

# Nature-based solutions for sustainable urban development

ICLEI Briefing Sheet - Nature-based Solutions

Planting trees to improve urban air quality, converting disused brownfield sites into parks, greening roofs to reduce buildings' energy use, and restoring degraded wetlands to prevent floods: Nature-based solutions are increasingly being implemented in urban areas to enhance resilience, support sustainable development, and safeguard biodiversity. This Briefing Sheet showcases good practice examples from Germany and China which demonstrate the social, environmental, and economic benefits that nature-based solutions can offer in urban areas.

## Key messages

- Nature-based solutions (NBS) are increasingly deployed to address the multiple challenges urban areas are facing and accelerate sustainable urban development. They constitute 'smart' green infrastructure solutions aimed at increasing the resilience of a city with regard to disaster risk reduction and climate change adaptation. Moreover, they are deployed to advance urban renewal processes and the regeneration of neglected and degraded areas to enhance the livability of a city.
- Nature-based solutions and green infrastructure are multi-functional. As opposed to single-purpose grey infrastructure options, they offer numerous co-benefits in terms of public health, social cohesion, urban biodiversity, climate change mitigation, etc. creating win-win solutions for the environment, society, and the economy.
- Nature-based solutions and green infrastructure provide cost-effective and resource-efficient approaches to urban sustainability challenges. The additional direct and indirect benefits generated by nature-based solutions are likely to exceed the costs of implementation and maintenance once they are accounted for.
- To leverage their full potential across the entire fabric of the city, the integration of nature-based solutions needs to be mainstreamed. This requires establishing an evidence base for NBS, advocating their public benefits, and engaging with stakeholders for policy development and urban planning. To operationalize policy into practice, conventional and novel finance mechanisms such as green bonds and taxes need to be secured.



Figure 1: Urban green and grey infrastructure in Xiamen, China

## The relevance of nature-based solutions in an urbanized world

Cities face a myriad of social, economic and environmental challenges that are expected to be exacerbated by increasing urbanization and the impacts of climate change. Over the past few decades, the large-scale replacement of natural ecosystems with built-up areas has put cities and their surroundings under increasing pressure in terms of resource scarcity, degraded air and water quality, reduced availability of green space, socio-economic inequality, etc. In addition, rising global temperatures have led to an increase in the frequency and intensity of natural disasters such as floods, droughts and heat waves leaving densely-populated areas, their citizens and critical infrastructure particularly vulnerable.

Nature-based solutions such as green roofs, floodplains, open green spaces, urban trees and bioretention swales constitute effective means of addressing these challenges. In addition, they safeguard urban biodiversity and increase the attractiveness and quality of life experienced in urban areas.

### Overview of key concepts and approaches that have gained prominence in the urban context:

**“Ecosystem services** are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling.” (*Ecosystem Millennium Assessment, 2005*)

**“Nature-based solutions** 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.” (*International Union for Conservation of Nature, 2016*)

**Green infrastructure** “is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces and other physical features in terrestrial and marine areas. On land, Green Infrastructure is present in rural and urban settings. [...] It can sometimes offer an alternative, or be complementary, to standard grey solutions.” (*European Commission, 2010*)

**Ecosystem-based approaches to adaptation** refer to “the use of biodiversity and ecosystem services to help

people adapt to the adverse effects of climate change as part of an overall adaptation strategy” (*Convention on Biological Diversity, 2009*) while Ecosystem-based approaches to mitigation refer to “the use of the carbon storage and sequestration service of ecosystems to aid climate change mitigation.” (*UNEP-World Conservation Monitoring Centre, 2011*)

## Nature-based solutions for increased urban resilience

Adapting to climate change and improving urban resilience to extreme weather events and natural hazards are crucial strategic goals for cities, towns and metropolises all over the world. While the challenges differ depending on the local and regional context, nature-based solutions in their entirety offer the potential to address them, either on their own or coupled with man-made, grey infrastructure solutions. Measures include the conservation, restoration and management of natural urban and peri-urban ecosystems and the integration of environmental features throughout the urban fabric. These nature-based solutions provide the crucial regulating and supporting ecosystem services that enhance resilience as the following examples demonstrate:

- Nature-based solutions are able to mitigate heatwaves which are more pronounced in built-up areas due to the high heat absorption of grey infrastructure: Urban trees decrease inner-city ambient air temperatures, green corridors offer better ventilation and green roofs and walls enhance occupants' thermal comfort.
- Areas suffering from coastal flooding and erosion benefit from the restoration and management of saltmarshes, wetlands, mangroves and oyster reefs. These natural ecosystems form a buffer between sea and land which reduces wave intensity and prevents erosion.
- Permeable surfaces, green roofs, riparian forest systems and floodplains reduce the adverse effects of severe rainfall events. By absorbing excess rainwater they lower the risk of inner-city flooding and water-logging. Rain gardens, bioretention swales and constructed wetlands collect and remove pollutants from the stormwater. Combined with underground cisterns, the purified runoff can be stored for re-use during periods of drought to prevent water scarcity.
- Urban areas located in valleys or on hillsides are better protected by planning with nature. Measures such as the maintenance of vegetative cover and afforestation along slopes stabilize soils which in turn mitigates landslides and avalanches induced by extreme weather events and natural disasters.

## Stuttgart: Germany's 'coolest' city

Situated in a valley with a mild, temperate climate and low wind speeds, the southern German City of Stuttgart is particularly prone to the urban heat island effect and poor air quality. To better deal with these challenges and prepare for a warmer future, Stuttgart has implemented a comprehensive set of nature-based solutions coupled with key regulatory policies and incentive schemes. For example, green ventilation corridors have been created to enable fresh air to sweep down from the city's surrounding hills.



Figure 2: The green roof on Stuttgart's town hall

Prioritizing public health considerations over additional property tax revenues, construction is banned in strategic areas so as not to compromise the effectiveness of these green aeration corridors. A leading pioneer in the realm of green roofs, Stuttgart boasts over two million square meters of vegetated roofs which absorb pollutants and reduce excess heat. Since 1986, the local government has required any new building with a roof pitch below 12 degrees to be equipped with a green roof – a regulation that was extended in 1993 to encompass all new buildings. Tax incentives and tailored financial programs have further contributed to the city's green roof expansion strategy.

## Shenzhen's Sponge City transition

Shenzhen City, situated in China's subtropical south, is faced with heavy downpours during the monsoon season and water scarcity due to pollution and periods of drought. To address the dual challenge, the local government has long turned to nature-based solutions, particularly during the construction of its Guangming New District. Guangming's People's Sports Center, for example, is equipped with a green roof, raingardens and permeable pavement capable of capturing over 60% of annual rainfall. In 2011, the district was recognized as China's first low-impact development model town in storm water management. To further spur the city's ecological transition, it was selected to take part in the national Sponge City program<sup>1</sup> providing Shenzhen with an additional 1.5 billion yuan (205 million Euros) in subsidies over three years. The action plan set up by the local government foresees the re-designing of an additional 256 square kilometers in 24 areas in a water-sensitive way.



Figure 3: Shenzhen's peri-urban wetland

<sup>1</sup> For further information on China's Sponge City program, please refer to ICLEI's Briefing Sheet titled: "China's Sponge City concept: Restoring the urban water cycle through nature-based solutions"

## Nature-based solutions for urban regeneration

Availability of and access to urban green space are important indicators assessing the livability of urban areas. Local governments are increasingly turning to nature-based solutions to provide attractive settings and to enhance the quality of life, health and well-being of their residents. Examples include:

- The number of inner-city lanes is reduced to make space for green belts that improve air quality and encourage the use of alternative means of transportation.
- Polluted and degraded lakes, rivers and wetlands are restored to near-natural systems simultaneously increasing water quality and property values.

In addition, nature-based solutions are used to spur urban renewal processes through the regeneration of deprived and neglected residential and industrial areas. This becomes especially relevant for cities undergoing a post-industrial transition. Examples include:

- Former factory sites and disused infrastructure are torn down and de-toxified using bioremediation. In turn, they are transformed into parks and open green spaces for recreation.
- Abandoned land is converted into community gardens and urban farms to enhance social cohesion and regenerate disadvantaged urban areas.

## European Green Capital 2017: Essen's transition from grey to green

The City of Essen, located in Germany's former industrial heartland, the Ruhr Metropolitan Area, has reinvented itself from a grey, industrialized city to a green city with a high quality of life. While the urban landscape is still spotted with marks from its coal and steel past, hundreds of hectares of green space have been created over the past decades through the conversion of disused factory buildings and mining facilities. The former site of the Krupp cast steel factory, for example, was transformed into a 230 hectares green belt stretching from the city center to the district of Altendorf, while the adjacent industrial wasteland was turned into an 11 hectares addition to the Krupp Park. The gradual ecological restoration of the Emscher River and its tributaries which historically served as open sewers further contributes to Essen's goal of enabling every resident to access the city's green and blue infrastructure network within a range of 500 meters. By 2020 the conversion of the degraded river system into close-to-nature water bodies will largely be completed. In recognition of Essen's achievements and high ambitions the city was named European Green Capital 2017 and serves as a role model to other post-industrial cities striving for urban renewal and regeneration.



Figure 4: Essen's Krupp Park

## The multi-functionality, value and cost-effectiveness of nature-based solutions

Nature-based solutions are also dubbed ‘no-regret’ solutions since they are multifaceted offering a plethora of co-benefits in addition to the purpose they are intended for. As the following examples show, these include social, environmental and economic benefits drawn from the diverse portfolio of ecosystem services that nature-based solutions provide:

- Green walls and roofs foster urban biodiversity and improve the attractiveness of an area in addition to lowering tenants’ cooling costs.
- Forests and vegetation in and around urban areas sequester carbon, regulate the micro-climate, purify the air and reduce urban noise. In addition, spending time in nature and in direct contact with natural elements enhances mental health and well-being.
- Urban gardens increase local food sovereignty, enhance social cohesion, provide opportunities for learning and contribute to urban biodiversity.

There are numerous ways to more specifically identify the direct and indirect contributions of nature-based solutions, such as the monetary valuation of ecosystem services. In China, for example, the air purification and temperature regulating services of Beijing’s forest

ecosystems have been valued at 7.72 billion yuan (1.03 billion euro) annually based primarily on avoided air pollution charges and electricity savings (Wu et al., 2010). Due to their multi-functionality, their value and their relatively low cost of implementation and maintenance, nature-based solutions constitute cost-effective approaches to urban challenges, either on their own or in combination with grey infrastructure solutions.

### The manifold benefits of Guangzhou’s greenway system

The City of Guangzhou, situated in southeast China’s Guangdong Province, boasts a comprehensive network of greenways. The linear green spaces combine scenic trails with green belts for nature conservation. By providing safe infrastructure for recreational and commuter use, the greenway system promotes healthy lifestyles and encourages a modal shift from car use to cycling and walking. In addition, the creation of the network has increased tourism and stimulated the local economy since its various corridors and nodes connect most of Guangzhou’s cultural and historical sites, museums and recreational facilities. Reflecting the attractiveness of living close to open green space, adjacent property values have gone up by up to 30%.



Figure 5: Greenway in Guangzhou

## Key measures for mainstreaming nature-based solutions

Despite growing recognition for the potential of nature-based solutions, operationalizing them into policy and urban planning as well as facilitating their implementation requires additional efforts. Key critical aspects to accelerate these mainstreaming processes include:

- Establishing an evidence base for nature-based solutions, for example, by quantifying their ecosystem services and/or assessing their added value and co-benefits;
- Advocating for nature-based solutions by communicating their multi-functionality and ability to contribute to various

policy arenas such as climate change adaptation, public health, nature protection and economic development;

- Fostering collaboration across the full spectrum of stakeholders such as urban planners, utility operators, municipal officials and residents to ensure cross-sectoral buy-in and commitment for nature-based solution policies and planning guidelines;
- Leveraging conventional sources and unlocking novel mechanisms for financing such as green bonds, adaptation funds, taxes and fees, public-private partnerships to implement nature-based solutions.

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### References and Further Reading

- Haase, D. (2016, May 17). Nature-based solutions for cities: A new tool for sustainable urban land development? Retrieved August 10, 2017, from <https://ugecviewpoints.wordpress.com/2016/05/17/nature-based-solutions-for-cities-a-new-tool-for-sustainable-urban-land-development/>
- TEEB – The Economics of Ecosystems and Biodiversity (2011). TEEB Manual for Cities: Ecosystem Services in Urban Management. Retrieved August 15, 2016, from [http://www.teebweb.org/wp-content/uploads/Study%20and%20Reports/Additional%20Reports/Manual%20for%20Cities/TEEB%20Manual%20for%20Cities\\_English.pdf](http://www.teebweb.org/wp-content/uploads/Study%20and%20Reports/Additional%20Reports/Manual%20for%20Cities/TEEB%20Manual%20for%20Cities_English.pdf)
- Wu, S., Hou, Y., & Yuan, G. (2010). Valuation of forest ecosystem goods and services and forest natural capital of the Beijing municipality, China. *Unasylva*, (61), 28-36. Retrieved August 13, 2016, from <http://www.fao.org/docrep/012/i1507e/i1507e07.pdf>

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