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Editorial: Nature-based solutions in the built environment

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Editorial on the Research Topic
Nature-based solutions in the built environment

Nature-based Solutions (NbS) are actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, while simultaneously providing human wellbeing and biodiversity benefits (Cohen-Shacham et al., 2016). NbS work with nature instead against it, and ideally they might be designed together with the built environment (United Nations World Water Assessment Program, 2018), for instance as swamp cities and climate smart cities. They are a core approach to address climate adaptation through Urban Green Infrastructure (UGI), focusing on a multifunctional use of spaces. In general, Green infrastructure (GI) describes a strategically planned network of high-quality natural and semi-natural areas that provide ecosystem services (European Commission, 2013). NbS are supported by blue (water elements) and green infrastructure (ecological systems). According to Dunlop et al. (2024), the seven societal challenges that NbS address are 1) Climate change mitigation and adaptation, 2) Disaster risk reduction, 3) Economic and social development, 4) Human health, 5) Food security, 6) Water security and 7) Reversing environmental degradation and biodiversity loss.

The built environment (grey infrastructure) is an urban ecosystem that is characterized by a particular urban metabolism. Thus, the management of the built environment requires an optimized green–blue–grey solution approach. In contrast to methods based solely on the use of natural processes, ecological engineering (EE) considers also the grey design and management part. EE and GI aim to support technical approaches with natural processes. This often leads to hybrid (so-called green-grey) infrastructure solutions. Similar approaches exist with the Engineering with Nature (Bridges et al., 2018), an initiative of the U.S. Army Corps of Engineers (USACE), Working with Nature (WwN), a concept of the World Association for Waterborne Transport Infrastructure, 2008, as well as Building with Nature for the multifunctional UGI development. WwN is defined as the conscious coordination of natural and technical processes in order to achieve economic, ecological and social benefits efficiently and sustainably through collaborative processes. EE, as a synthesis of ecology and engineering, deals with the sustainable design and operation of ecosystems that are heavily influenced by humans and uses NbS for this purpose.

The development of a changing environment in recent decades, due to population growth, industrialisation, globalisation and climate change, caused pressure on natural and engineered ecosystems. The built environment, being home to human societies, is particularly vulnerable to climate extremes like floods, droughts, heat, hurricanes, etc. To deal with these challenges, NbS provide an approach to upgrade the features of the built environment in order manage in a more sustainable way their environmental impacts. The solutions include water sensitive blue-green cities, with closed material flows, that serve not only the health and wellbeing of humans, but also other species in the urban context. The European Environmental Agency (2020) pointed out that GI, and in particular increasing the share of green space, is one of the most effective measures against the impacts of climate change in cities and is also considered a fundamental response to biodiversity loss. To reach their full potential in cities, NbS should not be stand-alone solutions but should be designed as a functional network to provide the multifunctional services. EE integrates ecological principles, processes and organisms with existing engineering practices to create a holistic approach to problem-solving (Schönborn and Junge, 2021).

EE applications can be categorized into three spatial scales: 1) mesocosms (~0.1 to hundreds of meters); 2) ecosystems (~1–10 km) and 3) regional systems (>10 km). The design complexity is likely to increase with spatial scale. Applications are increasing in breadth and depth, and are likely to impact the definition of the field as more ways to design and use ecosystems as interfaces between society and nature are explored. EE applications in cities have emerged from collaboration with other fields such as landscape architecture, urban planning and urban gardening (Bergen et al., 2001).

The Research Topic addresses NbS at all mentioned scales in the built environment. In this context, Giyarsih et al. had a closer look on the mesocosms scale, and highlighted the interrelation of urban farming and urbanization. Their results illustrate that urban farming provides several types of ecosystem services: it can provide various types of easily accessible food that is produced relatively close to residential areas, so the quality is still fresh and healthy and the price is affordable as well. Moreover, having in view further ecosystem services aspects, urban farming can optimize the use of limited or vacant land in residential areas into productive land, particularly for UGI applications.

Also Ferreira and Rocha considered the mesocosms scale, and performed a land use comparison between a Green Roofs and Permeable Pavements. They highlighted the NbS potential for disaster risk reduction.

In contrast, Cancio and Pierini had a look at the large scale, namely, the regional system of the irrigation basins of Bonaerense Valley of Colorado River (BVCR) and Mar Argentino, near the mouth of the Colorado River, and used numerical models (MOHID Land and MOHID Water) in a coupled way to evaluate the complex dynamics involved. The model could be used for future comparative assessments, to allow decision-makers to manage and regulate the different activities involved in the basin in a nature-based way (tourism sector, crops, irrigation, fishing, etc.) to mitigate impacts on water quality damage.

Design alternatives for traditional infrastructure are often compared in terms of expected and often narrowly defined costs and benefits to justify the selected plan. Kurth et al. had a look at the medium EE dimension, urban ecosystems, and took a broader life cycle perspective in the benefit-cost evaluation process helping to account for potentially rare, indirect, or accruing project benefits. In this way, the design process shall account in more comprehensive way for positive externalities, and a fundamental gap of conventional design is closed: natural infrastructure design alternatives are generally difficult to compare to conventional alternatives due to their distinctly different costs and benefits. The presented life cycle framework expands conventional life cycle analysis to capture other important and relevant aspects of natural and conventional infrastructure. It consists of four dimensions: risk mitigation performance, co-benefits, financial costs (life cycle costing) and environmental costs (life cycle assessment). In this way, NbS in the built environment can be quantificable.

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