Nature based solutions for sustainable resilient cities

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INTRODUCTION

Climate changes, growing cities with increased population density, extension of impervious areas and aged infrastructure pose great challenges in assuring a sustainable urban resilience on short and medium term.
Considering climate change uncertainty, one solution to address this challenge is an integrated approach, based on nature based solutions and grey infrastructure, that takes into consideration social, economic, and environmental aspects.

NATURE-BASED SOLUTIONS

Nature-based solutions (NBS) represent “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.” (Cohen-Shacham et al. 2016.).

Fig. 1 – Examples of NBS

Analysing NBS or traditional measures individually, leads to solving a local problem but sometimes generates other pressures upon the urban system elsewhere because of not applying the integrated environmentally sustainable approach concept. On contrary, applying both types of measures in an integrated manner usually leads to a more effective way of increasing the urban resilience. This concept is not new, but mainstreaming the progress and speeding its application is still set back by different challenges related to multiple stakeholders involved in the process that need to work together and access financial programs for initial investment and maintenance.

MODELLING NBS

Numerical modelling is a convenient and reliable solution to test the effects of NBS in conjunction with grey measures in an integrated manner, in the context of climate change, before these are financed and implemented. This way the entire urban water cycle can be integrated in the planning process, which is the best way to manage the stormwater sustainable and minimise environmental degradation.

Through advanced hydraulic and catchment modelling, comprehensive risk assessments and flood mapping, all cities can benefit from reduced runoff and improved water quality, efficiency and resilience to climate change.

Hydraulic modelling tools, such as MIKE+, a integrated water modelling platform for urban, river and flooding modelling, can test multiple scenarios for urban planning and reduction of drainage system overflows and flooding, simulating the “sponge city” concept, and quantifying the volumes of floodwater that needs to be soaked and released gradually.

NBS can be modelled through a method based on the reservoir concept, in which each layer of a NBS is considered to be a reservoir with the characteristics of the layer it represents. For example, for a bio-retention cell (Fig. 2), which is composed of a surface zone, a soil zone and a storage zone, the bio-retention cell is divided into 3 reservoirs, one for each zone, the water going from one reservoir to the next one up until it goes through the last one and ends up in the soil that is underneath the cell.

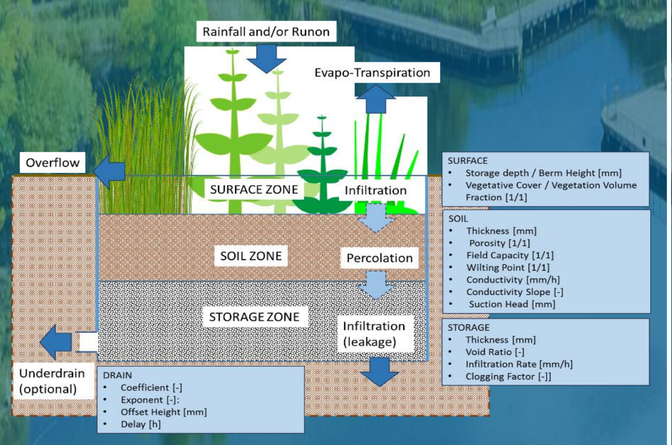

Fig. 2 – Bio-retention cell

CASE STUDIES

The first case study aimed to analyze the potential effect of bio-retention cells on the sewerage network of Krakow city, Poland, through hydraulic modelling. In the baseline scenario the drainage capacity of the Krakow city was simulated using a hydrodynamic model in MIKE+ and results showed an exceedance of the transport capacity which consequently generated urban flooding. NBS consisting of bio-retention cells with the size of 0.8 m x 0.8 m x 0.8 m, with highly permeable soil, were implemented with thepurpose of decreasing the runoff to the drainage system and assuring the sewer transport capacity (Fig. 3). After the implementation of this nature-based solution, an important impact can be seen in a significant decrease of the water level in the sewage system and in the full flood mitigation (Fig. 3).

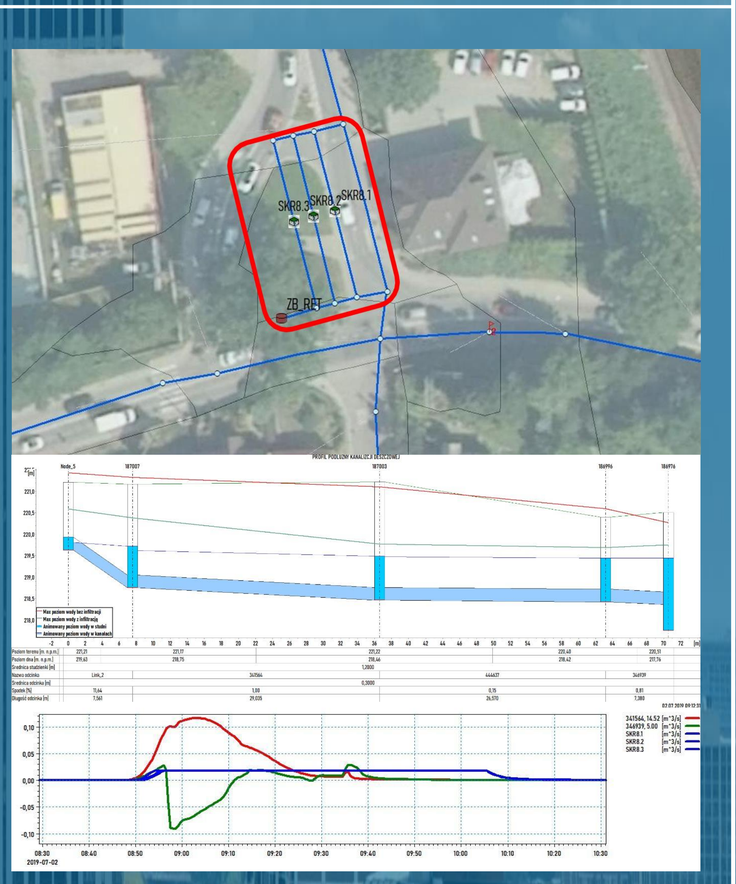

Fig. 3 - Bio-retention cells analysis

The second case study, the Mermaid Creek Salt Marsh Restoration project in Canada, that aims to restore the marsh out to and beyond historical extents, capture blue-carbon, and help protect upland development from hazards with the help of NBS. Since the 1960s, the salt marsh lost 72.4% of its area which led to the disappearance of ecological habitats and exposure to significant waves that could produce costal hazards. As part of the scope of work, a conceptual design that includes multiple NBSs was developed (Fig. 4). The primary design goals of this concept were to expand the Mermaid Creek marsh to at least 1964 extents, to provide suitable substrate for vegetation growth and to provide natural protection from waves.

Fig. 4 - Conceptual design for the Mermaid Creek Salt Marsh

CONCLUSIONS

- Nature-Based Solutions can be a sustainable way of increasing the urban resilience and work best as a complement to grey infrastructure;
- It is evident that NBS represent efficient and environmentally friendly proven solutions;
- The efficiency of Nature-Based Solutions standalone application should be critically assessed and numerical modelling is one of the best ways of testing the efficiency of NBS.

Article: Joachim Maes & Sander Jacobs 2017 Nature-Based Solutions for Europe’s Sustainable Development Conservation Letters
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Website: Urbanization – Stormwater Runoff https://www.epa.gov/caddis-vol2/urbanization-stormwater-runoff