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GestPatPluvO: sustainable and multi-scale asset management for nature-based stormwater solutions

GestPatPluvO : gestion patrimoniale durable et multi-échelles des solutions fondées sur la nature dédiées aux eaux pluviales urbaines

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ABSTRACT

The last decades have seen an impressive evolution in the way stormwater is managed: Nature-Based Solutions (NBS) are becoming as important as drainage pipes. The design of Nature-based stormwater management solutions seems well established when considering water quantity (and quality). More work is however needed to consider economic, environmental, societal aspects and adaptations to climate change related to the city and its inhabitants. Very few are also known regarding the required management for their long-term performance. The GestPatPluvO project is focusing on NBS implemented at the scale of the parcel and the district. It aims to propose a multi-criteria decision aid method to assess the performance of NBS and the (positive and negative) impacts of management strategies for the utility manager, the city, and its inhabitants. The work will build on existing scientific and operational literature related to sustainable urban water management, sustainability, and resilience. The analysis will also encompass methods developed for other infrastructures such as roads, green areas, dams, and dikes, as these assets share services functions with NBS dedicated to stormwater management.

RESUME

Les solutions fondées sur la nature (SFN) dédiées aux eaux pluviales se sont imposées ces dernières années comme des solutions de référence, au même titre que les réseaux. Le dimensionnement de ces solutions semble bien maîtrisé quand on considère les performances hydrauliques (et la réduction de la pollution). Mais ces solutions sont en contact avec la ville et ses habitants et rendent de nombreux autres services souvent mal évalués. Le projet GestPatPluvO vise à élaborer une méthode d'aide à la décision permettant de guider l'évaluation des performances des solutions fondées sur la nature pour la gestion des eaux pluviales. Les échelles considérées sont celles de la parcelle et du quartier. La méthode permettra également d'évaluer les effets de différentes stratégies de gestion de ces solutions pour le gestionnaire, la ville et ses habitants. Le travail s'appuiera sur la littérature scientifique et opérationnelle en lien avec la gestion durable des eaux urbaines, la durabilité et la résilience. Il s'inspirera également des méthodes développées pour d'autres infrastructures (routes, espaces verts, barrages et digues) qui rendent des services similaires aux solutions étudiées.

KEY WORDS

Nature-based solutions, asset management, multicriteria decision tool, sustainability, performance

1 NEW CHALLENGES IN STORMWATER MANAGEMENT WITH NATURE-BASED SOLUTIONS ASSET MANAGEMENT

Over the last decades, the water sector has seen a major paradigm change regarding urban drainage (Chocat *et al.*, 2007), with the development of nature-based solutions (NBS) to manage stormwater and mitigate the negative impacts of traditional stormwater pipe networks. Such infrastructures are often applied at or near to the source of runoff: swales, infiltration trenches, or green roofs. Different vocabulary is used to define them (Fletcher *et al.*, 2015), they provide numerous benefits to the city and the nature/environment (Belmeziti *et al.*, 2015). Their adoption faces many barriers, including their operation and maintenance (O&M) requirements (Cossais *et al.*, 2017; Comby *et al.* 2019).

The main function of a piped drainage network is to convey waste- or/and stormwater. Conversely, NBS address multifunctionality. They are typically integrated within the urban landscape, most often open-air, and thus have high visibility and public accessibility. Being open-air, the allocated space cannot be dedicated solely to stormwater management. As it is not raining most of the time, the infrastructure will often have a main function not related to water management: such as parking, driving, riding, walking or recreation. Such expectations have emerged from the concept often referred to as sustainable urban water management – SUWM (Brown *et al.*, 2006; Hellström *et al.*, 2000; Larsen and Gujer, 1997). Expectations related to SUWM may differ from place to place according to the local context and their typologies. However, there is a strong need for an exhaustive list of services that sustainable urban water management can provide. In short, NBS are expected to fulfil several functions related to the city or the environment: however, this often leads to specific issues related notably to their functions and asset management.

An exhaustive list of functions is required to guide the utility manager in the identification of the services specifically for the territory. Belmeziti *et al.* (2015) have translated this concept in terms of functions that the system must fulfil, including functions related to the preservation of the natural environment, protection of human health and guaranteeing social equality, see Figure below. Other authors have considered co-benefits and disbenefits regarding environmental, social, or economic effects of NBS (Alves *et al.*, 2019; Curt *et al.*, 2018, Wery *et al.* 2019a, 2019b).

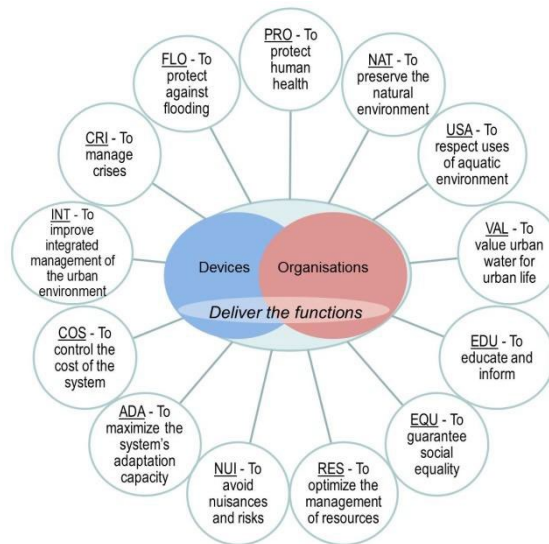


Figure 1. Generic representation of the service functions of the Sustainable Urban Water Management System (Belmeziti *et al.*, 2015)

However, the question of how to evaluate these functions through indicators has not yet been answered. More precisely, more research is still needed to elaborate the means (indicators) to assess their performance, due to lack of knowledge, lack of monitoring methods and capabilities and lack of interdisciplinary approaches. According to Langeveld *et al.* (2022) “the definition of the expected service life that has a major influence on the economic assessment is based on little data and would need reassessment.”

There is also a strong need to consider the system with both the traditional pipes and NBS, as NBS are not

meant to replace pipe infrastructure but to complement them (hybrid solution). While the design stage of NBS has been improved in the last years to take into account not only water quantity or quality expectations, but also economic, environmental and societal aspects, there is still room for improvement. More especially it is becoming primordial to connect the design performance (why the NBS has been designed for) to the performance over the life of the NBS. In another word, service functions as described by Belmeziti *et al.* (2015) or others or co- and disbenefits should also be assessed on a periodic basis and connected to operation and maintenance actions.

2 BUILDING A MULTICRITERIA NEW DECISION TOOL FOR ASSET MANAGEMENT OF NBS

GestPatPluvO aims to answer this challenge: this new three-year project is funded by the French Office of Biodiversity (OFB - <https://www.ofb.gouv.fr/en>) and the Graduate School H2O'Lyon (<https://h2olyon.universite-lyon.fr>). INRAE and INSA are partners in this project involving researchers in civil engineering, public management, ecology and decision support.

The project will be built on the existing scientific and operational literature related to sustainable urban water management, sustainability, and resilience. The partners have also a long-lasting experience in the subject with projects such as ANR OMEGA, OMEGA Ecocampus, URBIEAU, Eccorev APOGEE, MicroMegas, GIEMU, INCERDD, MANA, etc.. Bibliography analysis of course will be the first task; the aim is to analyse the existing approaches using criteria related to NBS, hybrid systems, multi-scale approaches, asset management of water infrastructures.

The interest of developing a multicriteria tool for evaluating the effects of asset management of Nature-based stormwater solutions is to obtain a diachronic model linking operation and maintenance actions to performance indicators. The model will consider hydraulic and water treatment processes, ecology (influence of the vegetation and biodiversity), thermic (climate regulation) and social criteria (for cultural services such as aesthetic, spiritual, educational, or recreational). The model will also require considering the effect of operation and maintenance action related to the grey (build) or green (vegetated) elements of the solution. Interdisciplinary co-construction is primordial to elaborate such a model.

This tool aims at answering several questions such as:

- How to manage devices at a neighbourhood scale in order to reinforce the ecological connectivity of terrestrial or wetland environments associated with stormwater management infrastructures?
- How to promote the ecological functionality of the facilities or how to ensure their maintenance without impacting the biodiversity that could have settled there?

Two full-scale case studies will be selected: one in the Lyon Metropolis territory and the second in the southeast of France (Aix-en-Provence or nearby). The case studies will be selected in agreement with both the project consortium (available data, stakeholder, scientific interest to the project, etc.) and the utility managers. An operational guide for local authorities on "sustainable, multi-scale (parcel, district) asset management indicators for nature-based or hybrid solutions for urban stormwater management" will be delivered at the end of the research.

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