like the Camargue, France and the Everglades, United States.

To combat the degradation that natural spaces suffer over time, especially when they are located near urban areas, ambitious strategic planning of these spaces is necessary. This planning should set clear and ambitious objectives for their management, avoiding stagnation once they have been declared.

Therefore, it is necessary to establish park governance that encourages collaboration between the relevant administrations and supports plans for the constant improvement of natural parks. This does not mean reducing the economic benefits that the park can generate sustainably. However, it is necessary to manage the park so that it offers environmental services that protect it from destructive activities.

TO KNOW MORE…

- Can artificial ecosystems enhance local biodiversity? The case of a constructed wetland in a Mediterranean urban context: https://core.ac.uk/reader/54613446?utm_source=linkout
- Environmental education and recreational activities in the constructed wetland (ESF) of the Parco Naturale Regionale Molentargius-Saline: http://www.sardegnaambiente.it/documenti/18_313_20101119132438.pdf
- Wastewater and Rainwater Management in Urban Areas: A Role for Constructed Wetlands: https://www.sciencedirect.com/science/article/pii/S1878029617300361
- General information on the Molentargius-Saline Park: https://www.parcomolentargius.it/servizi/canali/1039

NBS FOR MARSHES RECOVERY: VENICE LAGOON, ITALY

Source: LIFE Vimine Project

GEOGRAPHICAL LOCATION
Venice, Veneto Region, Italy

IMPLEMENTATION PERIOD
September 2013- August 2017 (Life Vimine Project)

TYPE:
Pilot Project

PARTICIPATING ENTITIES:
- Università degli Studi di Padova, Dipartimento di Ingegneria Industriale (Coordinator)
- SELC soc coop–Venice
- Agenda 21 Consulting srl–Mestrino
- Consorzio di Bonifica Acque Risorgive–Venice
- Magistrato Alle Acque–Venice
- Comune di Venezia
- Foundation for Sustainable Development-Wageningen
- AttivaMente Cooperativa sociale Onlus–Taglio di Po
- European Climate, Infrastructure and Environment Executive Agency of the European Commission (LIFE NAT: financial instrument of 70% of the budget).

FIELDS OF ACTION:
- Disaster risk reduction
- Climate change mitigation and adaptation
- Environmental degradation and biodiversity loss

LOCATION
Peri-Urban (960.000m²)

BUDGET
€ 2.024.295

Sea level rise caused by climate change threatens coastal cities. But while the water rises, there are also territories that sink due to subsidence: New York, Rotterdam, Bangkok or Alexandria are just some examples of a problem that Venice and the rest of the Venice Lagoon islands are also facing. Here, NbS are used as a natural process that stabilizes emerging terrain, using a traditional system of plantation that consolidates the sands.

Context

The Venice Lagoon is a 550 km² aquatic area protected by the Ramsar Convention on Wetlands since 1989 for its extraordinary ecological richness, but it is simultaneously affected by a series of significant impacts of diverse origins. Firstly, the lagoon comprises numerous settlements on artificial islands, first and foremost the city of Venice with its 100,000 inhabitants, while the surrounding area counts a population of approximately 350,000. The region also contains significant agricultural and industrial activities, which release substantial amounts of pollutants into the lagoon, combined with the impacts of high levels of maritime traffic. Moreover, the pressure exerted by tourism, particularly on the island of Venice, almost doubles due to the number of tourist overnight stays, compared to the pressure exerted by the annual resident population.

All of these processes have various negative effects on the delicate ecotopes of the lagoon, including flooding. This phenomenon is attributed to two complementary problems. The most famous is *acqua alta* (high water), namely temporary rises in the sea level of the lagoon. In response, the large MOSE floodgate system was built to attempt to protect the islands from flooding. The second, no less complex issue, is subsidence of the mainland due to erosion or a decrease of soil moisture. This places Venice, the other islands in the lagoon, and especially the *barene* (marshes) at risk of sinking. The LIFE Vimine project focused on the *Barene,* slightly emerged territories in the lagoon that are of significant ecological value. These areas are frequently submerged due to water level rise, making them more susceptible to erosion.

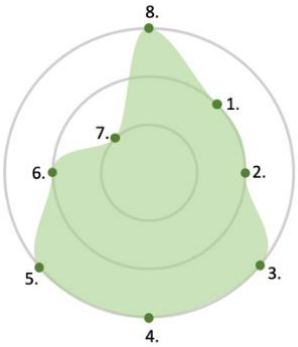
Description

LIFE Vimine aimed to define and apply a new type of integrated approach to territorial management in the Venice Lagoon, based on coastal erosion protection measures aimed at its sand berms and coastal marshes. These unique habitats are rapidly disappearing due to natural processes and human impacts. The project has contributed to repair and protect salt marshes borders as soon as erosion starts, build micro soil ***bioengineering works*** that are able to absorb wave energy, reduce erosion, promote sedimentation with a low effort and cost, and improve coastal resilience and protection.

The project applied small, low environmental impact interventions that play a key role together with the planning, monitoring and maintenance phases. The heart of the project is the involvement of local communities and stakeholders, who ensure a long-term future to the project due to linkages with the territory. Indeed, the demonstration project illustrated the effectiveness of this approach in the North Lagoon, in the Burano, Mazzorbo, Torcello and Palude Lakes. The regular identification and repair of the small, numerous eroded spots on salt marsh boundaries were carried out to stop erosion before it became irreversible, using low-impact soil bioengineering works (e.g. nature-based solutions such as fascines, small sediment nourishment activities) and manual labor. This cost-effective method was merged with participatory processes to involve stakeholders in conservation works, increase environmental awareness and promote sustainable local economic activities in the salt marshes, thereby generating employment. Due to these benefits, the demand for salt marsh conservation among local communities may emerge naturally, thus addressing the socio-economic drivers of erosion.

Ecological services

Environmental Benefits



1. Air purification
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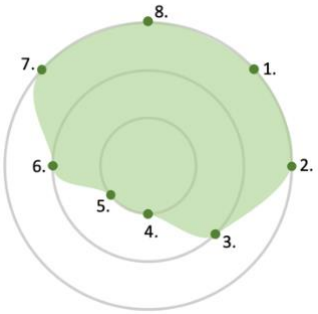
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

The LIFE VIMINE project deployed a complete monitoring system that demonstrated the effectiveness of an integrated approach based on soft soil bioengineering techniques and regular maintenance to protect the innermost Venice lagoon salt marshes from erosion (8 and 4). Its main focus was on constructing small but widespread soil bioengineering works, which are reversible and exert low environmental and landscape impacts. These interventions help to combat erosion in the Northern Lagoon of Venice, which is caused by both human and natural factors. Specific results of the project include:

- 96 hectares of innermost salt marshes protected from erosion in the Northern Lagoon, along with 171 hectares of mudflats and 387 hectares of shallow bottoms;
- 4200 fascines created and 1900 m^2 of salt marshes nourished with sediments (4 and 3);
- More than 90 m^3 of litter and waste removed from the project area (5);
- Restoration of a plant nursery area and of a wooded area in the Laghi Island.

These activities were calculated to help sequester 21.5 tonnes of CO_2, while avoiding the emission of 674.7 tonnes of CO_2 (1). Moreover, the project team found that salt marshes can reduce the amount of nitrogen entering the lagoon from its watershed by a third (2).

Social Benefits



1. Livelihoods, employment and social cohesion
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7. Aesthetic, cultural and recreational value
8. Educational and scientific value

The project resulted in the development of green jobs related to soil bioengineering and the local wood supply chain. Over 1,500 days of work were provided to local fishermen and other workers as part of the project (1). Additionally, the Charter of Sustainable Tourism of the Northern Lagoon of Venice was created to promote responsible tourism and already counts 22 companies (2 and 7). To increase awareness of the environmental challenges faced by the lagoon, the project team created an educational kit for schools and provided training to teachers. The project reached 32,500 pupils through its activities and produced and promoted new guidelines for protecting the target sites (8).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

The territory of the Venice Lagoon is extremely vulnerable to flooding. This problem has been addressed in various ways and with many different actions to tackle its different consequences. Perhaps the one that contrasts most clearly with the LIFE VIMINE project is the MOSE project, a large-scale engineering effort aimed at installing mobile floodgates capable of closing the entire Lagoon in the event of sea level rise so as to prevent flooding, especially in Venice. MOSE has taken decades to complete and has cost around €6 billion. Although the system has proven capable of protecting Venice from flooding in specific events, there are long-term concerns about its sustainability, maintenance and the environmental impact on the Venice Lagoon. Furthermore, climate change and sea level rise pose additional challenges for Venice's future, casting doubt on the long-term effectiveness of MOSE and requiring continuous monitoring.

While not addressing the same issues, LIFE VIMINE represents a radically different conceptual approach. It is grounded in a multitude of small-scale actions designed to control erosion on non-urbanized islands affordably, and with minimal impact on other ecological and social processes within the Lagoon. These actions can be flexibly and adaptively applied over time in response to evolving environmental processes. Thus, small, flexible, and low-impact interventions stand in contrast to large-scale engineering solutions that consume vast resources and have significant impacts, to the point of potentially becoming obsolete during their implementation.

Therefore, it is crucial to remember that both natural environments and cities are dynamic processes, constantly evolving over time. Whenever possible, it is imperative to opt for adaptive solutions like those offered by effective NbS, as opposed to the rigid frameworks typically associated with conventional 'gray' solutions. In embracing such adaptive strategies, we not only respect the inherent dynamism of our surroundings but also promote sustainability and resilience in our interventions.

TO KNOW MORE...

- Marshes protection in the Laguna of Venice: https://una.city/nbs/venezia/marshes-protection-laguna-venice
- European Commission - An integrated approach to the sustainable conservation of intertidal salt marshes in the Lagoon of Venice: https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE12-NAT-IT-001122/an-integrated-approach-to-the-sustainable-conservation-of-intertidal-salt-marshes-in-the-lagoon-of-venice#

General information on the LIFE VIMINE project in Venice (in Italian):
https://www.mase.gov.it/sites/default/files/archivio/allegati/life/progetti_mese/progetto_mese_life_settembre2017_vimine.pdf ,
https://www.comune.venezia.it/it/content/life-vimine-progetto-la-protezione-delle-barene

NBS FOR CLIMATE CHANGE ADAPTATION, ALBANIA

Source: Adapt Project

GEOGRAPHICAL LOCATION
Shkumbini River basin, Elbasan Municipality, Albania

IMPLEMENTATION PERIOD
2019-2024 (ADAPT Project)

TYPE:
Pilot Project

PARTICIPATING ENTITIES
- International Union for Conservation of Nature-Regional Office for Eastern Europe and Central Asia (IUCN ECARO)
- Administration for Environment, Ministry of Environment of the Republic of Albania
- Swedish International Development Cooperation Agency (Main Donor)

BUDGET
€ 2.690.000 (Adapt Project) € 250.000 (Shukumbini Basin)

FIELDS OF ACTION
- Climate change mitigation and adaptation
- Disaster risk reduction
- Economic and social development

LOCATION
Urban (surface: 85.000m²)

Resilience enhancement plans and actions constitute a significant advancement in environmental endeavors, yet their functions extend beyond merely ecological concerns. They also aim to mitigate risks faced by societies, whether they stem from ecological processes, social processes, or a combination of both, as observed in the case of climate change. This approach requires systematic engagement with the interplay between socio-economic and ecological processes, with the goal of increasing sustainability and diminishing vulnerability to potential stresses or shocks. Consequently, this approach not only yields ecological benefits, but also socio-economic ones, underscoring the multifaceted value of resilience-focused interventions in environmental management.

Context

Elbasan Municipality, the third most populous city in Albania, is situated in the upper reaches of the Shkumbini River basin. This region is home to a variety of natural environments, ranging from mountainous lakes and streams to expansive floodplains and coastal marshlands. The locality is especially prone to flooding and soil erosion, exacerbated by upstream forest degradation and frequent heavy rainfall events. Climate change has intensified the frequency and severity of these events, further impacting the area's livelihood and infrastructure. Additionally, the existence of multiple metallurgical factories in Elbasan heightens the threat of water contamination, as floodwaters carry pollutants downstream, affecting water supplies. The deterioration of forest landscapes is evident through the manifestation of

dry and barren soils, landslides, flooding, and a decline in biodiversity. This degradation diminishes the forests' ability to provide vital ecosystem services, such as oxygen production and carbon storage, supporting diverse habitats, and offering natural sources of income for the local population. As a result, these environmental issues significantly affect the quality of life, the integrity of infrastructure, and biodiversity within the Municipality of Elbasan.

Description

The ADAPT project focuses on addressing emerging environmental and societal challenges in the Western Balkans, placing NbS at the heart of disaster risk reduction and climate change adaptation. It aims to increase community resilience, reduce environmental degradation, and strengthen social and gender equality to adapt to long-term environmental challenges. To achieve this, various strategies have been implemented:

- Enhancing knowledge and awareness about nature-based disaster risk reduction solutions among decision-makers, natural resource managers, and local communities, with a specific focus on gender. This includes strengthening the knowledge base about the state of ecosystems and community vulnerability in the Western Balkans in the face of climate change.
- Integration of NbS and equitable climate-smart planning into adaptation and disaster reduction policies, supporting planning processes at various levels for the recognition of ecosystem-based approaches as opportunities that help governments meet multiple goals related to climate change.
- Implementation and scaling up of NbS for disaster risk reduction, demonstrating the value of ecosystem-based approaches in reducing vulnerability in selected landscapes of the Western Balkans.

As part of the project, a multidisciplinary baseline assessment was conducted in the Municipality of Elbasan to identify the most suitable site for the pilot project and to recommend feasible NbS measures. This assessment covered water management, biodiversity, and socio-economic and gender inclusiveness, identifying the Gurra catchment, a tributary of the Shkumbini River basin, as an appropriate pilot site for NbS measures. Local and national stakeholders were consulted to ensure their concerns and expectations were reflected in the analysis, identifying flood mitigation, soil erosion reduction, water pollution reduction, and enrichment of ecosystems and biodiversity as key environmental targets.

The NbS analysis demonstrated the potential of the village of Shushica, given its favorable climate for vegetable cultivation and high potential crop productivity, particularly fruit trees. Additionally, Shushica is on the national list of 100 potential tourism villages in Albania, with potential for agro-tourism and the alluvial forest near the Shkumbini River.

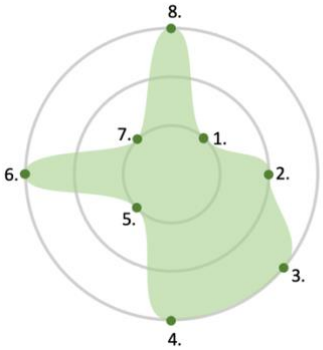
The project design phase followed a baseline assessment, planning detailed actions and proposing a combination of NbS interventions for implementation on the ground, including:

- Forest Landscape Restoration: tree planting, creation of grass strips, and direct grass seeding in nine heavily eroded zones (covering 8.2 ha), combined with the construction of gabions and brushwood check-dams to restore gullies;
- Grazing management plan at the Gurra catchment level;
- Guidelines for the restoration of the Gurra stream.

This integrated approach and strong stakeholder engagement ensured a broader understanding of the NbS concept among the local community and stakeholders, improving acceptance and local ownership of the proposed NbS interventions.

Ecological services

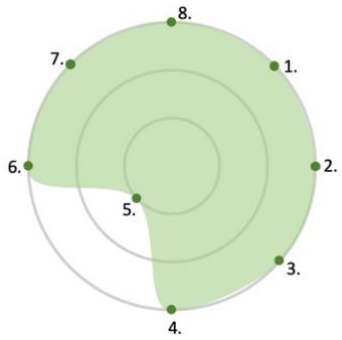
Environmental Benefits



1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

From an ecological perspective, mitigating the hazards associated with the loss of fertile soils and erosion due to runoff is crucial for soil protection (2) and preserving water quality. Reducing soil loss is also pivotal for forest conservation and the maintenance of their organic matter production (3 and 4). These measures positively impact local biodiversity and the stability of the underlying processes that shape the landscape (6).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

Enhancing resilience against frequent landslides and flooding in the area constitutes a clear advancement in territorial development, improving well-being and safeguarding the assets of the local population (2 and 3). This evident risk reduction for the inhabitants, coupled with decreased vulnerability of forests to degrading processes, signifies a substantial increase in resilience (6). The project estimates that adapting agricultural practices and improving crop quality, along with the potential introduction of rural tourism, will positively affect over 1,000 households, encompassing approximately 4000 individuals (1, 4 and 7). This represents an optimal cost-benefit ratio when considering the limited investment required to achieve such objectives in the territory. Finally, to increase the possibilities of local dissemination of the project and maximum continuity, an educational program about the importance and implementation of NbS has been carried out among stakeholders of the actions and citizens in general (8).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

Plans and actions that adopt an approach focused on adaptation, resilience, and disaster risk reduction are prevalent in the study of the relationship between nature and society, addressing environmental issues by examining their connections with social processes and the economy.

The systematic application of economic evaluation methods is crucial when assessing projects based on Nature-based Solutions (NbS) or hybrids, particularly for adaptation and disaster risk reduction. NbS often provide multiple co-benefits and typically require lower implementation costs compared to many conventional measures.

Therefore, employing economic evaluation methods that account for the future value of the land and the benefits provided by NbS not only represents a best practice for decision-making and policy formulation, but also offers a well-founded justification for selecting NbS solutions. This approach not only makes economic sense: it also aligns with a sustainable and resilient vision for our future, showcasing the power of NbS in creating a more adaptable and disaster-resilient society.

TO KNOW MORE…

- IUCN - NbS for Resilient Societies in the Western Balkans: https://www.iucn.org/our-work/projects/nature-based-solutions-resilient-societies-western-balkans
- Recommendations for an NbS pilot intervention in Elbasan Municipality, Albania, defined through the NbS Baseline Assessment of the Shkumbini River basin: https://panorama.solutions/en/solution/recommendations-nbs-pilot-intervention-elbasan-municipality-albania-defined-through-nbs
- NbS for climate change adaptation and prevention of flooding (albanian version): https://www.iucn.org/sites/default/files/2023-03/nature-based-solutions-for-climate_elbasan_albania.pdf

NBS FOR HEALTH: THESSALONIKI, GREECE

Source: BlueHealth Project

GEOGRAPHICAL LOCATION
Thessaloniki, Central Macedonia, Greece

IMPLEMENTATION PERIOD
January 2016 - December 2020 (Project BlueHealth)

TYPE:
Diagnostic Studies and Strategy

PARTICIPATING ENTITIES
- Aristotle University of Thessaloniki (BlueHealth Pilot City)
- European Union Horizon 2020 Program (Financing Entity)
- Thessaloniki Municipality
- Resilient Cities Network

FIELDS OF ACTION
- Disaster risk reduction
- Climate change mitigation and adaptation
- Environmental degradation and biodiversity loss
- Economic and social development

LOCATION
Urban

BUDGET
€ 5 998 671,25 (BlueHealth project)

Epidemiological studies show that certain types of water-related landscapes such as coasts, rivers or canals have a measurable positive effect on both mental and physical health. If this is true, urban planning and urban design should optimize this type of contact to raise not only the levels of well-being but also the health of citizens.

Context

Thessaloniki, a vibrant Greek city situated on the Thermaic Gulf at the northeastern edge of the Aegean Sea, stands prominently near the Axios River's delta. It anchors a metropolitan area composed of 7 municipalities, home to approximately one million residents and exhibiting a high population density of 7100 inhabitants/km². Characterized by a Mediterranean climate, Thessaloniki experiences cold, moist winters and warm, arid summers, with an annual precipitation of 450 mm and an average temperature of 16.8°C.

This city maintains a profound connection with the sea, highlighted by the extensive renovation of its waterfront and the redevelopment of numerous areas aimed at enhancing its appeal to international tourists. These efforts are designed to showcase Thessaloniki's rich and distinct cultural heritage, which also attracts domestic visitors. The city's

lengthy promenade, stretching along the coastline, has become a defining feature, with some buildings positioned merely 15 meters from the sea in certain sections. The urban heat island effect and sea level rise constitute the main climate change challenges facing Thessaloniki.

Presently, foreign nationals compose 6.2% of Thessaloniki's population, predominantly residing in the city's western districts. The significant influx of immigrants during 2018-2019 led to a gap in socio-economic data concerning the newly arrived Middle Eastern immigrants, complicating their integration into local society. There is an express need for establishing initial assessment facilities for immigrants and refugees to evaluate their backgrounds, valorise their skills in order to obtain appropriate employment opportunities, and facilitate the placement of their children in fitting educational institutions.

Thessaloniki is a key participant in the BlueHealth project, a European initiative aimed at exploring the impact of water landscapes on human health along with Amsterdam, Barcelona, Plymouth, and Tallinn. Additionally, the project includes other coastal or riverine cities from the Mediterranean, such as Rome and Lecce in Italy, underscoring the collaborative efforts to understand and enhance the health benefits derived from urban water environments.

Description

The BlueHealth project, supported by the European Union's Horizon 2020 program, investigates how rapid environmental and climate changes will impact our relationship with urban blue infrastructure by the year 2040, focusing on flooding, water quality, and urban heat island effects, while also proposing adaptation strategies. It explores the effects of water landscapes on human health, based on the discovery that urban populations that live on the coast or have contact with river areas are healthier than those living in inland cities. More specifically, evaluations carried out throughout Europe point to the fact that improving the landscape of cities, which includes water landscapes, has an impact on improving the health of their inhabitants.

The project investigates the significance of urban blue spaces, such as rivers, canals, and coastlines, which is emphasized not only in terms of cultural identity in cities like Thessaloniki, but also with regards to public health. The way in which climate, demographic backgrounds, and the presence of tourists influence the usage of these spaces is discussed. Collaboration among various stakeholders is deemed essential for maximizing the health benefits of blue spaces amidst growing concerns over water pollution and climate change.

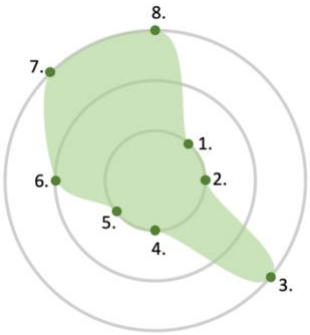
A pan-European comparison reveals how global trends and local values impact European cities differently, affecting the management and use of blue spaces. The analysis highlights how climate change and social inequalities have local implications that vary from city to city. Policy-making and decisions regarding blue spaces are influenced by local priorities and ambitions, showing differences and similarities in challenges faced by different cities. Specifically, the economy, tourism, and access to blue spaces present unique opportunities and challenges for each locality.

Through participatory workshops in cities including Thessaloniki, the project promotes inter-sectoral collaboration to understand how local decisions are influenced by global trends and local values. The developed scenarios envision how blue spaces can support health and the environment across various urban contexts, identifying potential risks and benefits. The importance of representative research and interdisciplinary collaboration for planning and managing health-promoting blue spaces is highlighted.

In response, stakeholders propose leveraging climate change as a driving force for the creation of healthier, more sustainable urban blue spaces. Utilizing sea breezes as natural ventilation within city streets, expanding tree coverage to increase shaded areas, and establishing additional public drinking water facilities are among the suggested strategies. Furthermore, encouraging aquatic recreational activities necessitates enhanced safety measures, including additional lifeguards and educational programs on swimming safety. Enhancing the accessibility to Thessaloniki’s extensive waterfront can boost its appeal to tourists, thereby stimulating economic growth. Offering free transportation to more distant beaches can ensure equitable access to blue spaces for all city residents.

Ecological services

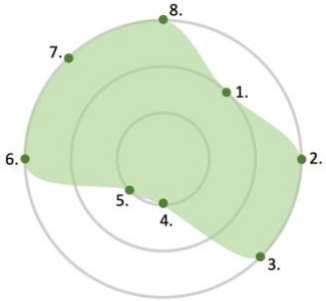
Environmental Benefits



1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

This research project seeks to understand how the urban landscape can be redesigned in order to improve the well-being and health of its citizens (8), with a view to incorporating the outcomes into Thessaloniki's urban resilience plan. However, in the creation of future scenarios, two environmental issues emerged strongly due to their importance in the context of climate change: the danger of sea level rise (3) and heatwaves (7).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

The BlueHealth project opens a very important scientific field (8) by relating urban design based on NbS to the improvement of the well-being and physical and mental health of citizens (3). The combination of the project activities with the drafting of the city's Resilience Plan (6), which can have a regulatory role on the city's plans and projects, can bring substantial change to the city's value creation and territorial development (2), provided the guidelines are truly maintained.

LESSONS LEARNT AND POLICY RECOMMENDATIONS

The BlueHealth project advocates for the integration of water landscapes into urban planning as a means of bolstering public well-being. The project emphasizes collaborative stakeholder efforts to maximize the health benefits of urban blue spaces while addressing threats like water pollution and climate change.

Research across Europe demonstrates the variable impacts of climate change and social inequalities on the management of blue spaces, advocating for adaptive, locally-informed policies. The future vision for cities like Thessaloniki includes leveraging climate change to develop healthier, sustainable urban environments, using natural elements for ventilation, expanding green spaces, and ensuring equitable access to blue spaces.

This initiative serves as a call to action, urging cities to recognize the value of urban blue spaces in promoting health and resilience. By aligning scientific insights on health with urban planning, the BlueHealth project illustrates the potential of informed, participatory approaches to crafting cities that are not only resilient to climate change but are also bastions of public health and well-being.

The significance of the BlueHealth project lies in its unveiling of the impact of urban environmental quality on the scientifically measured physical and mental health of its inhabitants. This highlights how efforts to enhance the urban environment influence not only the well-being of its residents but also their health and even productivity.

Thus, this objectively demonstrated relationship between the economy, health, and the quality of the urban environment serves as a compelling argument for justifying the use of NbS for urban development at all levels.

TO KNOW MORE…

- BlueHealth: https://bluehealth2020.eu/
- IUCN - Planning and delivering NbS in Mediterranean cities: https://portals.iucn.org/library/sites/library/files/documents/2021-036-En.pdf
- Resilient Cities Network - Thessaloniki's Resilience Journey: https://resilientcitiesnetwork.org/thessaloniki/

NBS AGAINST HEAT WAVES IN IZMIR, TÜRKIYE

Source: Project Urban GreenUP

GEOGRAPHICAL LOCATION
Izmir, Izmir Province, Türkiye

IMPLEMENTATION PERIOD
June 2017- May 2022
(Urban GreenUP Horizon 2020 Project)

TYPE:
Diagnostic Studies and Pilot Projects

PARTICIPATING ENTITIES:

- Izmir Metropolitan Municipality
- Urban GreenUP (Horizon 2020 financial instrument of the European Union)
- Other GreenUP cities:
  - Front cities: Valladolid (Spain) and Liverpool (UK)
  - Follower cities: Mantova (Italy), Ludwigsburg (Germany) Medellin (Colombia), Chengdu (China) and Binh Dinh-Quy Nhon (Vietnam)
- Other public and private entities: Acciona Infraestructuras, BitNet Bilişim Hizmetleri Ltd. Şti., CARTIF Technology Centre, Science and Technology Bureau of Chengdu Hi-Tech Industrial Development Zone, CENTA, Confederación Hidrográfica del Duero, Demir Enerji, Ege University, Fondazione ICONS, GMV Aerospace and Defence S.A.U., Università Bocconi, Izmir Institute of Technology, LEITAT, RMIT Vietnam University, SingularGreen, Sociedade Portuguesa de Inovação, The Mersey Forest, University of Liverpool.

BUDGET
€ 15.000.000

FIELDS OF ACTION:

- Climate change mitigation and adaptation
- Human health
- Economic and social development

LOCATION
Urban

Large urban areas can experience temperatures that are more than 12ºC higher than those of their surroundings as well as a greater number of torrid nights. This “heat island effect” is due to the lack of vegetation in cities, the use of pavements that avoid infiltration and evaporation of soil moisture, the use of materials that accumulate heat and devices that release heat, such as air conditioning. Given this serious problem that affects the health of the urban population, causing deaths in some cases, a series of NbS can contribute to achieving a cooler urban habitat that is less vulnerable to heat waves.

Context

Izmir is one of the oldest cities on the Mediterranean Sea, with 8500 years of history. It is also a modern and dynamic economic centre of the region. The metropolitan city of Izmir is the third metropolitan agglomeration in Türkiye, with about 4.5 million inhabitants. It includes the second largest port in the country, and important industrial and service

sectors, among which tourism stands out. The climate is Mediterranean with a long, hot and dry summer, and a rainy winter. In 2023 a temperature of 43.2 ℃ was reached, the highest recorded to date. The average temperature in the summer months is around 27 ℃, and some studies determine a number of about 30 heat waves per year with a high number of nights above 25℃. With its large population and expanding urban areas, Izmir offers an opportunity to apply European re-naturing strategies. These interventions focus mainly on creating green corridors and on decreasing the city's temperatures.

Description

The Horizon 2020 URBAN GreenUP project explores how to address several aspects of climate change in cities using NbS, implementing pilot tests and measuring the efficiency of these solutions and studying how to facilitate their large-scale implementation. In Izmir, research focused on a group of actions aimed at mitigating the urban ***heat island effect***, notably through:

- The installation of green rooftops over car parking areas;
- Cool pavements around selected car parking areas;
- Using climate-adapted soils, also called "smart soils", to support vegetation forming green shady structures;
- The integration of shaded areas and cooling trees alongside parking lots or ***Parklets*** in avenues.

The function of the pilot projects was to monitor the performance of these different NbS in heat mitigation and to describe their side effects on the city. To implement them correctly, other actions were also deployed in terms of:

Urban Regeneration: such efforts focused on revitalizing urban areas to improve environmental quality, enhance urban infrastructure, and increase green spaces. This includes developing and implementing plans for the sustainable renovation of urban landscapes, incorporating NbS to address urban challenges such as pollution and heat islands. Projects may involve the transformation of underused or deteriorated areas into vibrant, functional spaces that contribute to the city's overall resilience and sustainability.

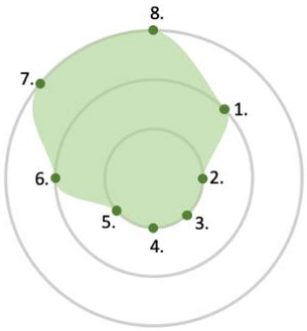
Participatory Planning and Governance: The project emphasizes the importance of involving citizens, stakeholders, and various community groups in planning and governance. This approach ensures that the development and implementation of urban projects are inclusive, reflecting the diverse needs and perspectives of the community. Through workshops, public consultations, and collaborative platforms, Izmir sought to foster a participatory culture where decision-making is shared, and community members have a say in shaping their urban environment.

Social Cohesion and Justice: Actions in this area aimed to strengthen social bonds, promote inclusivity, and ensure equitable access to urban benefits for all residents, regardless of their socio-economic background. By integrating NbS that enhance public spaces, improve accessibility, and offer recreational opportunities, the project strives to create a more cohesive urban community. Initiatives may also address social disparities by ensuring that urban regeneration efforts do not lead to gentrification or displacement of vulnerable populations, thereby promoting social and environmental justice.

Together, these actions represent a holistic approach to urban development, combining environmental sustainability with social equity and active citizen engagement.

Ecological services

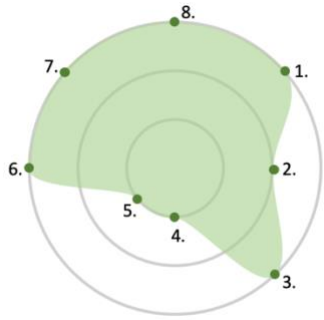
Environmental Benefits



1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

The Urban GreenUP project in Izmir focused on the potential of NbS to counter heat waves through a set of highly targeted solutions. For this reason, the environmental results are also concentrated in two groups of ecological benefits. The central issue is climate regulation (7), through small-scale, usually public interventions. The project also considers improving the quality and habitability of the urban landscape, introducing criteria for its management and maintenance (8). These actions, such as urban vegetation enhancement, can also have a beneficial effect on air, although their effects are limited due to the small scale of the actions (1).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

The Urban GreenUP project provides an analysis for each participating city on the potential for NbS to create a consistent job and goods market. Utilizing a SWOT matrix, the case of Izmir highlights several strengths, such as the government's commitment to implementing NbS, evidenced by the Turkish Climate Change Adaptation Strategy and Action Plan (1 and 2). However, it acknowledges poor coordination between different administrations as well as limited resources, although the commitment to public participation in drafting the projects and public awareness-raising contribute to social cohesion.

The NbS proposal for Izmir explores how to leverage Türkiye's dynamic economy to facilitate their implementation, including a study on how NbS can generate a labor market. This approach aims to develop NbS within the conventional framework of existing production methods, akin to a market study. The study also indicates the potential access to suitable professionals and technology, although the currently available professionals and materials are not adequately trained in NbS techniques. Nevertheless, Izmir is considered to have a promising foundation for the growth of sustainable solutions. Addressing the weaknesses will be crucial to fully harnessing the potential of NbS for significant impact.

Addressing urban heatwaves and their exacerbation by the urban heat island effect has clear implications for the health and well-being of residents. The impacts of heat on human health, both psychologically and physically, have been identified by numerous studies as being responsible for a significant number of premature deaths and various pathologies (3). The use of NbS to combat heat is therefore aimed at significantly enhancing the urban resilience of the

city of Izmir, associated with an improvement in the city's recreational capacity through the introduction of parklets and other solutions that have a beneficial effect on public spaces (7).

Horizon 2020 projects prioritize the evaluation of the performance of implemented actions. Urban GreenUP studied the most effective implementation pathways, while evaluating the performance of NbS using a set of criteria known as EKLIPSE, thereby giving the project significant scientific value (8).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

These studies of NbS implementation possibilities in Izmir make it clear that it is essential to carry out communication, education and participation campaigns that increase awareness of NbS among citizens and local communities. Nevertheless, it is also important to consider how NbS can be catalyzed by businesses and investors, while evaluating the possibilities for private sector uptake of NbS.

It is important to identify the NbS that can easily be deployed and adopted in specific economic and technological contexts. Otherwise, NbS run the risk of remaining confined to a small subset of society, namely wealthier groups, without ever impacting society as a whole.

TO KNOW MORE…

- Urban Green Up - Deliverables on NbS: https://www.urbangreenup.eu/resources/deliverables/
- Urban Green Infrastructure as a tool for urban heat mitigation: Survey of research methodologies and findings across different climatic regions: https://www.sciencedirect.com/science/article/abs/pii/S2212095518300579?via%3Dihub

NBS FOR CHILDREN AND YOUTH: LEARNING GARDENS, LEBANON

Source: Zaher NGO

GEOGRAPHICAL LOCATION
Bekaa Valley, Bekaa Governorate and Akkar Governorate, Lebanon

IMPLEMENTATION PERIOD
2016 - present

TYPE
Implemented Project

PARTICIPATING ENTITIES:
- Zaher (Danish NGO) – Grow to Learn
- SOILS Permaculture Association (Lebanese NGO)
- Buzuruna Juzuruna (Lebanese NGO)
- Malaak (Lebanese NGO)
- Action Aid Arab Region (AAAR)
- Food Heritage Foundation (Lebanese NGO)

MAIN FIELDS OF ACTION:
- Economic and social development
- Food Security
- Climate change mitigation and adaptation

LOCATION
Peri-Urban

BUDGET
€ 65.692,13

Wars not only destroy and take away countless lives. They can also rob those who manage to survive of the possibility of a better future. A clear example of this process is apparent in the challenges involved in providing a safe environment for children that have been displaced by wars and conflict to refugee camps. The lack of minimum conditions for personal development can hinder their prospects and development in the future, jeopardizing their lives and prospects even when the war has ended. This is where care and strengthening communities through engaging with children and youth and environmental education can play an essential role.

Context

Lebanon is a country facing major humanitarian, political and development challenges, amongst others due to the recent war in Syria. Lebanon has been a refuge for approximately 1.5 million of the 6.3 million Syrians who have fled the conflict since 2011. This population of Syrian refugees in Lebanon is the fourth largest in the world and the most concentrated per capita, according to UNHCR data from 2019. Approximately 80% of refugees in Lebanon lack legal status, preventing them from satisfying basic needs such as food, health and housing. Additionally, they face restrictions in access to education and healthcare. The crisis has had an enormous social and economic impact on Lebanon, overloading local, municipal and national services in areas such as health, education and water supply.

The project has been developed in the Bekaa Valley in eastern Lebanon and further north in Akkar Governorate. The two regions are in many ways similar, as some of the country's most deprived regions, with the highest proportion of Syrian refugees. Beqaa Valley is Lebanon's main agricultural region, accounting for around 42% of the total cultivated area in the country. It also counts the highest proportion of refugees from Syria, constituting 35.8% of the population according to the Syrian Regional Refugee Response (2019). Akkar Governorate is the poorest of Lebanon's governorates with one of the highest unemployment rates in the country, at 60% Due to the regions' proximity to the Syrian border, the conflict in Syria has had a strong spillover effect, with the arrival of high numbers of refugees. The crisis has also triggered a greater downturn in economic and commercial activities, as the areas strongly relied on trade with Syria. Many of the Syrian refugees residing in both Akkar and Bekaa have previously been engaged with agriculture and have significant farming experience since they used to be farmers and farm workers in Syria. Before the war, 40% of Syrian livelihoods were connected to agriculture.

Description

Since 2016, the Danish NGO Zaher - Grow to Learn, in collaboration with the Lebanese NGOs SOILS - Permaculture Association, Buzuruna Juzuruna and Food Heritage Foundation, has been working with displaced Syrian refugee communities in Lebanon. Zaher's main goal is to facilitate a platform where NGOs with expertise in permaculture, organic gardening and education of stigmatized Lebanese and Syrians can come together to support and engage marginalized children and youth.

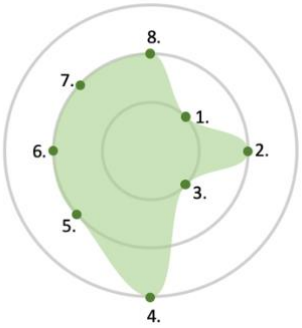
The project aims to enhance education and resilience among children and youth through organic gardening, incorporating traditional practices and promoting environmental awareness. It seeks to establish sustainable gardens as community and learning spaces, fostering social cohesion and enabling entrepreneurship. Additionally, it focuses on building local capacity to advocate for learning gardens in Lebanon, addressing social and environmental challenges. The project thus presents an opportunity for Syrian youth to learn more about farming, which can prevent traditional farming practices, skills and knowledge from being lost, and allow the youth to prepare themselves to rebuild their home country when and if they will be able to return.

Another key component of the work involves transforming unused areas into functional spaces capable of hosting gardening education programs and landscape improvements. This fosters a sense of ownership and responsibility among participants, enhancing their self-esteem and empowering them in various life aspects. The program educates on cost-effective, organic gardening techniques, enriching community and family practices, thereby bolstering food security. Participants gain skills for creating sustainable agricultural spaces, contributing to self-sufficiency in Lebanon and potentially in their countries of origin. The learning gardens also act as innovative social hubs, facilitating community engagement, social cohesion, and economic opportunities through the production and sale of garden produce. This approach strengthens social networks, promotes social stability, and integrates capacity building for local partners, ensuring project sustainability and amplifying the impact on the Lebanese learning garden movement.

The specific scope of the activities has been based on the education of 60 young people who, adding other types of less linked participants, the educators and local collaborators and the families involved, amounts to 500 people. Due to the limited size of this target group, dissemination is a focal point of the project. In each location, intense collaboration with local NGOs has taken place, which should extend the program's activities in time and allow local actors to run them in an increasingly autonomous manner.

Ecological services

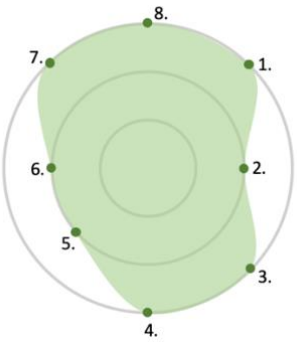
Environmental Benefits



1. Air purification
2. Water purification
3. Flood control
4. Soil improvement and erosion control
5. Decontamination processes
6. Biodiversity improvement and support
7. Climate regulation
8. Landscape protection and management

Despite its small physical scale and the fact that the environmental services generated are limited, this project, especially if scaled, would have a very positive effect on the improvement of soils thanks to the permaculture techniques it provides (4). In doing so, it could positively affect the water cycle (2), the promotion and protection of biodiversity (6) and even certain aspects of climate regulation (7). The clearing of unused places where teaching and agricultural activities take place can also be considered a decontamination process (5) and an improvement in the relationships of communities with the landscape, which is an appropriate strategy to promote its improvement and sustainability (8).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
4. Fair, sustainable and healthy food system
5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

The establishment of learning gardens where participants can grow a variety of plants for food or medicine supports a local food system (4), while seeking to establish a practical and sustainable educational system as well (8). Empowering student leaders by training dedicated students to tend to the gardens highlights a focus on sustainability and capacity building within the community (1). Knowledge exchange is also fostered, since the gardens serve not only as cultivation spaces but also as venues for the exchange of knowledge and experiences, thereby enriching the learning experience of the participants (3 and 7).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

The success of learning garden projects relies on local involvement, collaboration, and strong communication among stakeholders, ensuring the gardens meet community needs and enhance cohesion. Challenges include limited land, insufficient funding, and engaging young adults who need to work for family income. The transient nature of displaced families in the Bekaa Valley also disrupts children's connection to the gardens, as families may move unexpectedly during the project.

Therefore, even if we think in pure economic terms, it is necessary to consider that NbS can also be an element of stabilization for populations that may tend towards marginality, offering an education to young people and a future to populations with an uncertain destiny. These factors must also be included in the cost-benefit analysis of this type of NbS, since failure to act on this population will not only generate conflicts but will end up generating much greater expenses (perhaps in humanitarian aid) over time.

TO KNOW MORE…

- Zaher - Danish NGO for learning gardens in Lebanon: https://www.zaher.dk/
- SOILS - Permaculture Association Lebanon: https://www.soils-permaculture-lebanon.com
- Case Study: Grow to Learn - Learning gardens for syrian children and youth in Lebanon: https://ebrary.net/211602/environment/grow_learn_learning_gardens_syrian_children_youth_lebanon

NBS AGAINST FLOODS IN ALEXANDRIA, EGYPT

Source: Egypt Today (25 October 2018)

GEOGRAPHICAL LOCATION
Alexandria, Alexandria Governorate, Egypt

IMPLEMENTATION PERIOD
2023

TYPE:
Diagnostic Studies

PARTICIPATING ENTITIES:
- Faculty of Urban and Regional Planning, Cairo University, Egypt
- College of Civil Engineering and Architecture, Zhejiang University, Hangzhou, China
- School of Civil and Environmental Engineering and Earth Sciences, Clemson University, Clemson, USA
- Disaster Prevention Research Institute (DPRI), Kyoto University, Kyoto, Japan

BUDGET
Unknown

MAIN FIELDS OF ACTION:
- Economic and social development
- Climate change mitigation and adaptation

LOCATION
Urban

Fast-growing cities in the south of the Mediterranean basin have a promising future, but require careful planning and investment in resilient infrastructure to ensure the continued prosperity and safety of their inhabitants as climate change impacts intensify.

Context

Alexandria, a large coastal metropolitan area located in the northwest of Egypt, is the second-largest metropolis of the country, sprawling over almost 2,500 km² and counting 6.5 million inhabitants. It is emerging as a key industrial and logistical hub, accounting for 40% of the nation's industrial output. The city is divided into eight urban districts defined by administrative boundaries, featuring a mix of regular grids and a network of irregular streets closely intertwined with the seaside promenade, bordered by buildings ranging from three to twenty-three stories high. Moreover, most of Alexandria's districts exhibit a dense and compact urban pattern with mixed land uses. Like many North African metropolises, it has witnessed the rise of informal, unregulated expansion, which has surged by nearly 47% over the past two decades, resulting in increasingly impermeable surfaces and overstretched public utility infrastructures.

According to geomorphological maps, the city is characterized by an arid Mediterranean climate, making it susceptible to stressful climatic factors such as floods, tsunamis, migratory cyclones, and sea-level rise. Alexandria experiences rainy winters, locally called *nawas*, from October to January and warm, dry summer months. Annual precipitation varies significantly, from 368 mm in 2004 to 70 mm in 2014, averaging 195 mm yearly.

Alexandria's high population density poses significant challenges in terms of urban planning and resource management. Its dense urban fabric presents unique challenges, especially when it comes to infrastructure and urban planning, making it difficult to implement both traditional and modern solutions for flood management. Rapid urbanization over the years has rendered much of its ancient infrastructure ineffective in managing floodwaters.

Regarding its drainage infrastructure, recent data from the Alexandria Sanitary Drainage Company (ASDC) reveals that approximately 93.4% of the urban area is connected to the sewer system, handling around 1.6 to 1.9 million m^3 of wastewater effluents per day. This capacity, estimated over a two-year ***return period***, indicates that the city is at risk of frequent flooding in the future.

Description

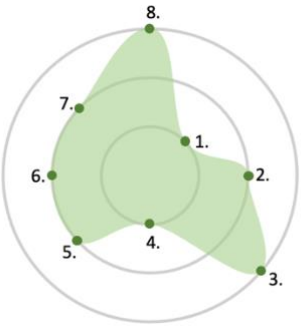
A collaboration between the University of Cairo and three foreign universities yielded proposals to address the frequent flooding suffered by the metropolitan area of Alexandria, entirely based on low-impact NbS and based on a general ***Sustainable Drainage System*** strategy. Due to the small scale of the NbS, the integration of numerous units is necessary to achieve the desired overall effect in flood prevention and reduction. The different types of NbS used are:

- Waterways: channels that capture and convey flows from catchments, including streams, creeks, and rivers, and can be natural or modified systems.
- Rainwater harvesting: rainwater is collected from building rooftops and stored in cisterns, interception wells, aquifers, or reservoirs with percolation.
- Infiltration trenches: linear excavations with a gravel cover are used to infiltrate water. .
- Green corridors: linear green spaces that can enhance connectivity between green areas, including natural habitats and recreational pathways.
- Vegetated swales: linear, shallow depressions (pots or surfaces) with sealed bottoms, filled with fertile soil, and densely planted with hydrophilic vegetation.
- Bioretention basins: linear depressions adjacent to a pavement, planted with multiple
- species of plants that are resistant to regular flooding.
- Rain gardens: small depressions and containers planted with flood-resistant vegetation to collect stormwater for reuse or infiltration into the soil.
- Wetland ponds: open water bodies that are designed to hold water permanently. If appropriately managed, they will support urban microclimates, enhance groundwater restoration, and add to the aesthetics of recreational areas.
- Permeable pavements: walkways built on flat or low-sloped surfaces, made of porous materials such as gravel, stones, grass, eco-grids filled with grass or gravel, and so on.
- Green roofs: roof and ceiling coverings made up of numerous substrate layers that allow for the growth of flora.
- Green walls: greenery established on walls, fences, and other vertical structures, such as vines or plants in pots.

The different characteristics of these solutions allow them to be adapted to the different types of urban fabrics of Alexandria in a site-specific manner, with a view to ensuring environmental services deemed most appropriate for each area. Virtually all of the solutions mentioned can offer improvements in the urban landscape, notably to improve the water cycle, reduce pollution and facilitate water infiltration, reduce the urban heat island effect, reduce air and noise pollution, and boost urban biodiversity.

Ecological services

Environmental Services



1. Air purification
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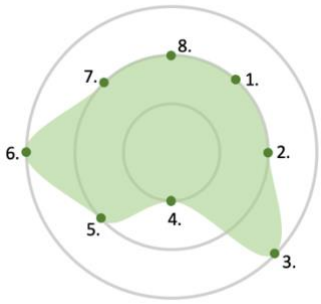
The proposed actions focus on flood control (3), a critical risk that, combined with the subsidence of the deltaic lands on which most of the metropolis of Alexandria is located, has the potential to make large areas of the area uninhabitable. However, the proposed actions, if disseminated throughout the urban territory, should substantially improve its resilience to flood risks, thanks to the massive contribution of vegetation (8). Depending on the different solutions used, other livelihood services can be secured, such as improving water quality, increasing infiltration (2), improving urban biodiversity vegetation (6), or even climate regulation obtained with evapotranspiration and shading created by vegetation (7). The fact that part of the actions could be carried out in ***brownfields*** or abandoned places would also require the removal of waste that currently occupies certain urban areas (5).

Social Benefits



1. Livelihoods, employment and social cohesion
2. Investments and territorial development
3. Citizenship wellbeing and health
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5. Waste management and circular economy
6. Urban resilience and risk prevention and adaptation
7. Aesthetic, cultural and recreational value
8. Educational and scientific value

Flooding threatens well-being and human health in areas such as Alexandria, as various animals that can act as disease vectors proliferate more easily in flooded areas (3). On the other hand, as mentioned, the risk of flooding and delta subsidence is the most critical risk that Alexandria suffers. This is why increasing the city's resilience to this risk is vital (6). In addition to these primary services, using NbS to address flooding positively impacts many other social aspects. The major transformations required would be capable of generating employment and investments, leading to a more equal urban environment not only in economic terms but also thanks to the reduction of risks that are higher in the city’s most deprived areas (1 and 2).

LESSONS LEARNT AND POLICY RECOMMENDATIONS

The study recognizes that, given its large scale, the flooding problem in Alexandria cannot be addressed solely through NbS. It is necessary to incorporate other solutions pertaining to traditional gray engineering. However, it also highlights the better cost-benefit ratio of NbS compared to gray solutions in many cases, as well as their better performance in terms of negative impacts and positive side effects. But to achieve a maximum proportion of NbS to address flooding, while optimizing the positive effects that ***gray engineering*** cannot offer, it is important to follow a series of principles:

It is impossible to completely counteract the effects of problems such as the urban heat island effect solely with NbS. It is also necessary to advocate for more sustainable urban intensification through effective building control legislation, focusing on setbacks, land use, building heights, and building coverage ratios.

NbS must be designed in such a way that their side effects support urban communities. NbS can be a meeting point for local inhabitants due to their ability to create enhanced environments, while citizen involvement in NbS can be a multiplying factor of their positive effects and guarantee their proper functioning. It is therefore important to take this into account in land use planning, which should include participatory approaches to public policy, for instance in terms of emergency land acquisition.

In order to incorporate NbS into urban planning effectively, a comprehensive strategic plan is necessary. This plan should incorporate NbS as a systemic instrument and avoid approaching NbS as isolated initiatives deprived of a systemic dimension..

Multi-criteria decision analysis can take urban land demand, regulations, investments, socio-economic factors, and the long-term impacts of NbS planning solutions into consideration, bearing in mind that conditions and solutions are dynamic and can change over time.

TO KNOW MORE…

- Assessing the effectiveness of NbS-strengthened urban planning mechanisms in forming flood-resilient cities: https://www.sciencedirect.com/science/article/abs/pii/S0301479723010484
- Case study on flooding in Alexandria, Egypt: https://reliefweb.int/report/egypt/climate-and-mobility-case-study-january-2023-alexandria-egypt-al-max
- The sinking city: Alexandria's race against climate change: https://watersciencepolicy.com/article/the-sinking-city-alexandrias-race-against-climate-change--dd3efaca2db9?language=English
- In the aftermath of the October 2015 Alexandria Flood Challenges of an Arab city to deal with extreme rainfall storms: https://www.researchgate.net/publication/324836051_In_the_aftermath_of_the_October_2015_Alexandria_Flood_Challenges_of_an_Arab_city_to_deal_with_extreme_rainfall_storms

NbS and the Legal Instruments of the Barcelona Convention

As previously mentioned, Plan Bleu acts as an observatory of the Mediterranean basin within the institutional framework of UNEP/MAP, in particular to monitor the level of ratification of the Mediterranean Strategy for Sustainable Development and the Barcelona Convention's Protocols by signatory countries. In the following section, we propose a qualitative and comparative analysis of the degree to which the NbS case studies presented in this report potentially contribute to 3 selected objectives of the MSSD, including 7 sub-objectives, as well as to the 7 Protocols of the Barcelona Convention[1]. The following legend is used in Table 3 and Table 4 below:

	Direct link with the legal instrument
	Indirect link to the legal instrument
	No link with the legal instrument

In Table 3, we zoom in on the following sub-objectives of the MSSD:

- **MSSD Sub-objective 2.3.2.** - Establish programmes to enhance awareness among local stakeholders on the economic, social and environmental value of ecosystem services and the implications of biodiversity loss for their daily lives.
- **MSSD Sub-objective 2.3.3.** - Set up financial mechanisms (national funds, payment for ecosystem services, compensations) to support policies ensuring the provision of environmental and social services.
- **MSSD Sub-objective 3.1.1.** - Utilize spatial planning systems to ensure balanced development in urban areas that incorporate measures for infrastructure provision, and land-take reduction where possible, as well as the provision of multifunctional urban green and blue infrastructures, which provide urban ecosystem services that are also important for climate change adaptation.
- **MSSD Sub-objective 3.7.2.** - Develop national guidelines for auditing and planning of green and blue infrastructure, with reference to natural and human-induced risks, including climate change.
- **MSSD Sub-objective 3.7.3.** - Prepare and implement action plans, based on prevention, preparedness and response approaches, to improve urban resilience to natural and human induced risks, including through natural solutions, smart development and awareness-raising.
- **MSSD Sub-objective 4.1.2.** - Assess, communicate, protect and enhance climate change adaptation capacity of ecosystems such as coasts, wetlands and forests, as well as their mitigation services, as in the case of forests and marine areas.
- **MSSD Sub-objective 4.4.1.** - Mainstream climate change into national legislation and policies with a focus on measures concerning energy and transport and on delivering no/ low regret adaptation measures across all vulnerable sectors and territories such as coastal and urban areas, water management, agriculture, health, and tourism; introduce climate change measures into urban and coastal policies and plans.

[1] See https://www.unep.org/unepmap/who-we-are/barcelona-convention-and-protocols for a list and description of the Barcelona Convetion's Protocols.

List of NbS case studies:

- Case Study 1: Landfill Rehabilitation: Qortin Landfill, Malta
- Case Study 2: Local Food Systems: Carthage Edible City, Tunisia
- Case Study 3: Green Corridors and Agriculture: Oued Tine, Tunisia
- Case Study 4: Wastewater Treatment and Reuse: Boukhalef WWTP, Morocco
- Case Study 5: Air Pollution: Barcelona Green Axes, Spain
- Case Study 6: Rivers: Llobregat Park, Spain
- Case Study 7: Coasts: Hyères Old Salt Marshes, France
- Case Study 8: Water Reclamation: Molentargius-Saline Park, Italy
- Case Study 9: Marshes Recovery: Venice Lagoon, Italy
- Case Study 10: Climate Change Adaptation, Albania
- Case Study 11: Health: Thessaloniki, Greece
- Case Study 12: Heat Waves in Izmir, Türkiye
- Case Study 13: Children and Youth: Learning Gardens, Lebanon
- Case Study 14: Floods in Alexandria, Egypt

Table 3. Level of coverage of MSSD objectives by the NbS case studies

NbS Case Study / MSSD Sub-objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MSSD (2.3.2)														
MSSD (2.3.3)														
MSSD (3.1.1)														
MSSD (3.7.2)														
MSSD (3.7.3)														
MSSD (4.1.2)														
MSSD (4.4.1)														

Table 4. Level of coverage of Barcelona Convention Protocols by the NbS case studies

NbS Case Study / Barcelona Convention Protocols	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ICZM Protocol														
Specially Protected Areas Protocol														
Land-Based Sources Protocol														
Hazardous Waste Protocol														
Dumping Protocol														
Protection and Emergency Protocol														

Several general observations can be made about both tables. Table 3 illustrates the potential of NbS to contribute to numerous aspects of the MSSD, especially related to raising the awareness of stakeholders and populations regarding the benefits of ecosystem services, the impacts of biodiversity loss and the risks and impacts associated with climate change. However, it is important not to overstate the impacts of the case studies presented. Indeed, the NbS interventions described in the latter illustrate the overall potential of NbS to contribute to the selected MSSD's sub-objectives when implemented at scale. This highlights the need to build institutional capacity to mainstream NbS into decision-making and spatial planning, while raising awareness amongst key urban stakeholders and coastal populations. All in all, the dissemination of small-scale NbS projects can contribute to the necessary political and scientific momentum to develop national guidelines for green and blue infrastructure (Sub-objective 3.7.2.).

Table 4 also provides several insights:

- The seven Protocols of the Barcelona Convention are very specific and may not be declinable to the local challenges that are targeted by the NbS presented in each case study.
- The ICZM Protocol expresses a high level of direct connection with the NbS case studies, which highlights the strong potential of NbS to inform spatial planning and coastal management in Mediterranean coastal zones.
- NbS can indirectly assist in supporting biodiversity and protected areas, the objects of the Specially Protected Areas Protocol. In particular, NbS that involve biodiversity conservation or landscape restoration can support ecological connectivity between protected areas and other valuable natural areas, located in urban and peri-urban zones. Agricultural practices involving regenerative agriculture, permaculture and agroforestry may also have positive impacts on biodiversity conservation, regeneration and ecological connectivity.
- Several of the Protocols concern activities or processes located at sea. In particular, the Barcelona Convention's Offshore Protocol was not included in the Table, since it concerns offshore maritime activities. Similarly, the Dumping Protocol and Protection and Emergency Protocol are not directly concerned by the NbS presented, but their overall objective of avoiding marine pollution can be supported by NbS for landfill rehabilitation (Case Study 1) and NbS for wastewater treatment (Case Study 4).

Conclusion

The 14 case studies presented above are a non-exhaustive sample of NbS implemented in the Mediterranean region over the last years. During this period, the concept of NbS has evolved and gained momentum, often to refer to traditional practices that are deeply rooted in Mediterranean communities. In parallel, the potential of NbS in addressing key Mediterranean challenges is sometimes overstated, while conventional solutions and approaches that comprise a small “green” component are also coined as NbS. It is therefore important not to overstate what NbS are and, more important, to avoid contributing to a catch-all and fashionable term that has little to do with its original meaning.

To that end, the recommendations drawn from the case studies seek to synthesize key insights into NbS, aimed at supporting the mainstreaming of these solutions without losing their original meaning. Overall, it is key to ensure that NbS are used to support the emergence of sustainable urban environments that are rooted in communities, designed in a context- and site-specific manner, and have beneficial effects for humans, fauna, flora and key resources in urban and peri-urban environments: notably water and soil.

Despite the key disparities that characterize the Mediterranean region, these recommendations are intended to be general in order to provide a set of overall regional guidelines, both from an environmental and social point of view. In essence, the adoption of NbS embodies a forward-thinking, multifaceted strategy that not only effectively mitigates environmental challenges, but also enhances urban livability and resilience, underscoring the need for an integrated approach to urban planning and environmental management. To achieve this, the following strategic recommendations should be taken into consideration:

1. **Assume NbS are ecologically site-specific:** it is essential that NbS adapt to the specific environmental characteristics of every city and urban environment. Most Mediterranean cities present similar but not identical bioclimatic environments. Moreover, cities are very altered environments, making their ecological evolution, as well as that of NbS, difficult to predict. It is therefore necessary to be cautious by implementing NbS in properly monitored phases, while bearing in mind that adaptive management will be necessary to ensure that each NbS performs optimally in its specific context.
2. **Assume NbS are socially site-specific:** NbS should be adapted to the social, technological and economic specificities of the urban context concerned. Although technologies can be implemented almost everywhere in our globalized world, often involving or targeting those groups that present the highest levels of resources and education, NbS should not remain confined to the most affluent and educated groups in society. Otherwise, they run the risk of being perceived as both benefiting from and contributing to urban gentrification. If they do not target and involve the largest groups of population possible, their uptake and acceptance may be jeopardized.
3. **Incorporate NbS as low impact actions:** NbS are increasingly being recognized for their strategic approach to addressing environmental challenges through what scholars have referred to as "low impact developments" (LID). This concept designates the large-scale deployment of numerous small-scale interventions that collectively aim to address specific environmental issues. One of the key strengths of this approach lies in its resilience. Indeed, the decentralized nature of NbS ensures that the failure of one element does not precipitate a collapse of the entire system as is the case for monolithic, traditional solutions, thereby safeguarding the continuous provision of vital environmental services. If one element in the system fails, its functions will still be ensured by another element elsewhere. LID also minimizes impacts on other key urban functions compared to gray solutions.
4. **Put traditional and local solutions at the core of NbS implementation and innovation:** NbS should be seen as an instrument to showcase and promote existing solutions and methodologies within the targeted territories, rather than external instruments to import. In this sense, NbS can effectively promote an endogenous approach to ecosystem management, while valorising traditional and indigenous techniques, approaches and worldviews.
5. **Avoid isolated solutions funded by one-off projects:** in recent years, NbS showcase projects have been implemented as one-off projects, often funded by international programs. These are useful to test methodologies and implement pilot actions. However, these efforts should be embedded into local

community and policy-making contexts in which they unfold in order to ensure their long-term uptake and mainstreaming by local actors.

6. **Guarantee that NbS projects have an impact at the policy level:** NbS should transform local and national policies in a way that contributes to a systemic change within ecosystem management. It is therefore crucial to reinforce the policy dimension of NbS projects, and to work hand-in-hand with policymakers to guarantee the transformative impact of NbS in the widest possible area. A balance is needed between the immediate projected impacts of NbS projects on communities and the systemic transformation in policy-making and urban governance.
7. **Create awareness and communication without patronizing vulnerable populations:** in order to guarantee the acceptance of innovative practices, successful awareness and communication strategies need to be an intrinsic part of NbS projects. It is important to engage the community in these activities, using simple and inclusive language that avoids technical jargon. It is also crucial to avoid patronizing the local population, and especially its most vulnerable groups, who may often be the most impacted by NbS projects. Supportive and well-trained participatory experts are needed to guarantee this engagement and avoid that NbS are delivered in a technocratic manner.
8. **Identify barriers to transferring at all levels:** transferability is at the core of the mainstreaming challenge when it comes to innovative practices, including NbS. Transferability is a multi-dimensional challenge composed of technical-scientific, socio-economic and cultural dimensions. Going beyond expert-led approaches, it is crucial to test the transferability of NbS with local communities before moving ahead with Nbs projects.
9. **Design projects from multiple perspectives:** the need to address human development challenges using an ecosystem-based approach is intimately linked to the implementation of NbS. In the different cases analyzed, the double analysis from a social and environmental approach is an example of the multi-disciplinary dimension of NbS. To that end, the creation of teams with different backgrounds and expertise, notably from the social sciences, can contribute to this purpose.
10. **Foster data-based decision-making:** public opinions on NbS may not necessarily integrate nor reflect the empirical outputs of NbS projects, since the perception of their results often depends on preconceived ideas and traditions. In the case of NbS, technicians and politicians frequently believe that inert and mechanical engineering solutions are more reliable than solutions that depend on the stability of an ecosystem. The use of data may help to overcome this reluctance.

Glossary

Agroforestry	Agroforestry designates land-use systems and technologies based on the integration of woody perennials (trees, shrubs, palms, bamboos, etc.) into agricultural plots, which may or may not include animals. In agroforestry systems, there are both ecological and economical interactions between the different components of the system. Agroforestry can also be defined as a multifunctional dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. In particular, agroforestry is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health. There are three main types of agroforestry systems: • Agrisilvicultural systems are a combination of crops and trees, such as alley cropping or homegardens. • Silvopastoral systems combine forestry and grazing of domesticated animals on pastures, rangelands or on-farm. • The three elements, namely trees, animals and crops, can be integrated in what are called agrosilvopastoral systems and are illustrated by home gardens involving animals as well as scattered trees on croplands used for grazing after harvests. **TO KNOW MORE…** https://www.fao.org/forestry/agroforestry/80338/en/
Bioengineering works	Bioengineering is a subset of green infrastructure that uses vegetation to ensure an engineering function. The most common uses of bioengineering include soil surface protection against erosion, soil stabilization, and improved drainage functions. **TO KNOW MORE…** https://www.adb.org/sites/default/files/publication/577066/bioengineering-green-infrastructure.pdf
Brownfield	A brownfield is a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant, most often due to previous industrial activities. **TO KNOW MORE…** https://19january2017snapshot.epa.gov/brownfields/brownfield-overview-and-definition_.html
Ecosystem Services	Ecosystem services refer to the ways in which ecosystems directly and indirectly contribute to human well-being, affecting our survival and quality of life. The concept of ecosystem services is relatively recent, developed to highlight the value of nature and draw attention to environmental degradation. This growth in our understanding of the true value of nature to humanity is alarming, given the increasing degradation of ecosystems at a global scale. There are four types of ecosystem services that humans derive from natural systems: 1. Provisioning Services, which include the products obtained from ecosystems, such as food, water, wood, oil, genetic resources, and medicines. 2. Regulating Services, which refer to the benefits obtained from the natural processes and functioning of ecosystems. Examples of such services include climate regulation, flood regulation, natural hazard regulation, pollination, and water purification. 3. Cultural Services are non-material benefits people receive from ecosystems, such as spiritual enrichment, intellectual development, recreation, and aesthetic values. 4. Supporting Services are essential to habitat functioning and, therefore, support species' survival. Photosynthesis, the water cycle, and nutrient cycles are the basis of ecosystems, which, in turn, support our existence. **TO KNOW MORE…** https://earth.org/what-are-ecosystem-services/
Edible City Solutions	Edible cities enable the public to grow and harvest produce on public land, supported by public governance arrangements between city administrations and civil society. The main goal of such initiatives is to transform urban food systems to a more sustainable, healthy and fair model. This kind of shift can take place in a city, with solutions that include neighborhood gardens, urban beekeeping and sheep farming, rooftop farming, green facades, high-tech indoor farming that employs hydroponics or aquaponics, cooking and dining events and the use of locally grown urban food in restaurants. It affects the entire food value chain, and is able to instigate positive changes not only in terms of production but also with regards to distribution and marketing systems as well as and the food culture of urban populations. An improvement in the environmental and landscape quality of the city is always sought as the main side effect of their actions.

	TO KNOW MORE… https://www.edicitnet.com
Green Infrastructure	Green infrastructure is a strategically designed infrastructure network made up of natural or semi-natural elements that must guarantee the provision of a wide spectrum of environmental services to the population, while promoting biodiversity. **TO KNOW MORE…** https://environment.ec.europa.eu/topics/nature-and-biodiversity/green-infrastructure_en
Green Corridors	A thin strip of vegetation used by wildlife and potentially allowing movement of biotic factors between two areas. A wildlife, habitat, or green corridor is an area of habitat connecting wildlife populations separated by human activities or structures (such as roads, developments, or logging areas). This allows an exchange of individuals between populations, which may help prevent the negative effects of inbreeding and reduced genetic diversity (via genetic drift) that often occur within isolated populations. Corridors may also help to support the re-establishment of populations that have been reduced or eliminated due to random events (such as fires or disease). This may potentially moderate some of the worst effects of habitat fragmentation, since urbanization can split up habitat areas, causing animals to lose both their natural habitat and the ability to move between regions to access resources. Habitat fragmentation due to human development is an ever-increasing threat to biodiversity, and habitat corridors serve to manage its effects. **TO KNOW MORE…** https://www.eea.europa.eu/help/glossary/eea-glossary/ecological-corridor
Heat Island Effect	Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies. Urban areas, where such structures are highly concentrated and greenery is limited, become "islands" of higher temperatures relative to outlying areas. These pockets of heat are referred to as "heat islands." Heat islands can form under a variety of conditions, including during the day or night, in small or large cities, in suburban areas, in northern or southern climates, and in any season. **TO KNOW MORE…** https://www.epa.gov/heatislands#:~:text=Heat%20islands%20are%20urbanized%20areas,as%20forests%20and%20water%20bodies
Parklet	A parklet is a sidewalk extension that provides more space and amenities for people using the street. Usually, parklets are installed on parking lanes and use several parking spaces. Parklets are intended for people. They offer a place to stop, to sit, and to rest while taking in the activities of the street. In instances where a parklet is not intended to accommodate people, it may provide greenery, art, or some other visual amenity. A parklet may accommodate bicycle parking within it, or bicycle parking may be associated with it. **TO KNOW MORE…** https://en.wikipedia.org/wiki/Parklet
Permaculture	A return period, also known as a recurrence interval or repeat interval, is the average time or estimated average time between events such as earthquakes, floods, landslides, or river discharge flows. It is a statistical measurement typically based on historical data over an extended period, and is used usually for risk analysis. Examples include deciding whether a project should be allowed to go forward in a risk zone, or designing structures to withstand events with a certain return period. This type of analysis assumes that the probability of the event occurring does not vary over time and is independent of past events. **TO KNOW MORE…** https://www.usgs.gov/centers/new-jersey-water-science-center/floods-recurrence-intervals-and-100-year-floods#:~:text=The%20average%20number%20of%20years,of%20the%20naturally%20changing%20climate.
Sustainable Drainage Systems	Sustainable drainage systems (SuDS) are stormwater management and urban planning techniques that aim to imitate hydrological processes in urban development, controlling runoff in the urban landscape. These systems aim to reduce the amount of water in the final discharge and improve the quality of the water discharged into the natural environment, achieving integrated management solutions for the water cycle linked to the environmental protection of the receiving waters. SuDS try to reproduce the natural hydrology of a basin. Therefore, different techniques implemented will be combined in an attempt to achieve the global objectives of a runoff water management chain listed below:

	• **Prevention:** first of all, non-structural measures must be applied to prevent pollution of runoff water, such as controlling the application of herbicides and fungicides in parks and gardens. • **Stop:** controling runoff water at its source or in the immediate vicinity, using, for example, structural measures such as green roofs or pavements. • **Slow down:** reducing runoff water through urbanized land, through drains, strips or infiltration areas. • **Store:** runoff water is stored, using structural elements such as cisterns, ponds, surface or buried reservoirs, artificial wetlands, cistern covers or buried storage areas. • **Infiltrate:** finally, stored water is infiltrated into the ground or reused, using structural elements such as infiltration ditches, bioretention strips, wells and infiltration tanks. To accomplish these objectives, most of the concrete solutions that SuDS offer for urban design and drainage can be considered NbS: • **Waterways** are channels that capture and convey flows from catchments, including streams, creeks, and rivers, and can be natural or modified systems. • **Rainwater harvesting** are diverse devices and techniques used to harvest water from the building rooftops and divert it to cisterns, interception wells, aquifers or reservoirs through percolation. • **Infiltration trenches** are linear excavations to stop and infiltrate runoff water. • **Green corridors** are linear green spaces that can provide connectivity services, including natural habitats and recreational pathways. • **Vegetated swales** are linear, shallow depressions (pots or surfaces) with sealed bottoms, filled with fertile soil, and densely planted with hydrophilic vegetation. • **Bioretention basins** are linear depressions that are placed adjacent to a pavement and planted with multiple species of plants that are resistant to regular flooding. • **Rain gardens** are small depressions and containers planted with flood-resistant vegetation that collect stormwater for reuse or infiltration into the soil. • **Wetland ponds** are open water bodies that are designed to hold water permanently. If appropriately managed, they can improve microclimates, enhance groundwater restoration, and add to the aesthetics of recreational areas. • **Permeable pavement** are surfaces to walk on flat or low-sloped surfaces that are made of porous materials such as gravel, stones, grass, eco-grids filled with grass or gravel, and so on. • **Green roofs** consist in covering roofs with multiple substrate layers that allow for the growth of flora. • **Green walls** add greenery to walls, fences, and other vertical structures, such as with vines or plants in pots **TO KNOW MORE…** https://thefloodhub.co.uk/wp-content/uploads/2018/09/An-Introduction-to-Sustainable-Drainage-Systems-SuDS.pdf
Traffic Evaporation	Traffic evaporation or “disappearing traffic” refers to the reduction in traffic flows which is often observed following a reduction in road space capacity. This phenomenon means that the impacts of road space reduction on traffic congestion are less severe than predicted by traffic models, which assume that traffic levels are inelastic. Traffic evaporation can be thought of as the opposite of induced traffic, i.e. the observed rise in traffic volumes following road capacity expansion. **TO KNOW MORE…** J. Sadik-Khan, S. Solomonow, Streetfight: handbook for an urban revolution, Viking (2016) Cairns, S.; Atkins, S.; Goodwin, P. (2002). Disappearing traffic? The story so far. Proceedings of the Institution of Civil Engineers - Municipal Engineer, 151(1), 13–22. doi:10.1680/muen.2002.151.1.13 https://www.sciencedirect.com/science/article/pii/S2213624X22002085