Evaluation of synergetic opportunities between Nature Base Solutions and sewer networks and processes.

Paulo Ramísio[1] and Maria do Céu Almeida[2]

[1]Department of Civil Engineering, University of Minho, Campus of Azurém, 4804-511 Guimarães, Portugal (Email: *pramisio@civil.uminho.pt*)
[2]Hydraulics and Environment Department, National Laboratory of Civil Engineering, 1700-066, Lisbon, Portugal (Email: *mcalmeida@lnec.pt*)

Keywords
Nature Base Solutions, urban drainage, urban runoff

INTRODUCTION AND MOTIVATION

Since 2007 more than half of the world population is concentrated in urban areas. Not surprisingly, managing urban areas is one of the most important development challenges of the 21st century (UN DESA, 2014).
The high urban growth, the imperviousness of urban centres, and the changes of meteorological patterns, has been giving rise to situations in which urban drainage systems are absent or insufficient to provide the expected performance for which they were initially designed.
The desired integrated management of different utilities is often not possible (due to different management agendas and financing sources). This issue is aggravated by the location of these infrastructures, mostly underground, subject to an aggressive environment, being pathologies difficult to detect.
Understanding of the systems' behaviour is complex given limited knowledge of nature and characteristics of the infrastructure and, sometimes even the location is uncertain. Consequently, the implementation of effective operation procedures and the design of effective corrective measures is a challenge.
Furthermore, the increasing imperviousness of urban areas over the last decades led to increasing changes in precipitation-runoff processes. For the same precipitation patterns, the resulting runoff events have higher peak-flows and shorter durations. Therefore, the limitations to predict meteorological conditions and the uncertainties related to climate changes generate an additional difficulty on the management of urban drainage systems. These conditions aggravate the flooding risk, with consequences in terms of limitations to urban activities, with high economic losses and risk to human life's (Jha, Bloch & Lamond, 2012).
Interactions between different types of drainage systems are also frequent, especially when separate sewer systems are adopted (foul and rainwater systems). The overall efficiency of these systems is better achieved with the understanding of the theory concepts and operational limitations of both systems.
The presence of rainwater in foul sewers can result from subsurface infiltration or from direct entry of runoff. The first has a slower hydrodynamic response, and does not normally represent an increased pollutant load. On the other hand, the contribution of overland flows ads a direct flow response in wet weather (WW) conditions, with the presence of contaminants leached from the urban surfaces. Both problems have direct impact on sewer processes and networks' operation, as well as on the efficiency of Wastewater Treatment Plants (WWTP). Despite some variations in daily flows, domestic sewage represents peak flows that are typically 3 to 5 time the average flow, and seasonal variations are also

reasonably predictable, allowing an effective management of wastewater. The predominant organic nature of domestic sewage, with the presence of nutrients (essentially N and P), promoted the design of WWTP specifically designed to reduce specifically these types of pollutants, including sometimes a final disinfection.
Runoff has an intermittent nature, with high peak flows, that transport particles and pollutants from roads and other surfaces, including heavy metals and micro organic compounds (Ramisio and Vieira, 2012). Due to a diffuse origin, intermittent nature, and presence of non-biodegradable pollutants, urban runoff represents a big challenge, affecting the processes in sewers and in WWTP.
Nature Base Solutions **(**NBS) can be effective for flow control and retention of pollutants, including heavy metals. Therefore, the inclusion of NBS throughout the catchments could represent an opportunity to address the above-mentioned problems with the benefit of promoting the liveability of cities, the quality of life, and enabling sewer systems to evolve from being passive to active adaptive units that can respond differently depending on the given situation (Kerkez et al., 2016).

METHODOLOGY

The simple design of urban drainage networks hides their importance to urban activities and the complex phenomena involved, that challenge their correct operation. An effective retrofit relies on the understanding of the involved processes, that depend on scientific knowledge, local conditions and operational measures.
A scientific approach, identifying the most important variables was the starting point to understand the main constrains and the to retrofit drainage systems in order to fulfil the challenges of this new millennia. The study continued to identify important limitations and important key variables, and how monitoring systems can help to understand precipitation-runoff processes and their effect on sewer processes. The opportunities and limitations of Nature Base Solutions for synergetic scenarios are discussed and presented, as a methodology for the integration of NBS in the urban environment.

RESULTS AND CONCLUSIONS

The main goal of this research was to analyse the main design and operational constrains of urban drainage systems, and to evaluate the benefits and opportunities of including NBS, as surgical interventions contributing to the sustainable management of water in the urban environment.
The use of NBS do not only contribute for the mitigation of urban flooding but can also represent an opportunity to reduce the pollution load from urban diffuse pollution.
It is paramount to understand rainfall-runoff processes and to optimize the management of different NBS and sewer systems, based on local specificities, by adapting operational conditions. Last, but not least, the can also represent and opportunity to enhance urban sustainable development, by introducing green spaces, increasing the liveability of urban spaces and contribute for a better life in the urban environment.

REFERENCES

Jha A. K., Bloch R., Lamond, J. (2012). Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century. World Bank.

Kerkez, B., Gruden, C., Lewis, M., Montestruque, L., Quigley, M., Wong, B., Bedig, A., Kertesz, R., Braun, T., Cadwalader, O., Poresky, A. and Carrie Pak (2016). Smarter Stormwater Systems. Environmental Science & Technology **50** (14), 7267-7273. DOI: 10.1021/acs.est.5b05870

United Nations Department of Economic Social Affairs (UN DESA) (2014) "World Urbanization Prospects" 2014.

Ramísio, P. J., Vieira, J. M. P. (2012). Characterization of road runoff: A case study on the A3 Portuguese Highway. Alliance for Global Sustainability Bookseries: Science and Technology: Tools for sustainable development. Volume **19** - Urban Environment. Morrison Rauch (eds.) (ISSN 1571-4780). Published by Springer, pp. 285-295.