



**CLEVER
Cities**

CLEVER Regional Solutions Catalogue

Showcasing good practice NbS interventions and enablers from China, Europe and Latin America



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About the CLEVER Regional Solutions Catalogue

The CLEVER Regional Solutions Catalogue seeks to elevate the role of nature-based solutions (NbS) across the urban landscape. It aims to inspire uptake and continued energy for implementing nature-based solutions that meet the varied needs and requirements of modern cities.

Conceptualised as a compilation of good practice examples, this catalogue is a resource specifically developed for city officials and local government staff,

with a particular focus on China, Latin America and South Eastern Europe. It illustrates the various benefits that urban NbS interventions can generate for the environment, society and economy.

This is coupled with a showcase of different mechanisms and enablers that cities can learn from and transfer into their own NbS projects. These span areas such as impact monitoring, policy design, stakeholder engagement and access to finance.

About CLEVER Cities and the UrbanByNature programme

The catalogue’s case study selection is based on the work carried out within the European Horizon 2020-funded project CLEVER Cities and the UrbanByNature capacity-building programmes for China, Latin America, and South Eastern Europe that were launched during the project.

Within the CLEVER Cities project, Hamburg, London and Milan have implemented nature-based interventions in key districts of their cities for urban regeneration. Six other cities, namely Belgrade, Larissa, Malmö, Madrid, Quito, Sfântu Gheorghe, have accompanied them,

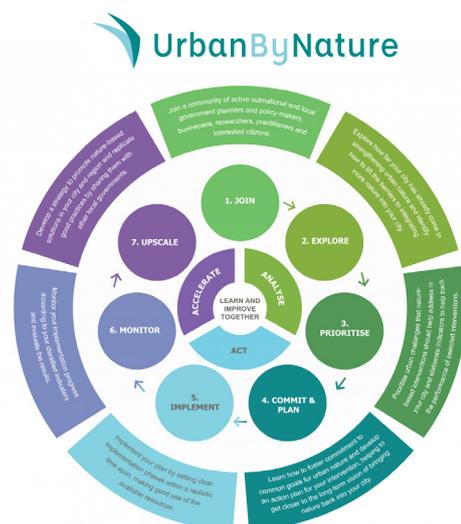
learned from them and contributed their own expertise. The project has built and leveraged local capacities and expertise to generate innovation and develop new, future-proof governance, financing, and business models for NbS.

Through exchange between cities as part of the UrbanByNature programme, the CLEVER Cities project has aimed to drive a new kind of nature-based urban transformation for sustainable and socially inclusive cities across Europe, Latin America and China.

About UrbanByNature

UrbanByNature is a facilitated capacity-building programme promoting exchange among cities, researchers, SMEs and NGOs to build bridges with the nature-based solutions communities across Europe, Asia, Latin America, and other interested regions. Its 7-step curriculum guides local governments on NbS planning and implementation covering a range of aspects from co-creation, impact assessment, financing, business models to upscaling.

Link: <https://urbanbynature.eu/>





The CLEVER Cities front-runner cities of Hamburg, London and Milan have demonstrated outstanding examples of the co-benefits that can be expected when people and nature thrive together. An introduction to the key activities within the CLEVER Cities project sites, referred to as CLEVER Action Labs (CALs), are presented in each of the front runner cities, prefacing the more nuanced case studies throughout the remainder of the catalogue.

Hamburg, Germany

The CLEVER Cities project area is located in the southwest part of Hamburg in the district of Harburg, more specifically, in the quarter of Neugraben-Fischbek. It covers an area of approximately 220 ha with approx. 13,300 inhabitants. Perched between two vast nature reserves, the hilly heath areas of the Fischbeker Heide in the south and the swampy marshland area called Moorgürtel in the north, the overall settlement area is rather small, amounting to only 29% of the whole land area. This means that most people live within 1-2 km, i.e. walking distance, of the nature reserves.

Both Neugraben and Fischbek used to be independent villages until they became part of the city of Hamburg in the 1930s. In recent years, the city has then begun to build three new large housing areas which will increase the current population by more than 35% by 2025. These new medium-density urban housing areas are specially designed to be 'close to nature' ('naturverbunden Wohnen'), i.e. living in and with nature is defined as the underlying design principle for all the new architecture and the public realm. The CLEVER Cities project in Ham-

burg has addressed these emerging demographic and environmental disparities between the existing and the new housing areas in Neugraben-Fischbek by aiming to regenerate the existing neighbourhoods to become more nature-based, too.

The CLEVER Cities Hamburg team has focused on these three CALs:

- **CLEVER Action Lab 1 - Green corridor:** CAL1 focuses on developing a green corridor in Neugraben-Fischbek. It includes various small-scale NbS interventions intended as stepping stones for nature in a densely built-up urban area. These encompass flower meadows, sculptural insect hotels, nature playground, bee-friendly qualification of existing green roofs;
- **CLEVER Action Lab 2 - Green roofs, facades and sustainable urban drainage systems:** CAL2 focuses on green roofs and facades, as well as stormwater management (e.g. through infiltration beds, earth dams, blue roof technology, soil bound green facade) on different locations in the Neugraben-Fischbek project area;
- **CLEVER Action Lab 3 - Environmental education & nature connectedness:** CAL3 focuses on green roofs and facades, as well as stormwater management. NbS measures that have been implemented in the Neugraben-Fischbek project area include infiltration beds, earth dams, blue roof technology, a soil bound green facade and a green noise barrier.



Aerial view of the CLEVER Cities project area in Neugraben-Fischbek (© adapted from Landesbetrieb Geoinformation und Vermessung)

London, UK

London's CLEVER Action Labs are all located in South Thamesmead, an area of Thamesmead, Southeast London. Thamesmead is a captivating place with a fascinating history. Planned in the 1960s and hailed as the 'town of tomorrow', this Southeast London town – with its abundance of green space, man-made waterways and modern homes – was designed as an appealing alternative to cheek-by-jowl inner city living. But like many of the new towns, the ambition of Thamesmead was soon undermined by difficulties of a similar magnitude. Site constraints, under-investment and waning political support, alongside insufficient facilities, poor transport links and inconsistent governance, sparked a steady decline in the town's fortunes over the decades.

Fast forward to today and Thamesmead faces brighter prospects. Having taken ownership of two-thirds of the land in 2014, CLEVER Cities partner Peabody, a not-for-profit housing association, is on a mission to improve, grow and look after the town for the long-term, which is now one of the largest urban regeneration projects in Europe. With this rapid change comes a challenge to ensure that a wide range of people benefit. The CLEVER Cities team in London recognise that creating inclusive and sustainable places is one way to help mitigate negative impacts of change.

The focus of the CLEVER Cities London CALs are as follows:

- **CLEVER Action Lab 1 – Connecting People and Places:** CAL 1 focuses its efforts on Maran Way, a car dominated road. It addresses urban challenges by adopting the 'Healthy Streets' approach found in the

Mayor of London's Transport Strategy. This is about improving streets and the public realm, so they become places where people feel safe, have things to see and do, and where people can choose to walk, cycle and have better access to public transport.

- **CLEVER Action Lab 2 – Green Corridor:** CAL 2 focuses on Abbey Way - a key walking and cycling route that runs from Lesnes Abbey, a much-loved local heritage site, to Southmere Lake, a lesser visited space within the South Thamesmead Estate. The focus is on exploring how to improve this green corridor for both human and ecological connectivity.
- **CLEVER Action Lab 3 – Greening Unusual Spaces:** CAL 3 is driving nature-based innovation by working in difficult spaces and testing different products and processes. The CAL is focused on four core elements:
 - a. Learning Classroom:** ensuring young people are aware of these future opportunities there is a need to educate and inspire young people in their educational journey.
 - b. Greening walkways, walls, underpasses:** seeking opportunities to green difficult spaces, testing a variety of methods and approaches.
 - c. Tiny Forest:** the planting of a Tiny Forest in Southmere Park to raise awareness of the issue of climate resilience and the value of NbS.
 - d. Community Grant Programme:** providing residents with grants of up to £2000 to identify their own urban challenges and present solutions that they will design, implement, and manage in the long term.

Aerial view of South Thamesmead (© Peabody)





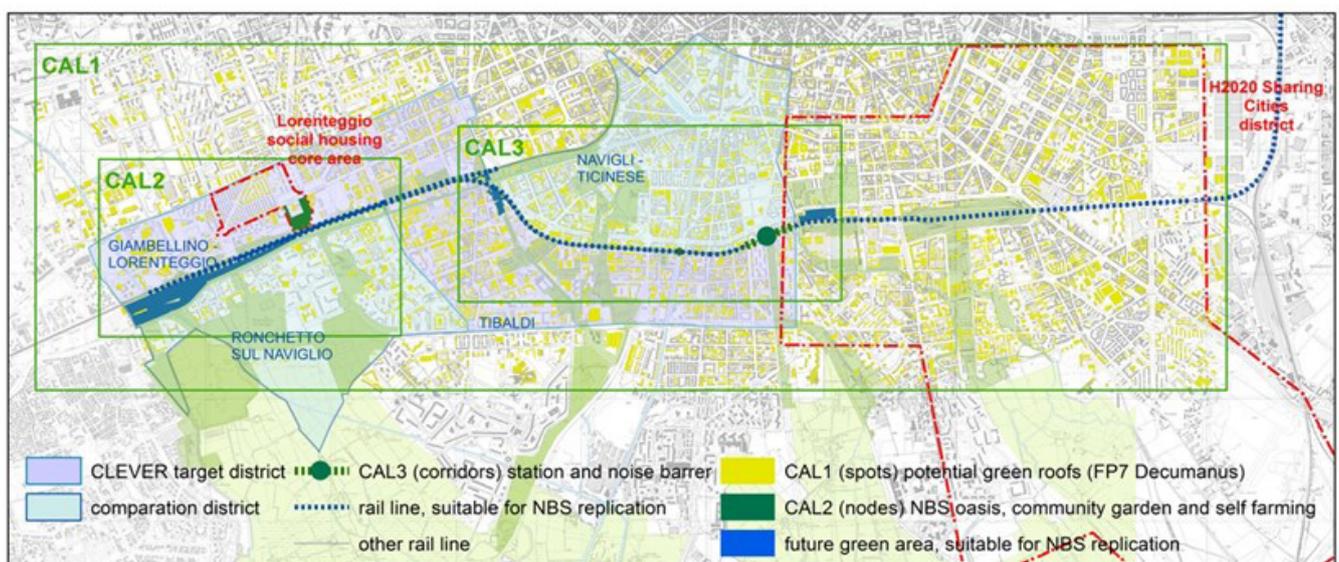
Milan, Italy

The three CLEVER Action Labs of Milan are primarily located in the southern part of the city. More specifically, they are situated in the densely built-up residential neighbourhood of Lorenteggio-Giambellino (CAL2) and in the area where the new railway stop Tibaldi is being constructed (CAL3). The CLEVER target district is marked by significant social deprivation. The neighbourhood of Lorenteggio-Giambellino is mainly inhabited by elderly residents and migrants from other countries, many of which live in social housing. At the same time, Lorenteggio-Giambellino is the target of an overall redevelopment plan which will result in the rehabilitation of some of the old degraded social housing blocks and result in overall urban regeneration and greening measures across the neighbourhood.

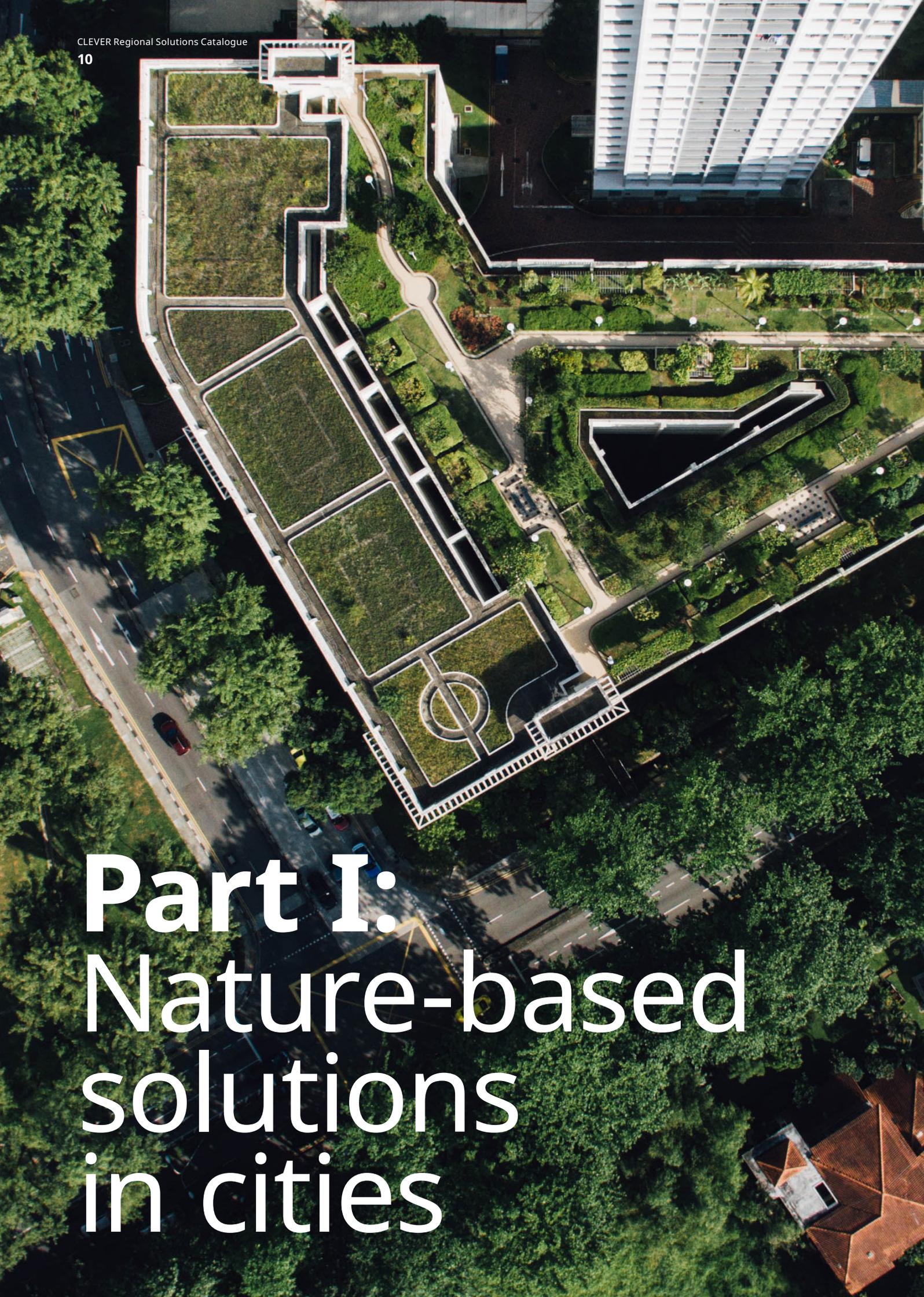
Nonetheless, project activities have also taken into account other areas of the city and have expanded their reach even to the northern districts of Milan. This is the case with CAL1, which includes a „Reward your Greenery/ Premia il tuo Verde“ prize competition spread across the city.

The focus of the CLEVER Cities Milan CALs are as follows:

- **CLEVER Action Lab 1 - Regreening Milan:** CAL1 is focused on mainstreaming green roofs and walls for a wider awareness raising of their environmental and social benefits and on providing implemented examples that will demonstrate these benefits in a co-creation process.
- **CLEVER Action Lab 2 - A new public park:** CAL2 focuses on Giambellino 129, a previously abandoned and polluted green lot. A restoration programme has been foreseen by the Municipality of Milan in order to create a community garden and a public green area encompassing an area of 27.000 m².
- **CLEVER Action Lab 3 - A new Tibaldi train stop:** CAL3 focuses on the experimental integration of nature-based solutions (wall, barriers, etc.) in the building, infrastructure and a public space which pertain to the Tibaldi train stop area.



Map of the CALs in Milan (© CLEVER Cities Milan)



Part I: Nature-based solutions in cities



Nature-based solutions (NbS) serve as extremely powerful means for addressing the multiple environmental, social and economic challenges that cities face. They are defined 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” (IUCN, 2016).

In an urban context, the implementation of NbS constitutes a vital strategy for developing sustainable, resilient, and attractive cities. As such, they contribute to a wide range of urban policy domains spanning, amongst others, climate change adaptation and mitigation, biodiversity conservation, urban regeneration, healthcare and economic development. For example, local governments can plant street trees to address the urban heat island effect through the provision of shade, replace former industrial sites with urban parks to revitalise degraded neighbourhoods, and implement rain gardens to reduce the risk of flooding during heavy rainfall events. They can create urban gardens to foster social cohesion, implement green roofs to cut energy costs and design green corridors to encourage walking and biking.

NbS are multi-purpose and cost effective approaches. While grey infrastructure solutions usually only serve a single purpose, NbS can be leveraged to simultaneously provide a range of benefits. Using the above examples, street trees not only ameliorate the micro-climate but also purify the air, urban parks contribute to urban regeneration whilst also enhancing local biodiversity outcomes and rain gardens act as important carbon sinks in addition to tackling stormwater issues. In their totality, the co-benefits generated by NbS often outweigh their design, implementation and maintenance-related costs. In short, NbS constitute important win-win solutions for catalysing impactful urban transformations.

1. Generating environmental benefits through nature-based solutions

Natural areas in and around cities are under increasing threat due to urbanisation, climate change, and resource exploitation. This chapter highlights the multiple environmental benefits that NbS offer within urban and peri-urban landscapes.

The chapter begins by examining the role of NbS in preserving, restoring, and establishing natural spaces in and around urban areas. It addresses habitat loss and fragmentation caused by urban growth while also introducing green spaces into the urban landscape. Next, it explores the potential of NbS such as green corridors and linear parks to enhance connectivity between natural areas. The chapter also highlights instances where NbS effectively preserve and reintroduce urban biodiversity. Finally, it delves into NbS' capacity to combat pollution in densely populated areas by creating urban filters for air, water, and soil contaminants.



1.1 Preserving, restoring and creating natural areas

Intact natural areas deliver many co-benefits. These include, amongst others, carbon sequestration, water cycle regulation (e.g. reduce flood risk, buffer against drought), pollination, food and resource provision. These benefits are essential for safeguarding human needs and well-being. Preserving and restoring nature in and around cities helps to ensure that these benefits are sustained for future generations.

This section delves into the diverse array of NbS applications that can contribute to the preservation of existing, restoration of degraded, and creation of new natural spaces in urban and peri-urban environments. The following case studies exemplify how NbS can strengthen local ecosystems to deliver co-benefits for people and nature spanning rewilding initiatives that promote urban reforestation in London, UK, to the restoration of a ravine in Quito, Ecuador, and that of the Kunming River Basin in China.

London, UK: Planting a Tiny Forest

CLEVER Cities London has engaged in a two-year partnership with Earthwatch, an environmental NGO that seeks to connect people with the natural environment, to implement a 'Tiny Forest' in Thamesmead. Defined as dense, fast-growing, native woodlands made up of 600 trees planted in a tennis-court sized plot of 200 m², this NbS intervention applies rewilding principles on a small scale to bring more natural features to public spaces. In early 2022, over 70 residents joined in establishing a new Tiny Forest in Southmere Park comprised of 18 species and planted without chemicals or fertilisers. During the planting process, a rotovator was used to till the soil and organic matter was added in order to ensure that the trees quickly and successfully took root.



Tiny Forest co-implementation (© Richard Heald)

This space has the potential to attract 500 species of plants and animals within the first three years, leading to positive impacts for biodiversity throughout the area.

Kunming, China: Revitalising a lake ecosystem

The Dianchi Lake is a highly biodiverse basin located in Kunming City. In the past, untreated wastewater from industries and farms damaged the water quality and ecosystem of Dianchi Lake, leading to water shortages and ecosystem degradation. The environmental and ecological restoration work of Dianchi Lake has taken around three decades. Since the late 90s, the work has seen the deployment of nature-based solutions for ecological restoration as well as for pollution control. As the water quality upgraded, rebuilding the health of the water ecosystem integrated a series of actions in rivers, forests, farmlands, lakes, grasslands, and sandlands. By 2020, most ecological



Dianchi Lake (© Landi HE)

functions were recovered, as demonstrated by long-term biological and ecological monitoring which demonstrate the continuous development of aquatic vegetation communities, the return of several endangered and nearly extinct birds, and the stabilisation of several indicator species populations.

Quito, Ecuador: Restoring an urban ravine ecosystem

Ravines are natural landforms occurring in the Andean region of South America. They often harbour native biodiversity, even if situated in the heart of a city. The Caupicho ravine in the south of Quito suffered from a lack of maintenance and pollution. As a result, it had a very low drainage capacity, making the area swampy and prone to flooding and overgrown with grass, which prevented the use of the area and the growth of a more complex flora. Several nature-based solutions were implemented to restore the ravine, including drainage ditches, earthworm water filters, micro-forests, rain gardens, and mound cultivation slope trees. These low-cost and robust techniques built with locally available materials and inspired by nature helped restore the ravine and reintroduce local flora.



Intervention plan for the Caupicho ravine (© YES Innovation)

1.2 Enhancing connectivity between natural areas

Connectivity between natural areas is essential for avoiding biodiversity loss and ensuring benefits for people. NbS can help strengthen connectivity by patching together, connecting and/or creating corridors between otherwise fragmented ecosystems in urban and peri-urban areas. These areas offer critically important habitats that provide water, food, shelter and suitable living conditions for plants and animals. In turn, this benefits people with recreational areas, cleaner air, psychological well-being, climate buffers, and reduced urban heat island effects. Nature does not have to be excluded from

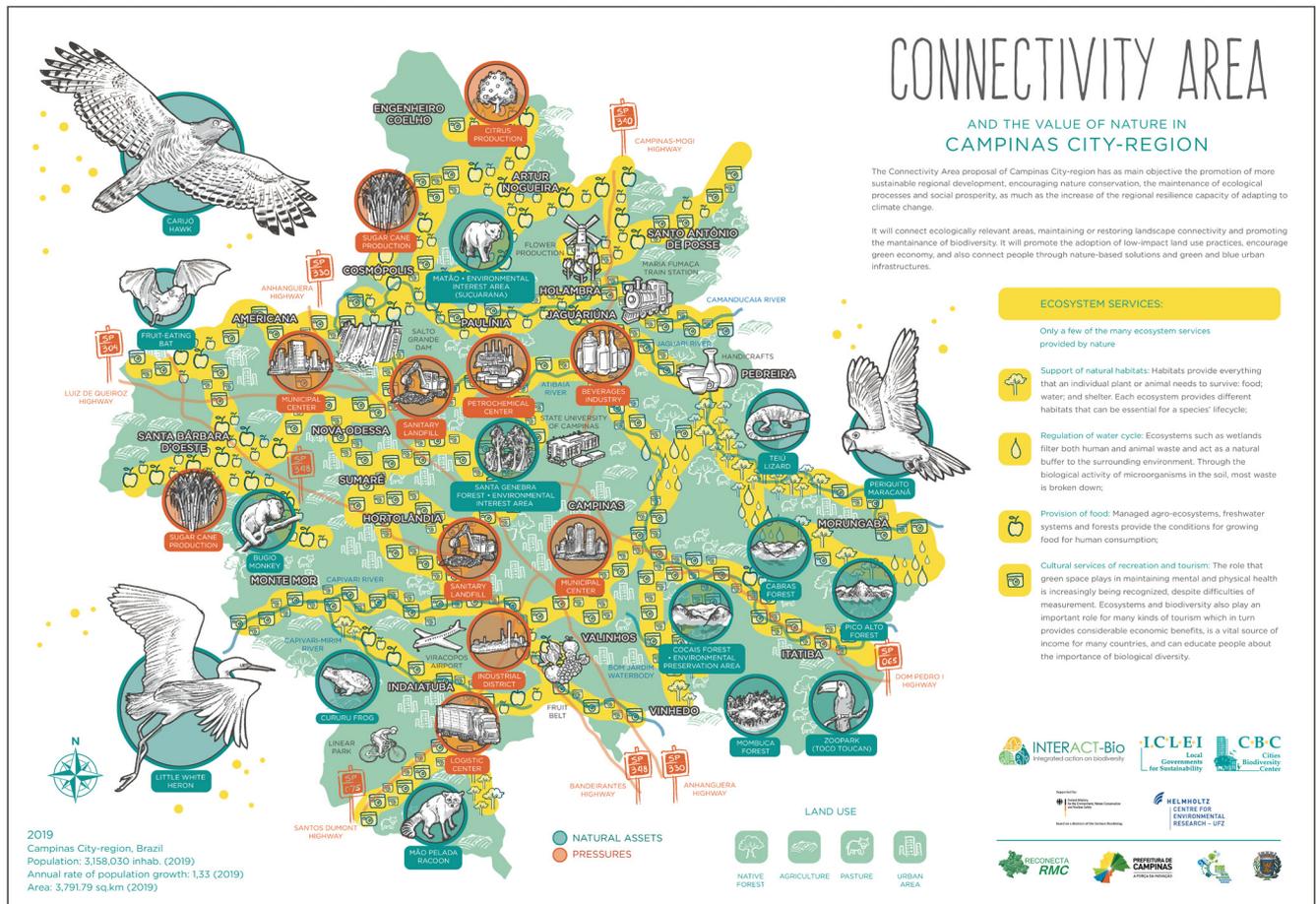
dense urban development. Initiatives for strengthening ecosystem connectivity can become integral features of sustainable urban planning, making cities greener and cleaner, to meet multifaceted climate and social goals.

This section provides examples of NbS projects that range from small-scale interventions throughout Hamburg's Neugraben-Fischbek district in Germany to large-scale endeavours such as the city-region-wide linear park system for Campinas, Brazil and China's largest urban forest in Xi'An.

Campinas, Brazil: Boosting linear parks

The Metropolitan Region of Campinas (MRC) is a priority area for conservation as it houses remnants of the Atlantic Forest and Cerrado biomes in the state of São Paulo, two of the most diverse biomes in Brazil. Through a collaborative process, the MRC identified and mapped priority buffer zones to connect fragmented natural areas throughout the metropolitan region.

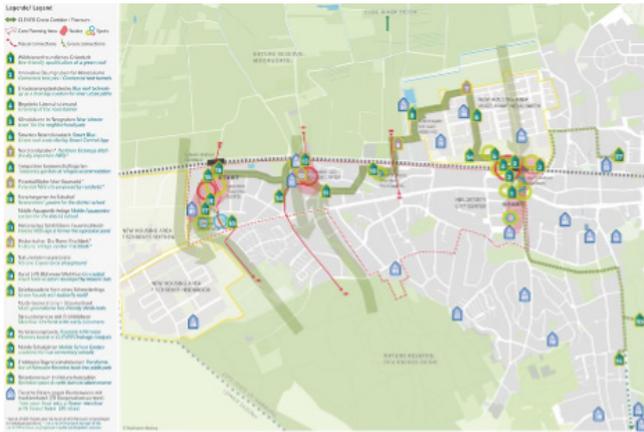
This led to the proposal of 40 linear parks, half of which already have some measures in place. Linear parks are natural spaces that connect ecosystems to support their continuity which in turn improves the management of natural resources. Their precise mapping has helped the MRC to incorporate ecosystem services into urban planning.



Illustrated Map of the planned Connectivity Area in Campinas (© RECONECTA RMC Program and INTERACT-Bio Project)

Hamburg, Germany: Implementing a stepping stone approach

CLEVER Cities Hamburg applied a so-called stepping stone approach to its NbS work in Neugraben-Fischbek. The district is situated between two nature reserves - the swampland Moorgürtel and the heathland Fischbeker Heide. NbS were planned and implemented along several corridors in an effort to connect the two reserves and allow for better species passage through the creation of a biotope network. The interventions range from large-scale measures such as the implementation of green facades on buildings and along a noise protection wall to micro projects such as the placement of insect hotels.



Stepping stone approach in the Neugraben-Fischbek project area (© BA Harburg)

Tying it all together, a communication and guiding system called CLEVER Parcours was established to incentivise residents and visitors to (re-)discover the neighbourhood through an urban nature lens. Throughout the project area, signage elements physically mark the locations of the implemented NbS using the symbolic form of a yellow 3D house as an easily recognizable icon. Each house is equipped with a QR code that refers to the respective online project page and offers residents and visitors further information, thus elevating public awareness for urban nature. In addition, the signs themselves constitute stepping stones through the provision of habitat and food sources: Several of them are filled with a bat house, a bird feeder or an insect hotel.



Putting up signage for the CLEVER Parcours system (© SUPERURBAN)

Xi'An, China: Creating a Happiness Forest Belt

In 2016, a significant urban regeneration project called the Happiness Forest Belt was initiated in the Chinese city of Xi'An, culminating in its public opening in July 2021. The project stands as one of the world's largest underground undertakings and constitutes China's largest urban forest, spanning 5.85 kilometres in length and 140 metres in width. Below ground, it hosts various

public services and amenities, while above ground the Happiness Forest Belt boasts expansive, high-quality green spaces with over 40,000 trees. The Happiness Forest Belt constitutes a key pillar of Xi'An's green route system that connects the urban landscape with its natural hinterland.



Xi'An's Happiness Forest Belt (© Xinhua Net)

1.3 Increasing urban biodiversity

Urbanisation exacts a toll on biodiversity by clearing green spaces for housing, roads and other types of grey infrastructure. However, integrating NbS into urban development can mitigate biodiversity loss. By reintroducing native plant species, creating habitat corridors, providing shelter possibilities and fostering green connectivity, NbS invite a diverse array of flora and fauna back into the urban landscape, enhancing the quality of life for both humans and non-human inhabitants.

The examples presented in this section include the biodiversity-enhancing re-design of a public park in Milan, Italy, the bee-friendly qualification of green roofs in Hamburg, Germany, the establishment of biodiversity hotspots in Shanghai, China, and the conversion of an abandoned tram line into a pollinator-friendly green corridor in the Greek city of Piraeus.

Milan, Italy: Turning an abandoned lot into a biodiversity-friendly park

The CLEVER Cities Milan team has put a strong emphasis on NbS that enhance urban biodiversity, particularly in their work on the re-design of the Giambellino 129 Park located within the area of the Lorenteggio-Giambellino regeneration programme. In collaboration with local residents and civil society organisations, chosen NbS for the previously abandoned and polluted green lot include a bird garden area, a wild meadow, an orchard, and a fenced vegetable garden area, all of which are aimed at attracting butterflies, natural pollinators and birds to the public park. Special consideration was given to NbS that provide habitat heterogeneity and preserve foraging, sheltering and breeding habitats using native vegetation. After a lengthy decontamination process, the first 35 native shrubs were planted together with local residents and associations in March 2023. Further planting work is planned throughout the year for the park's envisioned opening in December 2023. In addition, CLEVER Cities Milan's biodiversity-related activities have included

sensitising and mobilising residents by distributing do-it-yourself pollinator guides with information about local bird and butterfly species as well as packets with native plant seeds. By planting these seeds on balconies and in private gardens, residents could actively participate in strengthening local biodiversity.



Co-implementation day in Giambellino 129 (© Municipality of Milan)

Hamburg, Germany: Creating and supporting bee-friendly rooftops

In comparison to intensive green roofs, their extensive counterparts generally have less biodiversity. Their thin soil layer limits the diversity of vegetation to typically hardy, drought-tolerant, and low-growing varieties, such as succulents, grasses, and mosses. While they provide important food sources, they are less suitable for pollinator settlement and reproduction. To address this issue, the CLEVER Cities Hamburg team conducted various rounds of expert discussions. This led to the development of a guide on bee-friendly green roof design. The guide was distributed to building owners to encourage uptake of the measures across the district. In addition, the team collaborated with a local grocery store operator to turn an existing extensive green roof into an ecological sanctuary for pollinators. While the grocery store's green roof already provided sufficient food resources, the 2,400 m² area lacked suitable nesting aids. Several deadwood and rock piles as well as additional substrate and sand piles were placed to provide habitat for pollinators. These comparatively simple interventions are low-cost both in terms of their implementation and maintenance, yet provide important ecological functions, particularly

in heavily sealed urban areas such as Neugraben-Fischbek. The initial monitoring results revealed a remarkably high number of species and individuals: 30 distinct wild bee species and 23 wasp species were recorded with wild bees accounting for nearly 80% of the overall recorded individuals. These findings suggest significantly greater quantities of species and organisms than could be expected from comparable surveys.



Deadwood piles to create nesting possibilities for insects (© BUKEA)



Native ecological science demonstration base of the Forest City Studio (© Taoran Guo)

Shanghai, China: Supporting high biodiversity on small spaces

In Shanghai, the Forest City Studio is working to create biodiversity hotspots across the highly-urbanised megacity. To this end, the company focuses on the creation and restoration of natural 'micro-ecosystems' and the reintroduction of native plant and animal species. One such example that is underway is the conversion of an artificial forest covered in invasive species into a biodiverse plot of land made up of seven distinct types of habitat. Situated in the western region of the Pujiang Country Park in Shanghai's Minhang district, the 17,000m² area will include evergreen forests, deciduous forests and grasslands. In addition to replacing invasive species such as white clover with native carpet grass, the water system will be revitalised to allow for aquatic life such as amphibians to thrive. The company's focus on creating complex habitats within a compact and concentrated space helps to attain a relatively high level of biodiversity which can then radiate to the surrounding urban landscape.

Piraeus, Greece: Fostering pollinator biodiversity along a former tram line

The post-industrial Greek city of Piraeus is fostering biodiversity via the implementation of a co-created NbS plan. Amongst others, the plan foresees the establishment of a green corridor with pollinator-friendly school gardens. Learning from case studies around the world such as the Highland Park in New York City, the green corridor will run along the abandoned Marias Kiouri tram line that formerly connected the city's residents to the port. Collaboration with schools situated along the railroad has been an integral part of the biodiversity-enhancing re-design. Students at a lower school were invited to contribute to garden designs via art. They drew their ideal biodiverse and pollinator-

friendly school yards. At an upper level school, students were also involved in the technical planning of pollinator gardens. They created plans for existing garden beds with biodiversity in mind. Plants were selected so that something was flowering almost year round, in order to ensure that pollinators had adequate feed all year.

The schools and community members will remain involved even after the implementation by participating in the monitoring of pollinator communities, which will serve to evaluate the effectiveness of the NbS interventions in terms of their envisioned biodiversity outcomes.



Co-designing NbS with school children in Piraeus (© ICLEI Europe)

1.4 Reducing pollution

Urban areas are particularly prone to pollution. These can originate from a variety of sources, including road traffic, a dense concentration of industrial activities, water contamination and improper waste disposal practices. NbS such as green roofs, rain gardens, bioretention swales and wetlands can effectively cleanse water by extracting pollutants and toxins. Furthermore, forests and vegetation can sequester carbon, purify the air and reduce urban noise. Bioremediation is another powerful NbS tool,

which allows nature to detoxify former factory sites.

This section showcases NbS examples demonstrating their versatility in improving urban water quality. For instance, in Shanghai, China, an interconnected wetland system was established to reclaim a polluted industrial site. Similarly, in both London, UK, and Belgrade, Serbia, floating wetland islands were installed to tackle water pollution and offer ecological benefits.

London, UK: Tackling pollution in Southmere Lake

NbS were leveraged to improve the water quality and ecological state of Thamesmead's Southmere Lake. Subject to high levels of siltation and instances of algae blooms during the summer months, Southmere Lake offered low habitat quality both concerning aquatic and edge species. The Thamesmead housing charity Peabody, supported by the CLEVER Cities London team in an advisory role, have undertaken significant works to tackle the lake's water pollution issues. They removed the built-up silt and created floating wetland islands. These allow water to flow through the vegetation on the islands which helps to remove impurities and improve water quality. The vegetation will also create

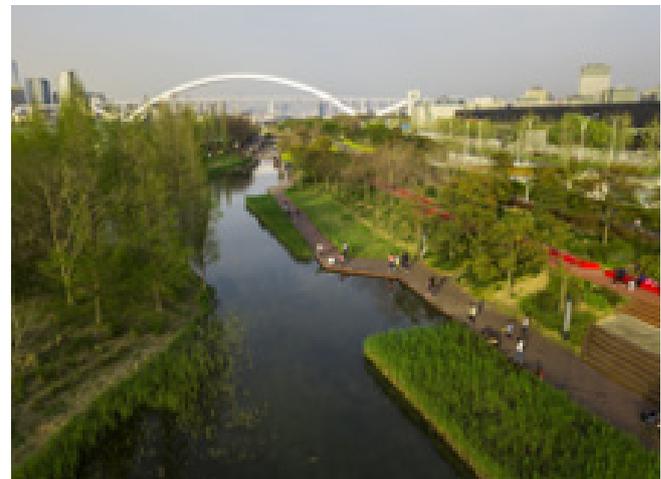


Southmere Lake in Thamesmead (© Nicola Murphy-Evans)

new habitats for wildlife, including birds and fish, and provide local interest and access to nature for those living nearby.

Shanghai, China: Using wetlands to improve water quality in Houtan Park

Designed for the Expo Shanghai 2010, Houtan Park demonstrates how nature-based solutions can help connect ecosystems and support biodiversity. The project site was previously a contaminated industrial parcel situated along the Huangpu River. Houtan Park consists of several layers of wetlands connected to an adjacent riparian area. This allows for the extracted water from the Huangpu river to travel through various types of wetlands for water retention, pollutant absorption, water purification, and sediment deposition. The wetlands also serve as a habitat for native species, as well as a site for carbon sequestration and storage. It also includes a terraced crop land for traditional Shanghai agriculture, which serves as a recreation activity.



Shanghai Houtan Park (© Turenscape)



First prize at the competition for the redesign of Zemun quay (© euPOLIS project and Mikser Festival)

Belgrade, Serbia: Enhancing natural river water purification

The City of Belgrade is implementing NbS in the Ušće Pocket Park on the Zemun quay, incorporating an integrated construction wetland featuring diverse biological filters to treat stormwater. The final stages of conceptualization are underway for this integrated wetland, aimed at improved stormwater management. The plan encompasses connections to the Danube River as well as multifunctional floating islands, which will serve as practical demonstration sites of natural river water purification.

2. Generating social benefits through nature-based solutions

NbS can provide substantial social and health benefits for urban residents, enriching the lives of the people who live in and around them.

The first section of this chapter explores how NbS can have a positive effect on social cohesion by providing spaces for interaction and encouraging collaboration. The following section examines how nature can support residents' physical and mental health and contribute to their well-being. Overall, well-designed green spaces and natural landscapes enrich the daily lives of residents, adding to their quality of life in multifaceted ways. Finally, the last section explores the nexus between NbS, public safety and social resilience in urban spaces. The key take home message is that NbS make urban areas more adaptive to stressors, which may be droughts, floods, heatwaves or pandemic restrictions. Social resilience is enabled by providing safe spaces for people to gather, play, relax, exercise and explore nature with the sounds of insects and birds rather than dangers and annoyances of cars and concrete.



2.1 Fostering social cohesion

Strengthening social cohesion through NbS means that cities are designed in a way that enables people and communities to thrive together with and because of the benefits nature provides. NbS such as urban parks and community gardens can catalyse social interactions, improve residents' sense of belonging and pride in one's neighbourhood. When NbS are properly designed to support human use in those areas, especially considering the diverse cultural preferences that different urban communities may have for those spaces, they can become focal gathering points for diverse urban residents, creating senses of place and

connection that make cities more inclusive and livable.

Examples explored here include the provision of high-quality green spaces for social gatherings and leisure activities in a residential social housing complex in Milan, Italy and throughout the South Thamesmead Garden Estate in London, UK. Moreover, the examples zoom in on the co-creation process to encourage community gardening in Malmö, Sweden, and the importance of incorporating an intergenerational lens for planning diversified public spaces in Shenzhen, China.

Milan, Italy: Implementing high-quality green roofs

Situated between the old city centre and the suburbs of Milan lies the residential social housing complex of Via Russoli 14-20. Built in the 1980s, the block consists of four high-rise towers that are connected by low-rise buildings. With the support of CLEVER Cities, green roofs and walls have been prominently featured in the redesign of the degraded complex. Next to increasing residents' thermal comfort, the NbS are aimed at fostering social cohesion through the provision of high-quality green space for social gatherings and leisure activities. For this purpose, different functions are envisioned for the green roofs: Amongst others, they will host 510 m² of orchards and 750 m² of vegetable gardens which the residents can use to grow food and produce honey. With regards to the management of the green roofs, resident



Green roof design for the social housing complex Via Russoli 14-20 (© Risehouse)

involvement will be key. In addition, a collaboration with a social cooperative whose aim is to reintegrate disadvantaged citizens - in many cases former prisoners - into society, is being explored.

London, UK: Creating new social spaces and opportunities for engagement

The CLEVER Cities supported South Thamesmead Garden Estate project will see thousands of metres of meadowlands planted with a focus on creating new spaces and an activation program for social cohesion. The project will also see innovative sustainable drainage, and new lighting. Creative play is embedded in the landscape designs, encouraging children to explore, forage, and interact with the natural environment. Improved accessibility through the area helps to improve access for those with mobility needs and encourages residents to walk and cycle. New routes help to create better links to people's homes and green spaces. All to help make this neighbourhood and its green spaces inclusive and climate resilient. In addition, a social gardening programme has been established in Thamesmead's Edible Garden, a space dedicated to the community to come together to learn how to grow and meet new people. The programme uses horticulture as a form of social prescribing with a focus on working with young people, helping to tackle feelings of isolation by becoming more involved in the community.



Drawing of a new social space in Thamesmead, due to be completed in Spring 2024 (© Muf Architecture)



Edible Garden (© Richard Heald)

Malmö, Sweden: Promoting community links through nature-based solutions

In collaboration with CLEVER Cities, Malmö is working to create nature-based solutions that support community health in the neighbourhood of Lindängen. In comparison to other areas in Malmö and Sweden, residents in this area have relatively low rates of post-secondary school education, employment, election participation, and life expectancy. Additionally, the neighbourhood faces physical challenges such as monotonous architecture, broad thoroughways and unsafe cycling and walking paths. CLEVER Cities is working with community groups in a co-creation process to encourage community gardening and is providing soil, seeds and plants to make the area greener, attract pollinators and teach local residents more about growing food and how to live alongside our important pollinators. These actions promote well-being in the community by providing a space for residents to meet, talk and grow food and flowers together.



Local women's group creating a pollinator-friendly flower bed in Lindängen, Malmö (© Shoshana Iten, City of Malmö)

Shenzhen, China: Supporting the establishment of community gardens

The Chinese megacity of Shenzhen has undergone a rapid process of urbanisation. Over the span of four decades its population increased from less than 0.3 million to 17.5 million inhabitants. This has resulted in a highly diverse urban population living in a dense built-up environment. In 2020, the city administration launched the "We Garden" programme to enhance social cohesion and improve quality of life for its residents through the conversion of idle public land into thriving community gardens. By 2025, the "We Garden" programme intends to facilitate the establishment of 600 community-led gardens across the entire city. The Spring Garden in Nanshan District and Harmony Paradise, a rooftop garden in Luohu District, constitute two initiatives that have since been implemented. The Spring Garden has seen the involvement of more than 500 residents in its creation as well as maintenance and now serves as a welcoming space for citizens to relax and socialise, as well as a vibrant area for children to play and engage in nature observation. Similarly, the Harmony



Nanshan District Community Garden (© Qixia LAN)

Paradise Garden was co-created by the residents of the Women and Children Center that houses the rooftop garden. Coupled with activities such as urban gardening and educational offerings, the NbS interventions have allowed residents to foster a greater sense of belonging. They have also helped address issues such as loneliness, anxiety, and social isolation, which were especially prevalent throughout the Covid-19 pandemic.



2.2 Enhancing health and well-being

NbS can improve the physical and mental health of urban residents. Spending time in nature can reduce stress faster than indoor or grey infrastructure environments while offering accessible spaces for exercise and sports that enable the establishment of health-positive and pro-social habits. Because NbS filter polluted air and buffer traffic noise, they offer oases of serenity in otherwise densely populated urban areas, reducing the likelihood of health related exposure risks to heat, stress, pollution and our captured attention in the busy urban landscape. More specifically, NbS like urban forests, green roofs, and vegetated open spaces cool the urban environment, creating comfortable microclimates and reducing heat-related risks of illness. Numerous studies and projects have shown that residential proximity to green spaces

like parks can be associated with increased levels of physical activity such as jogging, walking and group sports, which have many known benefits to mental and physical health.

This section showcases experiences in the European cities of Hamburg, London, Madrid and Zagreb. Despite their different contexts and scales, each city shows how NbS can spur active lifestyles. The importance of green urban spaces became even more pronounced during the COVID-19 pandemic. Nonetheless, effectively planning and implementing NbS for health requires careful attention to community diversity such as children, elderly, people with disabilities and different cultural groups to ensure access and inclusion.

Hamburg, Germany: Creating a nature experience playground

Near the old village centre of Fischbek, the CLEVER Cities Hamburg team turned a formerly inaccessible and degraded brownfield site into a nature experience playground, thereby converting the 2,800 m² area into a high quality public space and meeting point for local children, youngsters and grown-ups alike. Playground elements were carefully selected to fit into the surrounding environment using mostly natural materials. A wooden tipi was erected and a climbable spider web made from rope and wood was set up and gently integrated into the existing stock of old trees. Recycled cobblestones and felled trees were used for the toddler play area and as seating elements respectively. Nature-based landscaping elements include an arched tree alley that was planted at the entrance of the playground, and different wildflowers and insect-friendly plants which were co-planted by the kindergarden group of the local

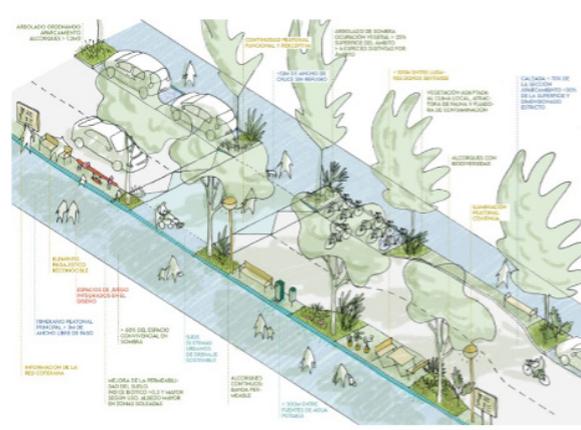


Spider web made out of natural materials as part of the nature experience playground (© Munder und Erzepky Landschaftsarchitekten)

church parish. The new play area fosters a wide range of activities, including building wooden cabins, digging, climbing, and hiding in bushes, thereby contributing to active lifestyles and connectedness to nature.

Madrid, Spain: Designing walkable streets with NbS

Within the CLEVER Cities project, Madrid focuses on the creation of a green corridor within a highly urbanised area of its Usera District that currently lacks green space. This nature-based urban regeneration project seeks to connect the Pradolongo Park in the south with the Madrid Río Park in the north of the district. Key objectives of the regeneration project include making the area more walkable and providing children with ample opportunities for play. The NbS measures foreseen include the replacement of concrete pavement with vegetation and trees to enhance the micro-climate and address stormwater issues. Where trees cannot be planted due to the presence of an underground car park, pergolas with climbing plants will be installed to provide much needed shade. In combination with other planned grey infrastructure measures such as the increase of pedestrian areas, these interventions will hence make it easier for residents to opt for walking and biking rather



Example of a street renaturation for the green corridor in Usera District (© Ayuntamiento de Madrid)

than taking their car. In addition, the blueprint entails playable water fountains and dedicated play zones to foster active and healthy lifestyles among the district's younger residents.



Therapeutic garden in Zagreb (© Mali Dom)

Zagreb, Croatia: Setting up a therapeutic garden

Zagreb, Croatia, is supporting citizens in reframing and reclaiming former industrial areas via co-created NbS. At the centre of this is making these areas more accessible and appealing to local residents. Through a series of workshops, the need for a therapeutic garden was identified. The garden was co-designed by therapists and other professionals working with the garden's target audience and was constructed in a former meat industry site of the easternmost, largest, and youngest municipality. The garden was in part a response to the desire of the target audience to have access to a garden. Furthermore, there is a significant need for therapeutic gardens for children and adults with disabilities, as such individuals often have little opportunity to explore the natural world using their senses. A landscape designer and parent of a child with disabilities designed the garden based on the input from the workshops. Several institutions utilise the garden on a regular basis. The garden is partially open to the public, as external parties can contact the organisers to arrange for events and visits. The aim here is to also reduce the stigma of disability.



2.3 Improving resident safety and resilience

NbS can play a significant role in enhancing resident safety and resilience in urban environments through various mechanisms. For example, they can buffer the impacts of extreme weather events such as flooding, drought or the erosion of coastlines from storms. Restoration initiatives such as planting native vegetation can help control soil erosion on slopes and riverbanks, which prevents landslides and protects infrastructure, enhancing overall safety and stability. NbS like constructed wetlands, permeable pavements, and bioswales can absorb excess rainwater, reducing the risk of flooding during heavy rainfall events, protecting residents and properties from water-related hazards. By restoring local ecosystems' ability to provide

key resources, nature-based solutions also offer opportunities to support resource security and safe sanitation.

The examples presented here showcase the diversity of resilience and safety-related benefits that NbS provide: Hamburg, Germany, has implemented vegetated roadside planters to improve stormwater management while London, UK, seeks to leverage NbS to increase the perceived security of a car-dominated street. Moreover, examples include the implementation of a city-scale network of green and blue infrastructure in Guangzhou, China, to combat extreme heat and the use of NbS to enhance food security in Samborondón, Ecuador.

Hamburg, Germany: Piloting innovative roadside planters for flood protection

CLEVER Cities Hamburg implemented six roadside planters that have a flood protection device built into them. These new and space-efficient solutions are especially suitable for areas with insufficient room for swales or ditches. Instead of constructing deep, hazardous concrete troughs filled with reeds that require fencing to prevent accidents, the Hamburg team opted for standard roadside planting strips with hollow plastic baskets at their bottom. These baskets create cavities capable of temporarily storing rainwater during storm events. Subsequently, the water gradually infiltrates the ground, replenishing the local groundwater table and restoring the natural water cycle. This effectively diverts water that would previously flood sealed road surfaces. This setup also allows for trees to be planted on top of the cavities, thus creating a nicer streetscape for the neighbourhood. In alignment with ongoing research, the



One of six roadside planters in Neugraben-Fischbek (© BA Harburg)

Hamburg team also investigates which tree species is best suited for this kind of construction - considering factors such as climate adaptability, local or non-local varieties, water tolerance, and shallow root systems. A different tree was planted in each of the 6 planters. Insect-friendly flower meadow seeds were also planted instead of the standard lawn mixture for the undergrowth of the planters.

London, UK: Incorporating NbS in street redesign

CLEVER Cities London has made NbS an integral part of its 'Healthy Street' redesign for Maran Way. Maran Way has long suffered from ill-health with its patchy paving, poor drainage, minimal shade, inadequate lighting and no places to sit and rest. This has made access particularly unsafe and challenging for residents with buggies, wheelchairs, and mobility scooters. The redesign will include a paved footpath with some permeable paving, raised wheelchair accessible crossings, and step-free access to Abbey Way. Additionally, the redesign will add benches for resting and lighting columns for better visibility during the evening and winter months. In terms of NbS, planting beds for rain gardens will be installed. These will be filled with a combination of evergreen shrubs and herbaceous perennials with ornamental grasses. By strategically incorporating biodiverse planting, the street will feel more inviting and will be safer for residents by providing shade and helping to absorb surface water when it rains. All this will contribute to making the street both safer and more pleasant.



The Maran Way 'Healthy Streets' pedestrian footway drawings, due for completion in Jan 2024 (© muf Architecture)



Guangzhou Heat island effect

Guangzhou, China: Addressing urban heat island effects

Guangzhou is a dense, highly urbanised megacity with a population of 18.68 million. Situated in southern China, the city is subject to a sub-tropical climate. The city's naturally warm, humid climate coupled with low wind speeds creates an urban heat island effect which makes it frequently uncomfortable and often unsafe for residents to be in the open. As the first city engaged in China's Sustainable Urban Cooling Program, led by the World Bank, Guangzhou set up a cooling plan and

identified effective nature-based solutions to counter the urban heat islands challenges it experiences. The city-scale plan includes six major ventilation corridors, which rely on urban green areas and Guangzhou's extensive network of water bodies. This network of green and blue infrastructure is expected to combat extreme heat by channelling cooling winds through the city in an effort to stabilise the microclimate.

Samborondón, Ecuador: Supporting water and food security

Situated on the banks of the Guayas River, the Ecuadorian village of Samborondón is located in an area primarily dedicated to rice cultivation. In the countryside there are hamlets which form raised slets that are isolated during the rainy season when the whole area is flooded. However, climate change has led to a more pronounced rainy season each year, reducing the land accessible for cultivation. Consequently, the village faces challenges in securing both safe water and an adequate food supply. In addition to rainwater harvesting and treatment and dry toilets to secure safe access to water, floating vegetable gardens were installed to support food security for a homestead of three families.



Samborondón, Ecuador (© YES Innovation)

3. Generating economic benefits through nature-based solutions

Nature-based solutions offer a diverse range of economic benefits for cities as well as their residents and local businesses. These range from NbS interventions resulting in tangible cost savings all the way to producing new revenue streams and economic opportunities.

The chapter initially explores how NbS can lead to cost reduction, emphasising their capacity to lower energy and stormwater management expenses while also underlining their cost-effectiveness compared to more expensive grey infrastructure alternatives. It then transitions to the potential of NbS to generate additional income, such as through the development of new business ventures and increased property values. The chapter concludes by presenting opportunities for skill enhancement through NbS projects.



3.1 Providing cost effectiveness and savings

NbS can generate savings for both cities and residents. For instance, green roofs and walls can increase the indoor thermal comfort of buildings, leading to lower heating and cooling expenses for their occupants. Rain gardens and water retention ponds can cut insurance and public health costs by protecting both infrastructure and human lives from flood damage. They can also filter out pollutants from heavy rainfall events, thereby reducing municipal expenses linked to water treatment.

It is important to note that not all benefits of NbS can be easily quantified in monetary terms. For example, the positive effects of NbS on residents' well-being are challenging to measure and assign a specific monetary

value to. When evaluating the economic benefits of nature-based solutions against initial capital investments and ongoing maintenance costs, it is essential to also take into account their non-monetary benefits. These should also be considered when evaluating their cost-effectiveness in comparison to grey infrastructure alternatives.

The below example from Milan, Italy showcases the potential of green roofs and facades to reduce energy and stormwater management bills, while the NbS intervention in Quito, Ecuador focuses on the cost-effectiveness of low-tech NbS versus more elaborate engineered solutions.

Milan, Italy: Greening roofs and facades to cut energy costs

The expansion of green roofs and facades across the urban landscape constitutes a key focus of the CLEVER Cities Milan team and is expected to result in cost savings at the municipal and individual level alike. The degraded social housing complex of Via Russoli 14-20, for example, will be equipped with 3,500 m² of green roofs. In addition, the facade will be reconstructed and greened. The original facades' insulation panels had to be removed a decade ago as they were laden with asbestos which in turn negatively affected residents' thermal comfort. The green facade and green roofs will be able to address this issue by increasing the energy efficiency of the social housing complex, additionally resulting in energy cost savings. Similarly, the installation of 310 m² of green roofs and nano gardens on Via E. Ponti 21 will increase the energy efficiency of the floor below. Moreover, it will contribute to improved rainwater management, thus lowering associated costs.



Green roof in E. Ponti (© Municipality of Milan)

Quito, Ecuador: Setting up low-cost rain gardens

Within the framework of CLEVER Cities in Quito, a set of low-cost and low-tech NbS interventions were implemented in the pilot neighbourhood of San Enrique de Velasco, as cost-effective alternatives to grey infrastructure solutions for stormwater management. Unpaved streets that easily deteriorate due to water runoff were equipped with rain gardens. The system is therefore based on a succession of drainage layers inspired by international standards for rain gardens, followed by a layer of substrate for local plants. These are designed to be lower than the level of the main road in order to divert rainwater by gravity. Additional drains running along the main road intercept and guide runoff into the rain gardens. This type of NbS intervention is easily and inexpensively replicable in many streets of the city, and has the potential to replace more costly interventions that the municipality cannot undertake



Low-tech rain garden in Quito (© YES Innovation)

due to financial constraints. At a low cost, it allows the management of stormwater through a new functional and living landscape, thereby also reducing associated costs for rainwater treatment.

3.2 Increasing revenue streams

NbS can increase existing revenue streams, create jobs and provide new and innovative business opportunities thus generating beneficial economic impacts for cities, residents and local businesses. For example, NbS have been shown to enhance the attractiveness of urban areas leading to increased property values and turning them into more desirable business locations. These in turn result in higher returns for property developers and an increase in municipal tax revenues. Furthermore, new business models can be developed around NbS innovations, such as the use of biomaterials in construction processes. Finally, restoring natural areas

can create attractive sites for residents in the region and beyond to visit, sparking tourism and positive spillover effects on local business when more people and customers are in the area.

The following examples showcase NbS innovations made in Ecuador and Germany, community-led urban agriculture initiatives that generate income in Quito, Ecuador, to strategically using NbS to attract new businesses in Tianjin, China, and boosting nature-based tourism in South Eastern Europe's Danube Delta.

Promoting nature-based innovations

Defined as an “enterprise, engaged in economic activity, that uses nature sustainably as a core element of their product/service offering” (Kooijman et al., 2021), nature-based enterprises have played a key role within the CLEVER Cities project and beyond to spur nature-based innovations. For instance, the CLEVER Cities Hamburg team collaborated with the private sector and academia to test a variety of green-grey solutions for storm-water management across Neugraben-Fischbek. These include a series of innovative roadside

infiltration beds and the installation of a blue-green roof coupled with a smart flow control app. Next to their more traditional NbS-related services in the realm of architecture and urban planning, Quito-based CLEVER Cities partner YES Innovation has been working with Ecuadorian cities to accelerate nature-based innovation. This includes, for instance, the development of thermal and acoustic insulation made from Ecuadorian rice straw and a wastewater treatment technology based on earthworms.



Showcase of the nature-based wastewater treatment solution implemented in Quito for the Innoqua project (© YES Innovation)



Smart blue-green roof in Hamburg (© BA Harburg)



Technical training for home growing during the Covid-19 pandemic in Quito (© YES Innovation)

Quito, Ecuador: Formalising community-led urban agriculture initiatives

With support from the CLEVER Cities Quito team, residents of the San Enrique de Velasco district were able to leverage NbS to address the economic difficulties they were facing due to the Covid-19 pandemic. After the first few weeks of the coronavirus lockdown, several groups of neighbours started to cultivate crops in their homes in order to sell them and generate income. The CLEVER Cities team and local administration organised a programme to support these endeavours with technical training and the creation of a neighbourhood fair to market the community's produce. The formalisation of these bottom-up initiatives was able to build on the city's long standing and successful Participatory Urban Agriculture Programme and enabled residents to create new revenue streams amidst the pandemic.



Tianjin Eco-City (© Sino-Singapore Tianjin Eco-City Investment and Development Co., Ltd.)

Tianjin, China: Attracting businesses through green and blue infrastructure

Tianjin Eco-city is built on 2.6 km² of rehabilitated coastal wastewater ponds. The eco-city features a wide array of green and blue infrastructure, which greatly upgraded the waterfront environment and attracted companies looking for appealing office and business

locations. Together with high standards for environment conservation and low-impact development, Tianjin Eco-city includes the creation of a vibrant central area with commercial, leisure and recreational facilities to further attract new residents and businesses.



Danube Delta (Royalty Free Image)

Danube Delta, South Eastern Europe: Boosting nature-based tourism

The Danube Delta spanning 580,000 hectares across several local jurisdictions in Romania, Ukraine and Moldova is a unique and biodiverse ecosystem. It provides important ecological services including flood regulation, water purification, and habitat for numerous species. Through collaborative efforts involving local communities, environmental organisations, and local government entities, the wetlands have been restored and managed in a sustainable manner. This has led to the development of nature-based tourism and related economic activities

in the region. Tourists are attracted to the Danube Delta for activities such as birdwatching, wildlife observation, fishing, and boating. Local residents have capitalised on these opportunities by offering accommodation, guided tours, boat rentals, and selling locally-produced crafts and products. The increased tourist interest and associated services have generated income for local communities, created employment opportunities, and contributed to the overall economic growth of the region.

3.3 Developing skills

NbS projects can offer opportunities for applied learning and skill development along their entire 'lifecycle'. Starting from the planning phase, through to implementation and continuing into the maintenance stage, they enable participating individuals to develop know-how in different domains.

These may range from developing hands-on skills in landscaping, horticulture and carpentry to acquiring more versatile competencies in project management, budgeting and monitoring as demonstrated by Hamburg, Germany and London, UK.

Hamburg, Germany: Acquiring landscaping skills through community gardens

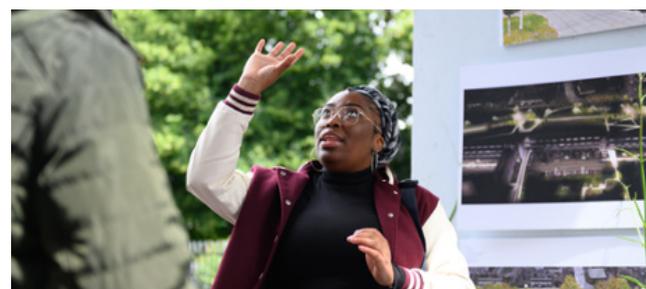
CLEVER Cities Hamburg involved the residents of a temporary refugee accommodation situated in Neugraben-Fischbek in the creation of a community garden. This included dedicated workshops with a local carpenter to build the raised beds as well as planting sessions with expert gardeners. By participating in these workshops the residents learned new competencies and developed marketable skills in carpentry and landscaping. This was especially beneficial for the refugee population that the community garden serves as they were working to integrate themselves into German society.



Workshop with local residents of the refugee accommodation (© Steg mbH)

London, UK: Enabling capacity-building for local residents

Providing opportunities for skill development for local residents has been an integral part of the NbS work of the CLEVER Cities London team. As part of the **community researcher** programme, for example, four residents were recruited, trained and paid for their time to bring better insight into the lived experiences of those in Thamesmead and help gather real time observation data on local issues such as flooding. In addition to creating better project outcomes, the programme was successful in helping local people develop new skills, even encouraging some to embark on careers in social research. Separately, ten local residents were also hired on the London Living Wage to help co-design the NbS interventions for Thamesmead alongside the appointed design practice. As group members of the self-titled **Community Design Collective (CDC)**, they received extensive training in areas such as landscape design, project management, budgeting, community collaboration and engagement to ensure they would be able to participate fully in the design review process. The CDC have become an effective part of the project team, working collaboratively, and enhancing their capabilities in understanding regeneration projects as well as building their professional confidence. Next to these paid opportunities, the NbS interventions have provided various volunteer opportunities. Six **Tree Keepers**, for example, were recruited and trained by the environmental NGO Earthwatch to support the monitoring and maintenance of the Tiny Forest that was planted in Southmere Park. Equipped with the necessary resources and tools, these Tree Keepers carry out simple science surveys, periodically measure tree growth, and assess and report risks and hazards stemming from extreme weather, pests or anti-social behaviour. All of these capacity-building opportunities have contributed to making participating individuals more competitive for the job market.



Community researcher at a community event (© Richard Heald)



CDC on site looking at the progress of landscape works (© Richard Heald)



Tree Keepers at the Tiny Forest planting day (© Richard Heald)



Part II: Mechanisms and enablers for nature-based solutions in cities



Nature-based solutions have the potential to deliver lasting co-benefits for the environment, communities and the local economy, as the above city cases exemplify. Yet mainstreaming NbS as go-to solutions still remains a key challenge, particularly in comparison to their engineered counterparts.

This chapter presents mechanisms and enablers that cities have put in place to facilitate the implementation of NbS and lists relevant resources from the CLEVER Cities project where applicable. It begins by looking at the evidence base that cities need to showcase the potential of NbS and encompasses different tools, methods and approaches they can leverage to prove the effectiveness of NbS to address urban challenges. These endeavours can in turn build the necessary conditions for mainstreaming NbS into local policy agendas and spatial planning as the section thereafter outlines. The section also demonstrates the benefits of collaboration across municipal departments as well as across different levels of government. The following section focuses on the community level. Putting communities at the heart of NbS projects has been an integral part of the CLEVER Cities project and is key to ensuring buy-in and continued support for urban nature. The section therefore zooms in on approaches that local governments have used to ensure that NbS interventions benefit all and different means of co-creation and engagement opportunities. The last section of this chapter presents various funding sources that local governments can leverage to implement NbS.



1. Building a solid evidence base for nature-based solutions



1.1 Analysing and prototyping the effectiveness of nature-based solutions

Mainstreaming NbS in municipal decision making and spatial planning requires demonstrating their effectiveness in tackling urban challenges and contributing to more livable urban environments. Access to data is key to this end, which is why local governments such as Guadalajara, Mexico, have made it a priority to collect data on their natural assets. In addition, it necessitates tools and methods that can assess and demonstrate their benefits. For example, data analysis and modelling tools can help pinpoint flood-prone areas where NbS would be most effective, as demonstrated

in the Hamburg, Germany example below. The thermal comfort modelling example from Madrid, Spain, further reinforces the role of NbS' in improving the microclimate in highly urbanised areas. Alongside these types of digital tools, cities can harness the power of prototyping and experimentation. Embracing the credo of 'seeing is believing', temporary interventions can have a profound impact in terms of showcasing the potential of NbS in promoting walking and biking, as illustrated in the Ambato, Ecuador case.

Guadalajara, Mexico: Collecting tree census data

Under the public policy titled 'Guadalajara Ciudad Fresca' (Fresh City Guadalajara), the environmental department of the Mexican city of Guadalajara aims to reduce the growing challenges of urban heat through reforestation. The policy's ultimate objective is to achieve a ratio of one tree per inhabitant. To support the reintroduction of vegetation and improve ecosystem services, the city carried out a tree census and developed a 'Tree Manual' to identify suitable tree species for different areas. This information is made publicly available through the MAPA GDL tool (Guadalajara Map), an online cartography service. It hosts spatial data on the city's territory, hence facilitating data-driven decision making by allowing a better informed selection of priority areas for reforestation.



Guadalajara is part of the Tree Cities of the World program (© Guadalajara Government)

Hamburg, Germany: Using open data to conduct a heavy rainfall analysis

The City of Hamburg's openly-accessible Urban Data Platform (UDP_HH) played a key role in supporting the work of the CLEVER Cities Hamburg team. Encompassing more than 565 up-to-date and geo-referenced data sets (more than 3,700 datasets when also considering development plans), the UDP_HH contains information on thematic areas such as population and society, health, environment, and traffic. Within the CLEVER Cities project, data from the UDP_HH were used to identify and evaluate suitable and relevant locations for nature-based solutions across the project area. For example, the digital terrain model and land use data from the UDP_HH were used to develop a computational hydrodynamic runoff model to simulate drainage characteristics under different rainfall intensities across Neugraben-Fischbek. Based on the results, the team was able to locate areas that were prone to water-logging

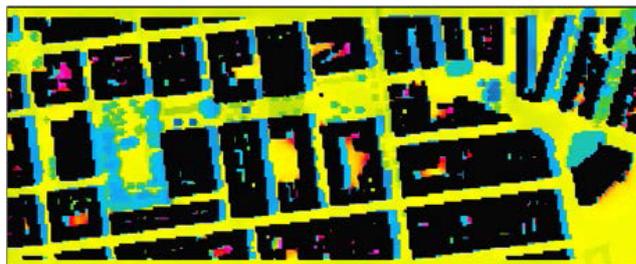


Drainage analysis for Neugraben-Fischbek (© Hamburg Wasser)

and suggest suitable NbS for stormwater management. This led to the implementation of six roadside infiltration beds and various retention dams in the nature reserve to prevent stormwater related flooding. In addition, the data produced within the CLEVER Cities project will be fed into the UDP_HH to enhance the NbS evidence base for future decision-making and urban planning across the city.

Madrid, Spain: Modelling thermal comfort

Within the CLEVER Cities project, a microscale modelling of thermal comfort was conducted to assess the benefits of the envisioned green corridor for Madrid's Usera district. Based on numerical models that take into account factors such as air temperature, solar radiation, humidity, wind speed as well as the presence of shadows and water bodies, the simulations compared corridor re-design options with and without nature-based solutions under current and future climate conditions. The results show that the corridor re-design options including NbS will be able to significantly reduce thermal stress along the route both under present and future climate scenarios.



Thermal modelling of the envisioned green corridor (© Tecnalía)

Ambato, Ecuador: Experimenting NbS with tactical urbanism

The Ecuadorian City of Ambato temporarily re-designed key areas in its urban centre with the support of NbS to promote biking and walking. Over a 15-day period, streets were enhanced with planters containing locally sourced plants and small trees. These planters were designed to ensure the well-being of the plants during implementation without the need for irrigation. Evaluations conducted before and after the project showed an improvement in the walkability index, with the total score increasing from 0.12 to 0.20 (composite index evaluated with e-MAPS) which is high for a tactical low-cost intervention. Furthermore, the assessment of the urban landscape indicated higher ratings in areas where NbS had been introduced compared to comparable areas without NbS. Next to fostering more active lifestyles, the NbS interventions were aimed to establish new areas for tree planting, offering shade and enhancing air quality and the city's overall appearance.



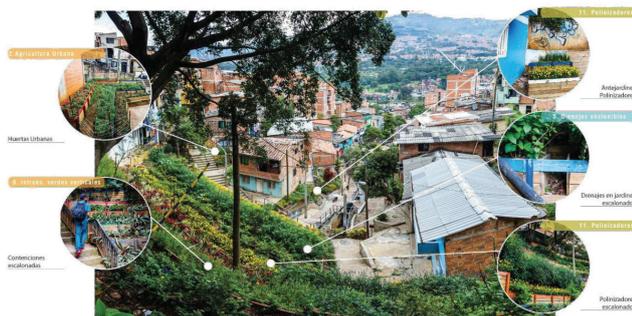
Tactical urbanism site with planters in Ambato (© YES Innovation)



1.2. Monitoring the effectiveness of nature-based solutions

Monitoring is important to evaluate the short and long-term benefits of NbS interventions and contribute to their upscaling across the urban landscape. Identifying and selecting appropriate indicators constitutes one of the first steps local governments have to take. These will depend on the needs and urban challenges that the NbS are expected to address. As a result, they may range from indicators aimed at measuring ecological restoration progress, to labour market benefits to increased human health and well-being. In the below case of Medellín, Colombia, environmental indicators were selected to measure the effectiveness of the city's

renaturalization plan. Many tools and approaches now exist for monitoring purposes. For instance, participatory citizen surveys can be used to assess the psychosocial benefits of NbS interventions on local residents, as outlined in the CLEVER resources box below. In addition, digital technologies such as automated sensors and data loggers present low-cost approaches to monitoring progress on biodiversity protection and enhancement. As evidenced by London, UK, these can be complemented by citizen science projects that engage local residents in monitoring efforts and can contribute to wider open data platforms.

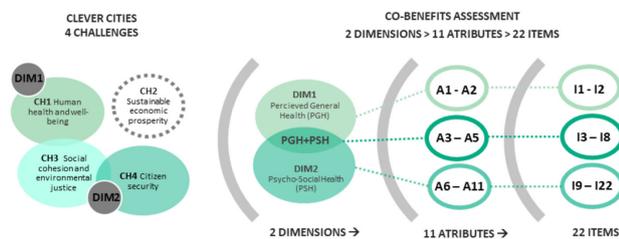


Early interventions in the Quebrada Juan Bobo (© Urban GreenUP project)

Medellín, Colombia: Monitoring the city's renaturalization plan

Medellín is implementing its 'Plan de Renaturalización' in cooperation with the European Commission. The plan encompasses, among others, eco-parks, creek and river bank restoration projects, community gardens, the expansion of wildlife habitats, and the implementation of green walls. The city has started a process to identify indicators to monitor progress over the plan's period 2020-2030. These indicators, to be based upon the methodology Renaturing Urban Plans developed under the project Urban GreenUP, will also be used to communicate with residents on progress made.

CLEVER resources: NbS-CoBAs tool



Initial version and structure of the NbS-CoBAs tool (Herranz-Pascual et al., 2023)

The **tool for NbS psychosocial benefit assessment** ('NbS-CoBAs tool in short) was developed in the framework of CLEVER Cities to assess NbS impact in urban regeneration on perceived health and wellbeing, as well as on social benefits. It encompasses 11 attributes that are assessed through 22 items. These NbS impacts are evaluated through a participatory and co-creation process.

Link: <https://clever-guidance.clevercities.eu/choosing-narrative>

London, UK: Using digital technologies for biodiversity monitoring

In Thamesmead, different tools and methodologies have been tested to monitor the impact of newly-created habitat on local fauna over time. In partnership with ecology experts at RSK Wilding, the CLEVER Cities London team is using AudioMoths to record the sounds of bats and birds at audible and ultrasonic frequencies. Next to this acoustic monitoring technology, DNA analysis methods such as metabarcoding are being used to allow for the rapid assessment of invertebrates. These new technologies offer low cost ways to assess the impact of the NbS interventions on local biodiversity. In addition, the CLEVER Cities London team has engaged local residents in the data collection process through the use of programs such as the BeeWalk Survey Scheme



AudioMoth low-cost, open-source acoustic sensor (© Open Acoustic Devices)

and the Big Butterfly Count. The collected data not only provide a better understanding of species health within the community, they also contribute to UK-wide datasets.

2. Institutionalising nature-based solutions



2.1 Integrating nature-based solutions in urban strategies, plans and regulations

Embedding nature-based solutions in municipal plans, policies and regulations offers the most effective strategy for the city-wide mainstreaming of NbS. Their institutionalisation helps make them resilient to political changes and ensures that they become a core feature of the urban planning toolbox. This section presents various instances of how cities have institutionalised NbS. Within the CLEVER Cities project, an NbS roadmap template was developed and tested in six cities to guide the development of more comprehensive NbS plans, such as the European Commission's envisioned Urban Greening Plans. Amongst others, this has supported Quito, Ecuador, and Belgrade, Serbia, in integrating NbS in key urban planning documents as illustrated

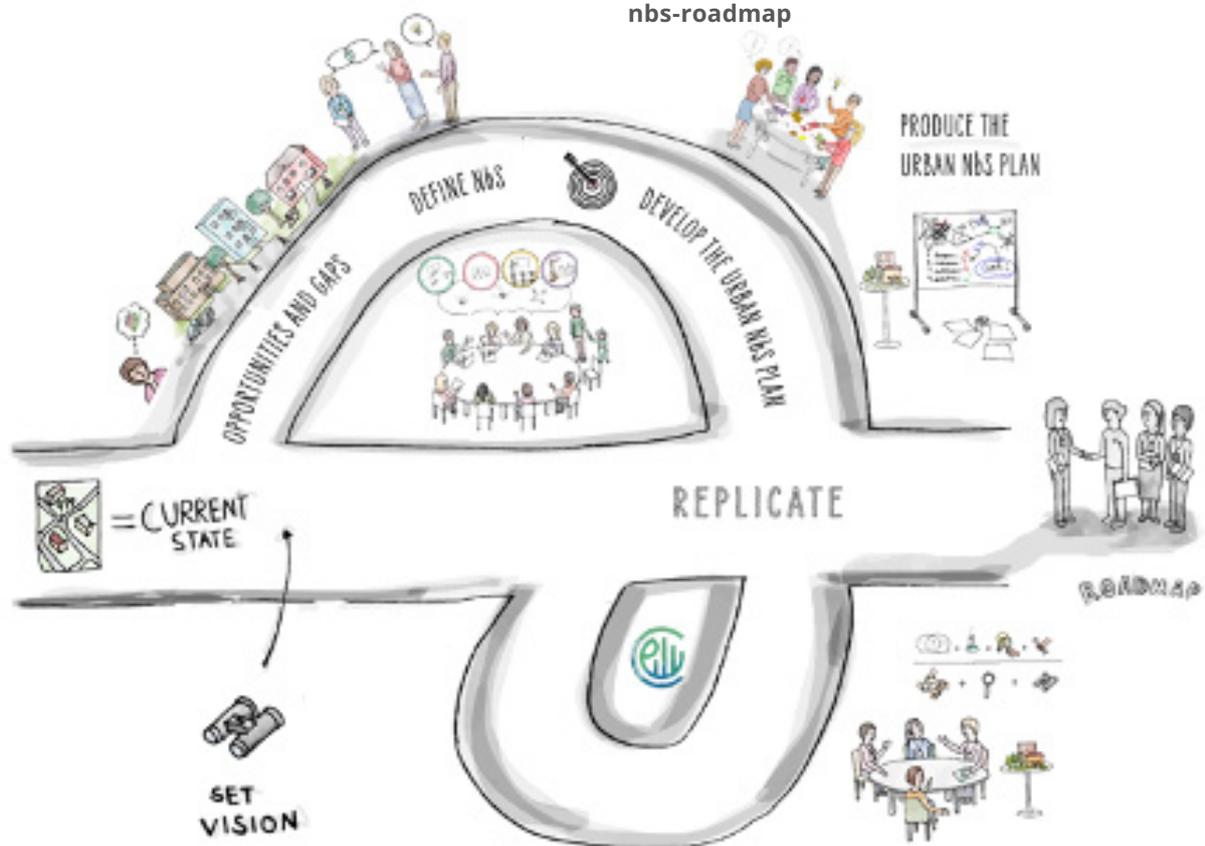
below. The Bosnian City of Banja Luka is ensuring the long-term protection of its urban and peri-urban forests through the creation of and adherence to a dedicated spatial plan. Lastly, the Brazilian City of São Paulo demonstrates that NbS can be integrated in a variety of urban agendas including plans on climate action, local disaster reduction and public housing. Collaboration with other municipal departments improves scalability and maximises their impact across the board. The section is concluded by a brief presentation of the Local Innovation Screening Tool that was developed within the CLEVER Cities project. Ensuring that NbS are innovative and create value is important to garner support for their institutionalisation.

CLEVER resources: NbS Roadmap

An **NbS roadmap** can outline and capture a city's path towards co-creating their own local nature-based solutions plan. It can help cities to create and follow up on their plan of how to overcome identified barriers and challenges and mainstream NbS replication activities into existing local (and/or national) policy, legislative, governance and citizen engagement structures as well as repeat replication activities in other districts.

Within the CLEVER Cities project, an NbS roadmap template was developed and filled in and adjusted by each of the fellow cities (Belgrade, Larissa, Madrid, Malmö, Quito, and Sfantu Gheorghe). Their experiences with replicating and upscaling the NbS roadmaps have also informed the European Commission's Urban Greening Plan Guidance.

Link: <https://clever-guidance.clevercities.eu/nbs-roadmap>



Based on @Veronika Hoffmann, CLEVER Cities

Quito, Ecuador: Embedding NbS in ordinances and plans



Quito Metropolitan Council assembly approving the Green and Blue Ordinance (© Quito Informa)

Including nature-based solutions in municipal plans and ordinances has played a key role in mainstreaming NbS in Quito. Throughout the lifetime of the CLEVER Cities project, the city successfully embedded NbS in its

Metropolitan Land Use and Development Plan 2021-2033 and in its Land Use and Management Plan 2021-2033. While the former document refers to the importance of NbS in terms of its climate change adaptation potential, the latter document positions NbS as key elements in the design of public spaces. NbS have thus become an integral part of long-term planning for the city. In terms of ordinances, the city was able to pass an ordinance on urban trees and Ordinance 041 which provides a regulatory framework for protecting and promoting urban vegetation in alignment with Quito's Urban Green Network. Most importantly, however, the city was able to put the Blue and Green Ordinance (Ord. No. 060-2023) into practice when it was approved on July 4th, 2023. This ordinance further strengthens the role of NbS as a means to advance urban biodiversity conservation and climate resilience through the implementation of green and blue infrastructure.

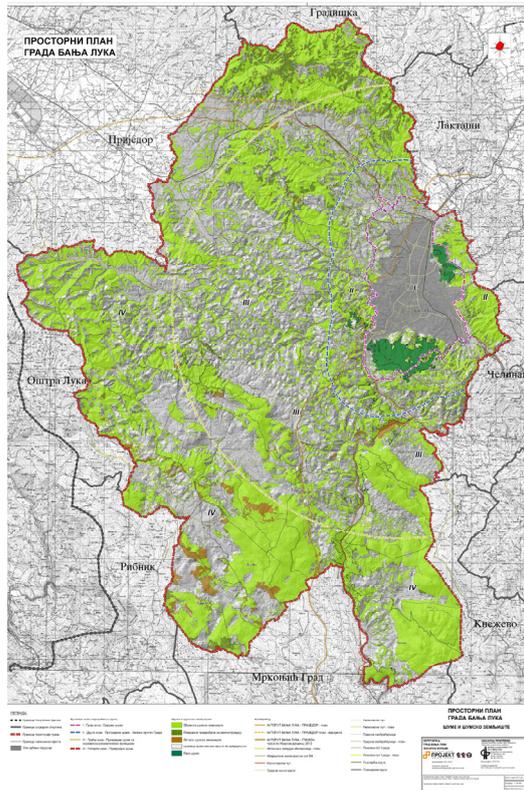
Belgrade, Serbia: Integrating NbS in urban planning practice

The City of Belgrade incorporated NbS elements in its 'Plan of Detailed Regulation of the Linear Park' with the support of the CLEVER Cities project. The plan is nested under Belgrade's overarching 'Plan of General Regulation' and defines the building and development rules pertaining to the conversion of a derelict railway track into a green corridor. The 4.6 km long railway track runs through residential and industrial zones of the Dorćol and Palilula districts along the Sava and Danube

rivers. The NbS elements integrated in the official urban planning document include several types of gardens, facilities for birds and other animals, green sound barriers and sites for urban agriculture and beekeeping. In addition, the document specifies the requirement to use native plant species that are compatible with the local environment. The plan was officially adopted by the city assembly in August 2021 and construction commenced in 2022.



Composition plan of a section of the Linear park (© Belgrade Urban Planning)



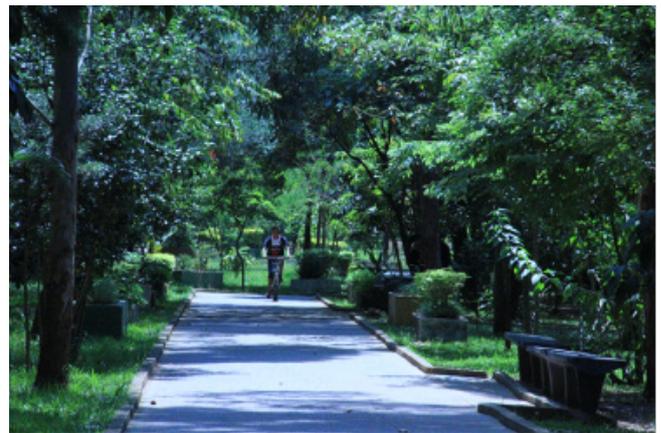
Banja Luka, Bosnia: Using spatial planning to protect forests

In 2014, Banja Luka adopted a spatial plan which divides the city's forested land into four zones and allocates specific usages to each category. The first zone includes all of the forests classified as 'urban forests', which are primarily used for everyday recreation. The areas in this zone are also considered opportune locations for new city parks. The second zone comprises the Green Belt of the city, referred to as the 'Green Horseshoe' in the local language. The zone is composed of suburban forests, and holds the potential of connecting non-urban parks through green corridors with the aim of revitalising the primeval mountain oak ecosystems. The third zone represents commercial forests with dominant recreation zones while the fourth zone encompasses all forests outside of the first three zones and focuses on intensifying types of recreation. These last two zones allow for some level of recreational and tourism activity such as paragliding, alpinism, mountain biking, photo safaris, and hiking.

Map of forests and forest land (© City of Banja Luka)

São Paulo, Brazil: Teaming up across departments

São Paulo faces many challenges related to land use planning, social dynamics, and limited public spaces. In order to tackle these issues, the city promotes linear parks as an instrument to support cross-sectoral policies. The initial 2006 plan proposed 20 parks throughout the city to address environmental problems such as flood mitigation, water services preservation and river recovery. Additionally, these parks were aligned with plans to address societal challenges, such as controlling urban expansion and re-organizing housing to achieve safer neighbourhoods. Since then, the city has been making efforts to highlight the synergies between environmental approaches and societal needs.



Internal view of Tiquatira Linear Park (© Municipal Secretary of Green Areas and the Environment of São Paulo)

CLEVER resources: Local Innovation Screening Tool (LIST)

The **Local Innovation Screening Tool (LIST)** is a web tool designed to aid urban planners and municipal administrations in enhancing innovation during the implementation of nature-based solutions. Developed for the CLEVER Cities project, LIST is designed to help capitalise on synergies between the NbS interventions (monitoring, management, methods and materials) and local capacities (place, people, platforms, prosperity). The tool highlights relevant starting points and existing gaps.

Within the CLEVER Cities project, the LIST has provided support to its partner cities London, Milan and Hamburg in moving towards a new and improved approach to urban regeneration through NbS. The tool also aided the partner cities of Malmö, Madrid, Larissa, Belgrade, Sfantu Gheorghe, and Quito in creating value by considering innovation in their designing of NbS and future NbS action plans.

Link: <https://clever-guidance.clevercities.eu/utilising-existing-tools>

2.2 Collaborating with different levels of government and neighbouring cities

Teaming up with different levels of government and across jurisdictions can lend further support to the institutionalisation of NbS. NbS interventions at the local level contribute to national policy goals and strategies as well as international agreements such as the Paris Agreement and the Kunming-Montreal Global Biodiversity Framework in the climate and biodiversity spheres, respectively. Cities can leverage these synergies by tapping into national and international schemes that provide further resources for NbS implementation

and maintenance. The below example from Dongying, China, illustrates the benefits of partnering with the national government and international level to boost protection and enhance recognition of its unique Yellow River Delta. In addition to vertical collaboration between different levels of government, cities can also engage in horizontal cooperation. This is particularly suitable and beneficial where NbS span across local jurisdictions, as the case example from Santo Domingo de los Tsáchilas, Ecuador, shows.



The Yellow River running through Dongying (© Dongying News)

Dongying, China: Working at the national and international level to protect the Yellow River Delta

The City of Dongying is located in the Yellow River Delta which constitutes the most extensive estuarine wetland ecosystem in China's warm temperate zone. In an effort to protect and restore the delta, the city administration has put in place several policies and regulations and heavily invested in ecological restoration projects. In addition, it has leveraged national and international schemes. At the national level, it has sought the establishment of the Yellow River Estuary National Park which was approved in October 2021, covering an area of

3,522.91 km². At the international level, the city applied for accreditation as an International Wetland City under the intergovernmental Ramsar Convention of Wetlands. In November 2021, it also submitted an application for the delta's recognition as 'China's Yellow Sea (Bohai Sea) Migratory Bird Habitat' under the UNESCO World Heritage Convention. All these measures provide further support in protecting the Yellow River Delta and ensuring its long-term sustainability.



Meeting under the Provincial System of Conservation Areas (© Santo Domingo City Hall)

Santo Domingo de los Tsáchilas, Ecuador: Collaborating across jurisdictions to combat deforestation

Santo Domingo de los Tsáchilas joined forces to develop a well-structured environmental and climate governance system at the regional level to combat deforestation. Through the creation of the Provincial System of Conservation Areas (SPAC), Santo Domingo de los Tsáchilas is able to work with neighbouring municipalities to link protected areas at the provincial level, promote biodiversity protection in regional planning and partner with the national government on large conservation projects.



3. Putting communities at the heart of nature-based solutions

3.1 Acknowledging particularities and vulnerabilities

NbS do not always benefit all residents equally and may even result in negative impacts, for example where urban greening efforts lead to gentrification through rent increases. Therefore, nature-based solutions need to be planned with different residents categories in mind to avoid adverse effects on vulnerable groups. To this end, the Argentinian City of Buenos Aires has

developed diagnostic tools to better understand and guide its public space design in an effort to create green spaces for all. Similarly, the City of Athens, Greece, has made sure to place NbS for urban cooling where they benefit residents that are most vulnerable to urban heat island effects.



Visualisation from the Public Spaces Design Manual with a Gender and Diversity Perspective (© City of Buenos Aires)

Buenos Aires, Argentina: Centering diversity in NbS development

The Argentinian city of Buenos Aires has developed a co-creative and participatory approach to public space design and implementation that takes into account diverse groups of residents. This has for instance culminated in the development of the 'Urban Quality Index with a Gender Perspective'. The diagnostic tool has been developed as an essential instrument for conducting assessments and territorial analyses. By utilising a diverse set of indicators, it becomes possible to pinpoint areas with specific issues that disproportionately impact individuals based on their gender. In addition, the city created the 'Public Spaces Design Manual with a Gender and Diversity Perspective' to ensure the integration of diversity in its design approaches.

Athens, Greece: Focusing on vulnerable groups

Through its 'Heatwave Action Plan' launched in 2016, Athens identified and addressed priority areas of urban heat risk. The baseline research showed that the areas with the least percentage of green space are also those that experience the most heat and host residents most

at risk, i.e. elderly people and low-income households. Measures of adaptation and mitigation were planned, with a strong focus placed on greening vulnerable areas through pocket parks, green roofs, green corridors, and other types of green spaces.



Design of a green corridor and square in Lamprini, Athens (© DATSARCH)

3.2 Participation and co-creation

Co-creation is a key process for the equitable design and implementation of NbS. The term refers to a collaborative approach which brings together diverse actors with different knowledge and backgrounds, working together toward a shared outcome or goal. In the context of urban regeneration and NbS, co-creation entails the involvement of stakeholders and citizens in relevant decision-making processes alongside local authorities and other municipal actors. By involving diverse stakeholders in all stages of the NbS project lifecycle - i.e., design, implementation, maintenance, and monitoring - co-creation ensures that NbS align with the needs of the people they serve. This ultimately fosters a sense of ownership and acceptance, and enhances NbS sustainability and the delivery of social benefits.

This section presents resources and good practice examples that cities can draw inspiration from when implementing their own co-creation processes. It begins by introducing the CLEVER Cities Co-creation Guidance, along with its accompanying 16-step co-creation pathway, which has guided the project's frontrunner cities in their respective journeys. Acknowledging that co-creation is never a linear endeavour, Milan, Italy, had

to continuously revise and adapt its citizen engagement strategy throughout the CLEVER Cities lifetime, as illustrated below. Similarly, there is no one-size-fits-all approach when it comes to co-creation, as different types of stakeholders require different means and levels of engagement. London, UK, decided to establish an overarching citizen engagement programme and provide direct financial support for community-led NbS projects. In Hamburg, Germany, the digital participation tool DIPAS was employed to collaboratively identify suitable locations for NbS interventions and consult residents on NbS designs options. Where co-creation is generally met with scepticism, it might be beneficial to create partnerships and forge synergies with more mainstream formats. To this end, the Greek city of Larissa made use of a local arts, music and culture festival to engage residents in NbS co-creation. Ultimately, participation and co-creation initiatives that engage with local stakeholders aim to ensure enduring commitment and support for NbS interventions. The Hongxu Habitat Garden in Shanghai, China, exemplifies how co-creation can lead to the sustained stewardship of an NbS project well beyond its initial implementation.

CLEVER resources: Co-creation Guidance

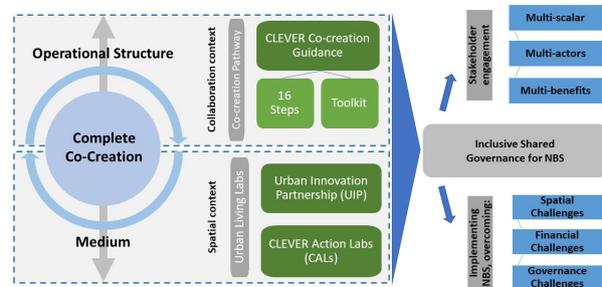
The **CLEVER Cities Co-creation Guidance** offers valuable advice and resources for local authorities looking to conceive and implement NbS in collaboration with their local communities and stakeholders. Structured around its **16-step co-creation pathway**, the guidance is intended to be flexibly adapted to different cities' contexts and includes a toolkit to support cities in their co-creation endeavours.

Link: <https://clever-guidance.clevercities.eu/evaluating-co-creation-process>

Research on co-creating nature-based solutions

The co-creation processes undertaken within CLEVER Cities have been the subject of various scientific publications. Take a look at the list below:

- **Integrated Collaborative Governance Approaches towards Urban Transformation: Experiences from the CLEVER Cities Project** (Bradley, Mahmoud & Arlati, 2022)
- **Stakeholder Participation in the Planning and Design of Nature-Based Solutions. Insights from CLEVER Cities Project in Hamburg** (Arlati et al., 2021)
- **Co-creation Pathway for Urban Nature-Based Solutions: Testing a Shared Governance Approach in Three Cities and Nine Action Labs** (Mahmoud & Morello, 2021)
- **Multi-Level Perspective on Sustainability Transition towards Nature-Based Solutions and Co-Creation in Urban Planning of Belgrade, Serbia** (Mitić-Radulović & Lalović, 2021).



Concept of the complete co-creation for NbS implementation (Mahmoud & Morello, 2021)

Milan, Italy: Ensuring adaptable co-creation

Throughout the process of co-creating green roofs, green walls and urban parks in Milan, Italy, CLEVER Cities Milan came to understand that co-creation is never linear and therefore requires flexibility. Rather than adhering to a strict pre-ordained path, CLEVER Cities Milan approached NBS through “learning by doing”. By working with the community, CLEVER allowed the phases of co-design, co-implementation, co-monitoring, and co-management to inform each other. This resulted in project redesign when necessary and enabled thoughtful consideration of the relationship between the NbS projects and the local stakeholders. This flexibility also fostered resilience to disruptive events such as delays in construction, administrative barriers, and new emerging opportunities. For instance, during the Covid-19 lockdowns in Milan, CLEVER Cities adjusted to continue the co-creation process online through workshops and the use of digital collaboration tools.



Co-design path in Ponti (© Municipality of Milan)

London, UK: Establishing the ‘Making Space for Nature’ programme and community fund

At the outset of the CLEVER Cities project in 2018, the London team established the public-facing Making Space for Nature programme to engage local civil society groups and residents in the co-creation and implementation of NbS for Thamesmead. Next to organising monthly Nature Forums, delivering outdoor learning experiences at a nearby nature reserve and providing volunteering opportunities, this included the launch of the Making Space for Nature micro-grant programme. Through this programme, Thamesmead residents have access to funding ranging from £200 to £2,000 for the implementation of greening projects. Individual residents as well as charities, social enterprises, schools and community interest companies are eligible to apply. The micro-grants can be used to cover costs related to materials, workers, space of workshops, marketing, training and equipment. Projects include, among others, the set up of edible gardens, bird watching walks, seed sharing clubs, collective planting of balconies and food growing training. Thanks to the micro-grants, over 30 community projects have been financed to help connect people in Thamesmead with nature, wildlife and the landscape.



‘Making Space for Nature’-branded seed packets (© Richard Heald)

Hamburg, Germany: Enhancing citizen participation with digital technologies



Local residents use the DIPAS tool during an information evenings (© Asja Caspari)

The CLEVER Cities Hamburg team used a variety of different tools and methods to engage citizens in the co-creation of the nature-based solutions for Neugraben-Fischbek, including the digital participation system DIPAS. Built on data from Hamburg’s Urban Data Platform, DIPAS allows citizens to obtain up-to-date information about ongoing urban planning projects, access digital maps, aerial photos, 3D models and other geodata and contribute precisely localised feedback, ideas, and criticism. During the first participation and consultation workshop with citizens in 2018, the tool was used to show the project area and invite residents to suggest locations and ideas for green and social improvements across Neugraben-Fischbek. Furthermore, DIPAS was used to gather ideas for the design of the nature experience playground in 2020 and to collect feedback on the CLEVER Parcours in 2022.

Larissa, Greece: Identifying local synergies to overcome barriers to co-creation

One of the main project goals of CLEVER Fellow City Larissa was to overcome citizens' reservation to participate in NbS co-creation activities. For this purpose, the CLEVER Cities Larissa team sought synergies with other projects and events that are taking place in the Greek city. Having used the CLEVER co-creation tools and methods in the climate change adaptation project 'LIFE-IP AdaptInGR' gave the team insights into how co-creation activities could be tailored to include a broad and diverse audience. To put this into practice, the team linked up to the Pinios River Festival, an annual four-day arts, music and culture festival that takes place in Larissa's Pinios' riverbed. As part of the festival, it conceptualised and hosted a modular workshop combining input and elements from both CLEVER Cities and 'LIFE-IP AdaptInGR' to engage citizens of different ages and levels of knowledge on the topics of NbS for climate change adaptation and urban regeneration. The modular form allowed a better flow of themes and introductions, giving space for discussion, and helping participants to relate and identify their expertise in addressing "big issues". Forging synergies with similar municipal programs and leveraging fun and engaging formats has helped the CLEVER Cities Larissa team to address residents' hesitation to participate in co-creation endeavours.



Modular workshop during the Pinios River Festival (© Department of European Programs of the Municipality of Larissa)

Shanghai, China: Co-creating a community garden in Hongxu

In response to the wider urban regeneration actions in Shanghai, Hongxu's Public Housing department co-created a habitat garden in the neighbourhood with community-based organisations. The co-creation and participatory process of the Hongxu Habitat Garden Initiative brought different actors into the design stage,

and continuously promoted communications and exchanges to keep the community engaged in the garden throughout the different steps of implementation. This resulted in residents and community organisations still being actively engaged in the community garden which was completed in 2019.



Shanghai Hongxu community garden (© Xianxia Xincun Community)

3.3 Communication and education in support of nature-based solutions

The visibility of NbS offers opportunities to communicate their multi-functionality and ability to contribute to various policy arenas such as climate change adaptation, public health, nature protection and economic development. They offer practical ways to raise awareness within communities about the value of the natural environment. Within the CLEVER Cities project the collaboration with schools and education

centres has played a key role in sensitising the next generation to become environmental stewards. This section showcases how Hamburg, Germany and Sfântu Gheorghe, Romania, have used NbS for environmental educational purposes and how London, UK, has increased awareness of NbS for human health and well-being.

Hamburg, Germany: Informing school curricula through NbS

Alongside local stakeholders, experts, and educational institutions, CLEVER Cities Hamburg created school gardens in three schools, with the goal of providing spaces for environmental education for both students and for the larger community. As a result of these interventions, local educators have integrated NbS interventions into the school curricula. For instance, students learned about the concept of NbS through the development of multi-generational bee-friendly shrub beds, and teachers explained aspects of an aquaponics project in biology lessons. In addition to creating playful, artistic opportunities to engage in the space, the work of CLEVER Cities has contributed to the development of other NbS projects, thereby giving young residents a sense of involvement in the environment in their



Co-designing the school garden model during the Urban Innovation Partnership event (© Steg mbH)

communities. By teaching young residents about sustainability and the importance of nature, CLEVER and its partners aim to build long-term community buy-in, thereby ensuring the longevity of these interventions and the potential for future involvement in nature and sustainability.

London, UK: Improving health outcomes with NbS

CLEVER Cities London hosted an event for 240 local students in Thamesmead to discuss and learn about the relationship between green spaces and mental health. Nature-based solutions, such as the Edible Garden and Tiny Forest in Thamesmead, enable residents to be more physically active, and spend more time outside, all while engaging with other members of their communities. These behaviours support both physical and mental health, which was especially necessary throughout the COVID-19 pandemic. In this time, open green spaces provided residents with places to meet others outdoors and to engage in recreational activities like afternoon walks. By engaging young residents in conversations



Young students in Thamesmead (© Richard Heald)

about the health benefits of NbS, CLEVER aims to inspire long-term commitments to contributing to the greening of their own communities.

Sfântu Gheorghe, Romania: Conducting environmental education for local children

The municipality of Sfântu Gheorghe, a CLEVER Fellow City, is working with local partners to host children's environmental education opportunities in order to foster love and respect for the natural environment. As a component of restoring the degraded urban environment of the flood prone Debren River area, CLEVER Cities Sfântu Gheorghe is using these education programs to facilitate long-lasting personal connections between the residents and the local environment. This is especially geared towards children living in the flood prone Debren River area, many of whom are also members of marginalised populations, such as the Roma



Invitation to educational event (© CLEVER Cities Sfântu Gheorghe team)

community. The educational programming has included a drawing competition on urban greening and a visit to the city's Hunting Museum, where 20 children aged 6-12 took part in several educational and interactive activities about the environment and conservation of nature.

4. Leveraging finance for NbS implementation

While the vast majority of NbS are funded directly through public budgets, there is a diverse and growing range of financing solutions that can provide upfront and ongoing funding sources for NbS projects. The NbS funding landscape now includes local and national governments, philanthropy and charity, commercial and social impact investors, private companies and even citizens. This variety reflects the diversity of NbS that can be implemented locally, from green roofs to coastline adaptations, linear parks and community gardens. Across the board, underlining the value and benefits generated by NbS, such as public health and well-being, climate mitigation and adaptation and revenue generation, forms a compelling case to secure funding.

This section highlights the three main sources of funding for the CLEVER Cities NbS interventions and how they were leveraged in practice by Hamburg, Milan and London. We conclude by referring to two key outputs of the CLEVER Cities project that provide a more comprehensive account of different financial strategies and mechanisms for implementing and maintaining urban NbS.



CLEVER resources:

Report on Governance, Business & Finance models

The financing section of this CLEVER Cities report delves into exploring the funding sources and financial strategies applicable to NbS projects of varying sizes and types. Structured around six key steps, it offers a methodological approach that culminates in the creation of a financial plan. These steps are:

1. Selecting the NbS,
2. Understanding the benefits of NbS,
3. Identifying funders,
4. Identifying funding types,
5. Identifying financing mechanisms, and
6. Building a financial model.

Link: https://clevercities.eu/fileadmin/user_upload/Resources/D5.3_Governance_business_and_finance_models.pdf

CLEVER Solutions Basket

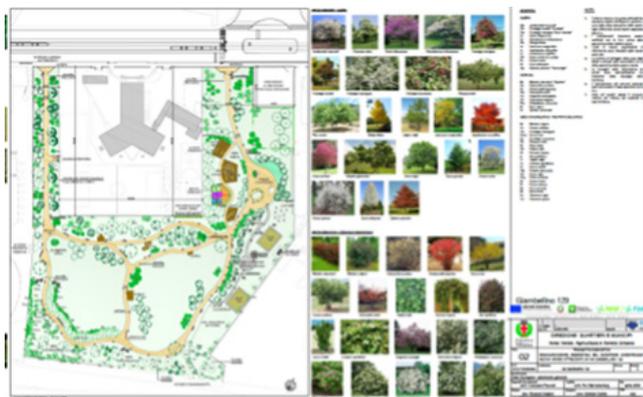
The CLEVER Solutions Basket provides an overview of the NbS interventions and the accompanying financing models that Hamburg, Milan and London chose to put them into practice.

Link: <https://clever-guidance.clevercities.eu/clever-solutions-basket>

4.1 Public sector funding

Funding from the public sector is an especially well-suited financing model for measures which provide main benefits for the public and no exclusive benefits, i.e. everybody can access and benefit from the NbS.

Thereby, pooling financial resources from different municipal departments as well as from different levels of government constitute viable options for many NbS interventions.



Giambellino 129 Park final project design (© Milan CLEVER Cities team)

Public funds in use in Hamburg, Germany and Milan, Italy

Leveraging public sector funding across different levels of government has been a common financing model within the CLEVER Cities project. In Hamburg, for example, the newly-erected nature experience playground was financed by combining EU-level funds with municipal funds. The CLEVER Cities Milan team opted for the same two sources of funding for the envisioned revitalization of its Giambellino 129 park. In both cases, the general public constitutes the primary beneficiary of the NbS projects, hence making public funding the go-to solution.



Fruit meadow orchard with local apple trees in Hamburg
(© Steg mbH)

4.2 Philanthropy funding

Philanthropic funding can be leveraged specifically where the goals and objectives of the NbS intervention align with those of the charitable organisation in question. These can for example be local charities that care for the prospective beneficiaries of the NbS measure or focus their philanthropic work on causes such as environmental conservation, community development or education - all of which NbS can contribute to.

Philanthropic funds in use in London, UK and Hamburg, Germany

The CLEVER Cities London team partnered with environmental NGO Earthwatch to leverage their corporate sponsorship funding for the creation of the Tiny Forest. In Hamburg, the CLEVER Cities team collaborated with the Rüm Hart Foundation which is dedicated to environmental causes to establish an apple tree orchard in Neugraben-Fischbek. The Hamburg-based foundation donated the rare and regional apple trees for planting.

4.3 Private sector funding

Funding from the private sector is most suitable where there is a compelling business rationale for their participation. This is for example the case where their business operations are directly depended on nature (e.g. companies operating in nature-based tourism) or

where they would exclusively benefit either from value creation (e.g. increase in property value through NbS) or cost savings (e.g. lowered energy costs through green roofs and walls).

Private funds in use in Hamburg, Germany and Milan, Italy

Within the CLEVER Cities project the private sector primarily played a role with respect to green roofs and walls. In the CLEVER Cities project area in Hamburg, the bee-friendly qualification of an existing extensive green roof was co-financed by the building owner. Similarly, EU-funding was combined with resources from the city-owned housing company SAGA to install a green facade on one of their buildings. Moreover, the housing company will be financially responsible for the upkeep of the nature-based solution. In Milan, the CLEVER Cities team launched a public call that building owners could apply for to request a contribution for the co-design of a green roof or wall for their property. This could be combined with Milan's municipal energy retrofitting subsidy and their own funding to then put the green roof or wall into practice.



Facade structure in the motif of a butterfly (© BA Harburg)

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CONTACT



Email
info@clevercities.eu



Website
www.clevercities.eu

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Authors:
Olga Horn (ICLEI World Secretariat), Luísa Acauan Lorenz (ICLEI South America), Marion Guénard (ICLEI World Secretariat)

Co-authors & case study contributors:
Maggie Armstrong (formerly ICLEI World Secretariat), Kelly Dai (ICLEI East Asia Secretariat), Jinfeng Du (Xi'an Jiaotong University), Nicolas Salmon (YES Innovation), Daniel Bonilla (City of Quito), Kassia Rudd (ICLEI Europe), Daniela Rizzi (ICLEI Europe), Ana Simić (CEUS), Ana Mitic-Radulovic (CEUS), Martin Krekeler (City of Hamburg), Bianca Lüders (City of Hamburg), Martina Zimpel (City of Hamburg), Johannes Robert (steg

Hamburg), Nicola Murphy-Evans (City of London), Stella Yeung (City of London), Sean Bradley (Groundwork), Emilia Barone (City of Milan), Myriam Alice Lunghini (City of Milan), Israa Mahmoud (Polimi), Helen Nilsson (City of Malmö), Carolina, Maria Nikolaidou (City of Larissa), Luís Tejero Encinas (City of Madrid), Marie-Christin Rische (HWWI), Igone Garcia Perez (Tecnalia), Carolina Cantergiani (Tecnalia), speakers of the UrbanByNature China, Latin America & South Eastern Europe webinar series

Reviewers:
Natalia Burgos Cuevas (Ecologic Institute), Dr. Magashen Naidoo (ICLEI World Secretariat), María Alonso Martínez (ICLEI World Secretariat)

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