

## **Green and blue infrastructure planning in cities - A reflective and evidence-based contribution to a topical debate framed by the introduction of nature-based solutions in urban landscapes**

Today, our world faces challenges such as tackling climate change, securing food for everybody, nutrition, healthy living conditions and water security. Next to complementary technological approaches, nature can play a much stronger role in tackling these challenges and to make cities more resilient to change. Nature solutions, this is mainly green and blue infrastructure (GBI), include the restoration of forests, rivers, riparian areas and wetlands, the greening of cities and the usage of ecosystems to buffer, store and fix nutrients and pollutants. Perhaps more important is the educational and learning impact that a return and an active implementation of nature will have on humans who's life happens more and more in artificial and technological structures of cities and urban areas. Nature-based Solutions (NBS) are living solutions inspired and supported by the use of natural processes and structures of GBI, and are designed to address various environmental challenges in an efficient and adaptable manner, while simultaneously providing economic, social, and environmental benefits. The core idea of NBS is to use the benefits of ecosystem services to prevent a system from crossing a certain threshold such as critical air temperatures, water shortages or water levels leading to dangerous floods. These interventions create net positive effects, e.g., clean air from pollutants, cooler air temperatures, and flood or coastal protection. Types of NBS relevant to urban water management and planning in cities include ecosystem restoration, greening of grey surfaces such as green rooftops, green walls or greened brownfields, and integrated broad scale climate change mitigation and adaptation measures such as afforestation, natural flood control, constructed wetlands and, potentially, geo-engineering.

The paper will shed critical light on the following aspects to foster discussion using vivid examples from water planning in urban environments and cities across Europe:

- When discussing NBS as instruments of urban planning, are we often referring to biotic nature – that is first and foremost plants and to a lesser extent animals, but how far do we include abiotic ecosystem components too? Do water-planning related NBS artificial grey structures and humans? Concepts such as green infrastructure (GI) only marginally involve abiotic ecosystem dimensions and resources such as soils or sediments so that they fail in making use of their capacities to serve to face challenges such as clean water supply or waste(water) management in cities. Here, NBS are a more complete approach to provide clean water and to severe pollutants. However, as some NBS might include the alteration of nature as such e.g., by favoring one ecosystem service or certain species over another and to what extent can NBS be altered in order to accepted by nature and its processes? Answers to these questions would help to define potentials and limitations of the NBS's approach not to forget the role of human capital for creating, implementing and maintaining NBS in cities.
- The problems associated with clean water, flood and drought vulnerabilities, human wellbeing, and sustainability in urban environments are complex and full of trade-offs. How can GBI as NBS deal with these complexities? It may be that they are complementary to other approaches that focus less on a pure problem solution rather than on a system integration and diversity enhancement in order to develop resilient cities. Thus, NBS would represent a “module” in socio-ecological-infrastructure

systems (SETIs) explicitly including technological components as humans will continue to develop techniques to solve problems that affect their livelihoods.

- There have been increasing discussions on how and to what extent greening and blueing strategies (river and channel revitalization, riverine greening) carry the risk of fostering greater inequality among social groups instead of fostering social coherence. GBI implementation can lead to an increase in the attractiveness of a residential area and to a higher quality of life as well as other environmental benefits. However, due to rising housing costs, these benefits might be limited to those households who can afford the higher costs and could displace low income, less affluent populations. In contrast, and what could strongly support NBS as a concept and an approach in cities and urban agglomerations is to ensure that all relevant stakeholders at various scales and all the concerned sectors are addressed and involved. NBS should contribute to social inclusiveness and lead to social cohesion and equity in cities through a more democratic design process.

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