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Urban Nature-based Solutions

INNOVATIVE PRACTICES FOR URBAN RESILIENCE

December 2022

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Acknowledgements

Author: Ádám Varga (CEEweb for Biodiversity)

Editor: Orsolya Nyárai (CEEweb for Biodiversity)

Copy editing: Endre Papp (CEEweb for Biodiversity)

Design: Eszter Sebestyén (CEEweb for Biodiversity)

Date of publication: December 2022

Katona József utca 35. 1/1., 1137 Budapest, Hungary

Introduction

Nowadays, cities and urbanised areas are facing numerous challenges. On one hand, climate change is severely affecting the functioning of cities, having an impact on the quality of life of millions of urban dwellers. Moreover, urban expansion and increasing urban populations are responsible for several economic, societal, and environmental threats. This study aims to guide decision-makers, local authorities, and practitioners in tackling these risks, by exploring how nature-based solutions (NbS) can support cities to increase their adaptive capacities and resilience. Therefore, this publication is providing a summary of innovative nature-based solutions - with a special focus on the challenges of extreme weather events cities are facing - to enhance urban resilience.

Figure 1 - Source: Pexels - Nancy Bourque

Urban population is constantly growing, over 56% of the world's population lives in cities and urban areas by 2021. This trend is expected to continue, over two third of the population will live in cities by 2050 (IPCC, 2022). The increasing urban population sets challenges for cities to provide affordable housing, viable infrastructure and transport systems, employment, and appropriate public and private services for their citizens (The World Bank). The functioning of urban systems is also disrupted by the impacts of climate change. Sustainable cities should aim for developing strategies and plans, which consider social, economic, and environmental aspects with a holistic approach to provide and sustain a decent quality of life for urban citizens. However, this endeavour is often hindered by the effects of climate change. As a result of climate change, cities are facing poor air quality, growing temperatures, and heat waves. Additionally, the urban heat island effect is causing even higher temperatures in urban areas due to the human-induced conversion of the landscape, as these structures are absorbing and re-emitting heat more than the natural elements. Additionally, climate change affects cities with extreme weather events such as extreme precipitation and urban flooding, urban water scarcity, landslides, and extreme urban wind and cold spells, too. The biogeographical breakdown of the observed and projected impacts is summarised in Figure 2 below. These impacts are affecting urban infrastructure elements, influencing the lives of millions of urban dwellers in unexpected ways. Effects of climate change may cause disturbances in the provisioning of services deriving from urban systems, e.g. in the *physical infrastructure* through transportation, energy and electricity supply, information, and communication technology. Services of the *social infrastructure* systems - associated with appropriate housing, health, education, and cultural heritage services – could also be interrupted, while further issues may arise in the *urban ecological infrastructure systems* responsible for

ecosystem services such as air-filtering, noise pollution reduction, microclimate regulation, recreational and cultural values.

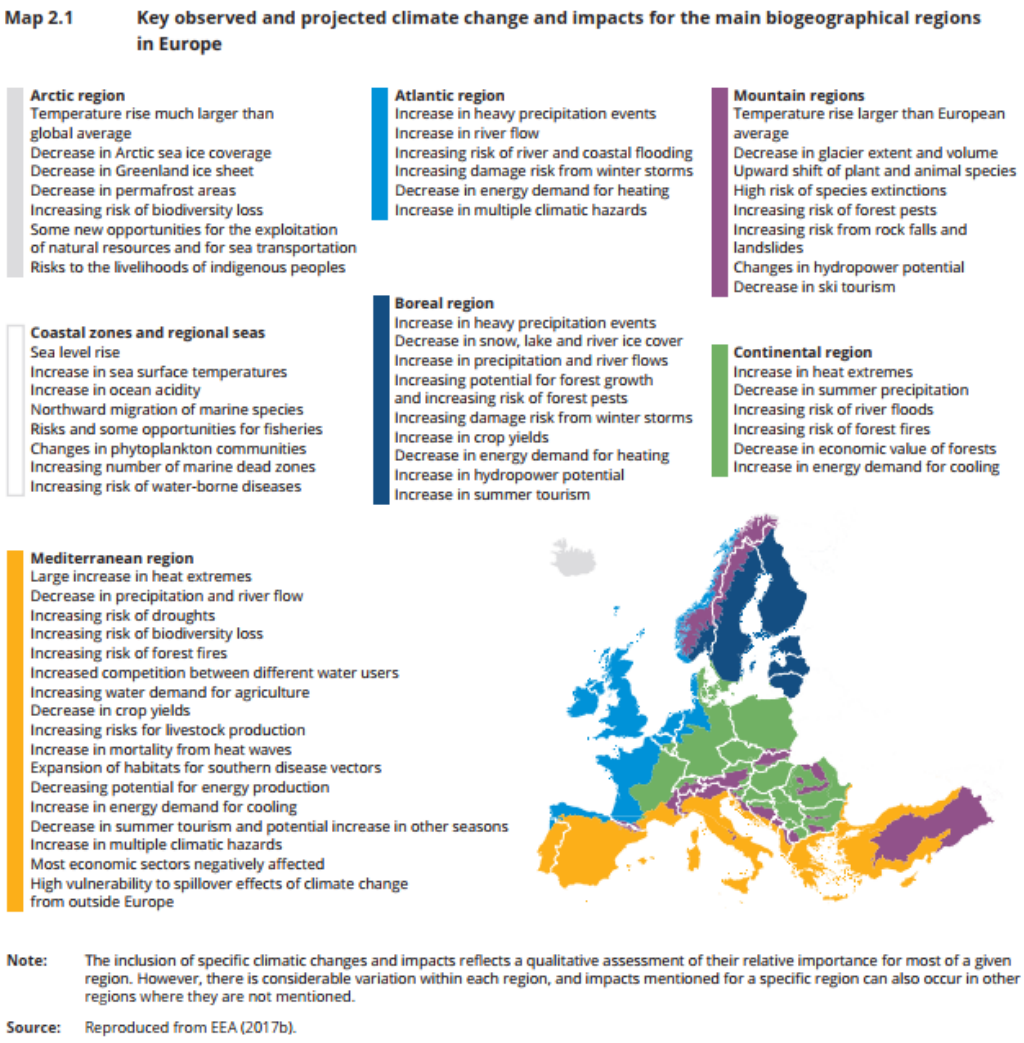

Figure 2 - Key observed and projected climate change impacts in Europe - Source: EEA, 2020

These climate-induced effects are also held responsible for economic impacts, such as losses associated with decreased labour productivity and economic outputs due to higher urban temperatures, health impacts causing higher levels of mortality, risks to human well-being due to water scarcity, costs for urban property damage of extreme weather events, etc (IPCC, 2022).

Nature at the forefront

Cities are benefiting from natural solutions, bringing back nature to urban areas is contributing to resilience and adaptivity, mitigation of climate change, and promoting biodiversity while improving urban quality of life and well-being of citizens (Wartsila). Enhancing natural features in urban areas provides a cost-effective, sufficient, and sustainable alternative to traditionally used, conventional engineering practices. Several concepts have been developed and implemented, all aiming to improve natural elements and green spaces in urban areas to tackle climate change. However, there are overlaps and common features in these approaches, therefore an overview of these concepts is deemed necessary. In the following, we will shortly review these approaches.

The importance and value of natural elements are becoming widely accepted in addressing social, environmental, and economic challenges. The need for integrated management of land, water, and living resources was first recognised by the ecosystem-based approaches. Numerous concepts were introduced, such as the incentives of Ecosystem-based Adaptation, Green Infrastructure, Ecosystem-based Disaster-Risk Reduction, and Natural Water Retention Measures. These concepts are often complementing each other, often focusing on short-term gains and effectiveness. Nature-based solutions are also fitting to the ecosystem-based approaches, but with the aim of promoting sustainability more explicitly. In general, nature-based solutions are providing cost-effective alternatives for tackling societal challenges, while highlighting the importance of the urban transition towards a more inclusive, resilient, and sustainable urban life. Benefits deriving from the promotion of natural areas and restoration of degraded ecosystems in urban areas are often taking the form of enhanced

human health, well-being, biodiversity conservation, improved climate change adaptation, or disaster risk management (Faivre et al, 2017).

The definition of NbS was shaped by both global and European-level policies and practices. The European Commission is defining nature-based solutions as the ones that are "*inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social, and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes, and seascapes, through locally adapted, resource-efficient and systemic interventions*" (European Commission). The Commission is emphasizing a more practical approach, including solutions that are not only using nature but the ones are inspired and supported by nature. The definition developed by the International Union for Conservation of Nature (IUCN) is similar in highlighting the importance of ecosystem services in addressing societal challenges but emphasizing the importance of the management and restoration of ecosystems. IUCN's is defining nature-based solutions as "*actions to protect, sustainably manage and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature*" (IUCN). Ultimately, both approaches are aiming to make use of natural systems in urban areas to tackle societal challenges, build resilience and enhance climate change adaptation.

The enhancement of natural elements and vegetation in urban areas is providing multiple benefits for cities. Nature-based solutions are contributing to increased human well-being, carbon sequestration, sustainable use of energy, better watershed management, and developed value of ecosystems (Faivre et al, 2017), while improving air quality, urban biodiversity, and ecological connectivity,

water quality and flow management and urban cooling (NatureScot). Examples of NbS often include the development of green roofs, rain gardens and pocket parks, as restoring floodplains or creating wetlands (Faivre et al, 2017; WWF). As was already discussed, nature-based solutions are effective tools to improve urban adaptation and resilience.

Examples of Nature-based Solutions

In urban areas, climate-change-related extreme weather events are affecting the functioning of urban systems and impacting urban infrastructure elements, interrupting transportation, energy supply, educational, ecological, and multiple other urban services. Therefore, this study is focusing on best practices of nature-based solutions aiming to address these effects, such as extreme urban temperatures and heatwaves, heavy rainfalls, urban flooding and water-runoff management, droughts, or even landslides. In the following, we will introduce examples of how European cities are implementing nature-based solutions aiming to tackle the challenges of the respective localities. These small-scale and hands-on examples may serve as an incentive for decision-makers, local authorities and practitioners to implementation of nature-based solutions.

Rotterdam Rooftops – The Netherlands

The city of Rotterdam took a whole new approach to improve urban life by extending urban areas to rooftops and showcasing examples of how future cities may look. Estimations show that Rotterdam has an estimated 18.000 m2 area of

unused flat roofs, while the dense city has challenges in finding placement for urban development projects. Rotterdam recognised the potential of urban rooftops first around 2008, and since then there are several initiatives made for the transformations from developing solar, green and blue roofs, enhancing social and residential functions or easing urban mobility in the city (C40).

Figure 3 - Rooftop Walk - Source: MVRDV

There are several examples of how to incorporate rooftops into urban life – Rotterdam's examples are varying from playgrounds, energy production, water storage and runoff management, exhibitions, or urban rooftop gardens (Rooftop Walk). For example, the Rotterdam Rooftop Walk initiative is providing a new layer for the city, aiming to enhance the liveability, sustainability, and biodiversity of the urban environment. The rooftop walk aims to introduce how

rooftops can be used as public spaces and showcase innovations and solutions for unlocking the potential of the solutions that can be implemented in the rooftops (ArchDaily).

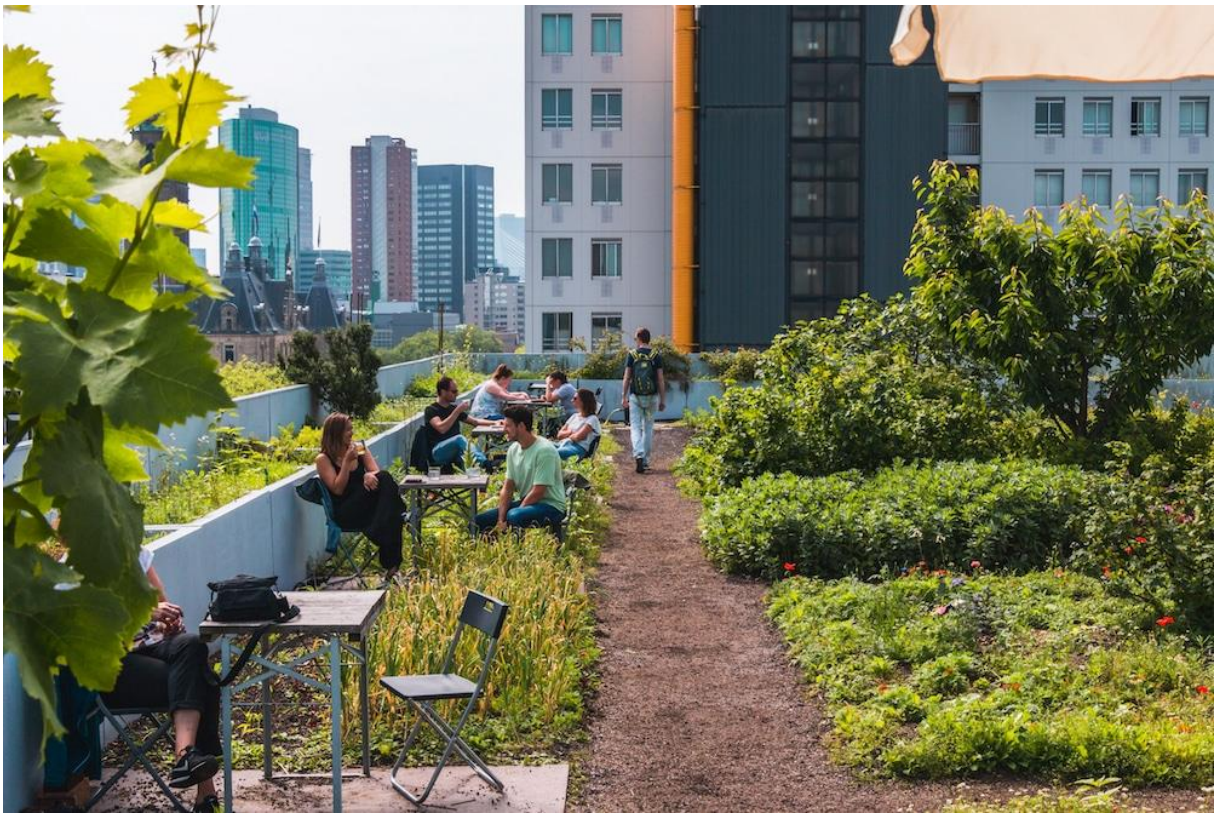

Figure 4 - Op Het Dak urban garden & park - Source: Weekends in Rotterdam

Another great example of Rotterdam's rooftops is the DakPark established at the top of a shopping centre, which is the largest rooftop park in Europe with its 1200 metres length and 85 metres width. The park accommodates several recreational activities for picnics, barbecues, gardening or the playground for children (Rotterdam.info). The park is opened in 2014, acting as a green urban oasis providing habitats for wildlife, places for urban gardening, and enhanced management for water runoff while tackling urban heat and promoting healthy activities and social interactions (GCA).

National Urban Park initiative - Finland

The concept of urban protected areas was raised in discussions around 1995 when the first national city park was founded in Sweden. Since then, there are already eleven national urban parks (NUP) were created aiming to preserve natural and cultural heritage. As a combination of valuable culture and natural elements, Finland's national urban parks are accommodating cultural, recreational and environmental services for its citizens by protecting valuable cultural elements and natural landscapes (Kansalliset kaupunkipuistot-a). National urban parks are "a combination of valuable culture and natural landscapes as well as recreational protected areas, located in an urban environment" (Kansalliset kaupunkipuistot-b).

Figure 5 - Porvoo National Park - Source: Porvoo Borga

Rapid urban expansion and land-use change resulted in ecological fragmentation, but with the concept of NUP Finnish cities managed to preserve

high-value ecosystems and promote the harmonious co-existence of natural and urban elements. Therefore, besides the preservation of natural values and valuable biodiverse areas, the NUP initiative also aimed to preserve culturally significant areas of high historical, architectural and aesthetic importance. The regulatory background of the NUPs was defined by the Land Use and Building Act, enacted in 2000 (Nordregio). These areas aim to ensure the connectivity between green areas from urban parks to city centres, to the outskirts of urban areas with extensive natural areas, while conserving biodiversity and providing further benefits for urban citizens, such as improved health, well-being and recreational opportunities (Kansalliset kaupunkipuistot-b).

Figure 6 - Kotka National Urban Park - Source: Europarc

In general, the NUPs are consisting of protected areas, Natura 2000 sites, forests, and elements of blue infrastructure such as marine, lake and river ecosystems. Finland's first Natural Urban Park was founded in 2001, and since then many others were established. The biggest challenge of the application phase and during the management of NUPs was making municipal politicians get on board and making them understand the importance of natural and cultural heritage in sustainable development. Furthermore, difficulties of long preparatory processes were also experienced. Ultimately, the concept of Natural Urban Parks proved to be an essential tool for biodiversity protection, sustainable economic development and providing benefits for urban dwellers.

Small-scale rain gardens in Glasgow – Scotland

Scotland has been an advocate for implementing nature-based solutions in urban areas, the country's nature agency recognised the importance of these solutions to make cities more resilient, and adaptive, and mitigate risks of climate change while making urban areas more appealing and healthy places to live. Scotland's placemaking initiative is a collaborative development approach to recognise the value of ecosystem services and to embrace green and blue infrastructure elements to make cities more sustainable and resilient. The concept aims to utilise the benefits of nature-based solutions and green infrastructure elements to enhance recreation opportunities, improving air quality and flood protection while empowering communities to take ownership of natural areas (NatureScot). The '10.000 Raingardens for Scotland' project is fitting to the placemaking

initiative, aiming to prevent flooding and improve rainwater runoff management. Rain gardens are designed to temporarily hold and soak rainwater runoff from impermeable surfaces. The garden of native shrubs, perennials and flowers is more effective in collecting pollutants - dirt, chemicals, fertilisers, etc – compared to traditional lawns (Groundwater).

In the case of Glasgow, the city often experiences flooding and has challenges with surface water runoff management, as the existing drain and sewer systems are often failing to cope with excess rainwater runoff. The project aims to establish rain gardens in sensitive areas to tackle surface water management, Glasgow is serving as a pilot area for the project. In the first phase, the project aims to raise awareness and engage the public community. In the second part, the project aims to develop rain garden plans and designs, while the effectiveness of the developments will be also monitored by gathering real data on the rain garden features (NatureScot).

The rain garden project is aiming to enhance Glasgow's resilience to urban flooding through awareness raising, community involvement and planning. The project aims to serve as a pilot and set good examples for further small-scale rain gardens in coping with heavy rainfalls (Placemaking Storymap). The further aim of the project is to extend the solution to other areas with the involvement of administration institutions (NatureScot).

Figure 7 - Community involvement - Source: NatureScot

Suburban development - Denmark

The new suburban district of Nye in Aarhus, Denmark serves as a great example of how the newly designed residential areas can utilise nature-based solutions to address climate-change-related challenges. Specifically, the district is aiming to enhance flood protection and water-runoff management while creating green spaces, and habitats promoting biodiversity - contributing to climate change adaptation and mitigation, health and well-being of its citizens (Urban Nature Atlas-a). The new urban district is promoting liveability and sustainability with the aid of blue and green infrastructure elements. Over the development processes, sustainable water management was essential, therefore the Nye

district is addressing nature-based solutions for rainwater management and purification, as rainwater is being collected from roofs, roads open areas, managed through ponds, and channelled into a central lake. Rainwater is the primary source for the district, with the "raw water" management system 40% of drinking water can be saved. (State of Green).

Figure 8 - Nye, Aarhus - Source: State of Green

The ongoing project has already implemented several measures for groundwater, rainwater, and wastewater management, with the development of blue infrastructure elements such as lakes and ponds, contributing to the attractivity of the residential area, too. In the next phases, the project aims to develop a climate park with nature reservation areas, aiming to further improve extreme rainfall and flooding management, while restoring habitats and damaged ecosystems.

Urban park of Saint-Étienne – France

The importance of natural elements and their advantages in urbanised areas was highlighted multiple times already within this study. However, the benefits of natural areas go beyond the environmental and social aspects and have implications for the economy too. Either if it is materialised in the added value of ecosystems, or by direct economic gains of the improved attractivity of a district.

The Public Development Agency of Saint-Étienne developed an eco-neighbourhood project in the central area of the city. The project is based on original urban park models, aiming to improve natural elements in the city centre, while making it attractive for inhabitants, ventures and research centres. The development of the city park also contributes to the promotion of urban biodiversity and the enhancement of the landscape and natural heritage.

Figure 9 - Francois Mitterand Park, Saint-Étienne - Source: Saint-Étienne Hors Cadre

The urban park development project aimed to enhance climate change adaptation by the improvement of outdoor areas to tackle urban heat, to advance drainage infrastructure while promoting biodiversity conservation with the use of climate-resilient plant species and restoration of valued species On one hand the park is hosting events and offering recreational area to the citizens, but was also designed to improve environmental conditions, too. The quality of the soil was improved, water-recycling and saving measures were implemented and no chemical weedkillers are used. The re-development of the district allowed the plantation of 1000 trees, improving the vegetation on 13 hectares while following a "zero irrigation system" with climate-adaptive plants (Urban Nature Atlas-b).

Brownfield regeneration in Antwerp – Belgium

Within the Park Spoor Noord development project - similar to the previous example - the city of Antwerp aimed to increase the attractivity of the area while addressing social and environmental challenges as well. The territory was previously used as a railway site and used as a mono-functional industrial land. The surrounding residential area was mostly inhabited by immigrants with a high population turnover, while the living density was four times higher than in the rest of the city. Therefore, the municipality aimed to enhance the liveability of the area while attracting investments for residential and commercial purposes. In doing so, the gist of the project was to create a green lung by restoring the former brownfield land and enhancing the social functions of the area, too.

Figure 10 - Park Spoor Noord, Antwerp - Source: Oppla.eu

The planning period took 7 years, including the negotiations, preparation and rehabilitation and the involvement of locals. The park consists of several green areas of gardens and forests, recreational functions for sports activities and social interactions. Several benefits are derived from nature-based solutions such as improved air quality, reduced urban heat island effect, accessibility of green spaces and increased well-being of citizens (Oppla. eu).

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