

Hydraulic Performance and Ecosystem Services of SuDS in the Urban Context of Bovisio Masciago (Lombardy, Italy)

Performance hydraulique et services écosystémiques des SuDS dans le contexte urbain de Bovisio Masciago (Lombardie, Italie)

Giulia Lussana, Giulio Senes

Department of Agricultural and Environmental Sciences (DiSAA), University of Milan
giulia.lussana@unimi.it, giulio.senes@unimi.it

RÉSUMÉ

Au cours des dernières décennies, le changement climatique et l'urbanisation ont accru le risque d'inondation et dégradé la qualité des eaux de ruissellement, mettant en lumière la nécessité de solutions fondées sur la nature, telles que les systèmes urbains de drainage durable (SuDS). Cette étude porte sur un dispositif de SuDS s'étendant sur un kilomètre à Bovisio Masciago (Lombardie, Italie), où des systèmes de biorétention et des bassins de rétention équipés de tranchées d'infiltration ont été installés le long d'une rue résidentielle et dans un parc adjacent. L'objectif est de développer et de tester des méthodes d'évaluation des performances hydrauliques, hydrologiques, ainsi que des services écosystémiques. Une zone de biorétention instrumentée est dotée de préleveurs automatiques aux points d'entrée et de sortie, de capteurs de niveau et de sondes d'humidité du sol, permettant la réalisation d'essais contrôlés avec camion-citerne et un suivi événementiel des volumes et de la qualité de l'eau. Parallèlement, des relevés de végétation, des mesures microclimatiques et des enquêtes par questionnaire seront utilisés pour évaluer le potentiel de biodiversité, la contribution à la réduction des îlots de chaleur urbains, ainsi que les services culturels tels que l'esthétique, le contact avec la nature et le confort perçu. Cette approche intégrée vise à soutenir une évaluation globale des bénéfices multifonctionnels apportés par les interventions de SuDS à l'échelle de la rue.

ABSTRACT

Over the past decades, climate change and urbanisation have increased flood risk and degraded stormwater quality, highlighting the need for Nature-Based Solutions such as Sustainable Drainage Systems (SuDS). The study focuses on a one-kilometre SuDS scheme in Bovisio Masciago (Lombardy, Italy), where bioretention systems and detention basins with infiltration trenches have been implemented along a residential street and in an adjacent park. The aim is to develop and test methods to evaluate both hydraulic–hydrologic performance and ecosystem services. A monitored bioretention area is instrumented with paired inflow–outflow automatic samplers, level sensors and soil-moisture probes, enabling controlled tanker tests and event-based monitoring of water quantity and quality. In parallel, vegetation surveys, microclimate measurements and questionnaire surveys will be used to assess biodiversity potential, contribution to urban heat island mitigation and cultural services such as aesthetics, contact with nature and perceived comfort. The integrated approach is intended to support a comprehensive evaluation of the multifunctional benefits of SuDS interventions.

KEYWORDS

Bioretention systems, Cultural Services, Regulating Services, Stormwater Management, Sustainable Drainage Systems

1 INTRODUCTION

Over the past 50 years, climate change has increased the frequency and intensity of extreme events such as heatwaves, hurricanes, and floods, altering global temperature and precipitation patterns. Rapid urban expansion has created extensive impermeable surfaces, increasing runoff, reducing infiltration, and degrading water quality, thus intensifying urban flooding (Yao *et al.*, 2016; Miller and Hutchins, 2017). Conventional “grey” drainage infrastructure often fails to manage these volumes, encouraging the use of Nature-Based Solutions (NBS) that integrate natural processes into urban landscapes. Within this framework, the project focuses on Sustainable Drainage Systems (SuDS), techniques designed to manage surface water by approximating pre-development drainage conditions. SuDS slow, store, infiltrate and treat runoff, reducing flood risk and improving water quality while also providing environmental and social benefits. They offer co-benefits such as microclimate regulation, habitat provision, air-quality improvement, ecological connectivity, and cultural and educational opportunities. These “ecosystem services” are the goods and benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2005).

SuDS are expected to deliver key regulating services such as runoff attenuation, infiltration, groundwater recharge, stormwater quality improvement and microclimate regulation, as well as cultural services that enhance visual quality, contact with nature and outdoor comfort, contributing to the well-being and quality of life of local residents (García and Santamarta, 2022). The aim of the project is to develop and test methods to evaluate the hydraulic–hydrologic performance and the ecosystem services provided by SuDS in Bovisio Masciago, a municipality in the province of Monza and Brianza (Lombardy, Italy).

In the study area, two main SuDS technologies are implemented: bioretention systems and detention basins complemented by infiltration trenches. Detention basins are shallow, normally dry depressions that temporarily store surface water during and after storm events. They attenuate flows by capturing excess runoff and releasing it gradually through a restricted outlet. In this case, their floors contain gravel-filled infiltration trenches that enhance infiltration and assist drainage after rainfall. When vegetated, detention basins can also improve water quality. Bioretention systems, including rain gardens and bioretention trenches, are shallow landscaped depressions with engineered soil, vegetation and microbial communities that temporarily pond runoff before filtering through the planting and underlying media. Filtered water is either collected by an underdrain or allowed to infiltrate into the subsoil, depending on site conditions. Beyond their hydraulic role, both systems improve the visual quality of streetscapes and public spaces, support biodiversity and contribute to local cooling, reinforcing their role as multifunctional green infrastructure.

2 CASE STUDY

The case study is located in Bovisio Masciago, a municipality in the province of Monza and Brianza (Italy), where a roughly one-kilometre Sustainable Drainage Systems (SuDS) scheme has been implemented along Via Giacomo Matteotti and within a small nearby park. The street currently features a continuous green–blue corridor composed mainly of vegetated bioretention areas and linear bioretention trenches positioned along the carriageway edges and within the footways. In the park, the system consists of dry detention basins that temporarily store runoff from adjacent parking areas before discharging it through infiltration trenches located at the basin floor.

The bioretention systems and linear bioretention trenches consist of narrow excavations up to about 1.20 m deep, backfilled with a stratified medium that combines storage and filtration functions. The typical profile includes a gravel drainage layer at the base, a transition gravel layer, and a filter layer composed of sand, compost and topsoil, topped by a thin gravel mulch to limit weed growth. The SuDS are planted with a diverse palette of largely native or well-adapted trees, shrubs and herbaceous perennials selected for their tolerance to alternating wet and dry conditions, urban heat and low-maintenance management. The plant species and their arrangement follow modular planting schemes that are repeated along the street. This configuration is intended to improve the local microclimate, mitigate the urban heat island effect, enhance air quality, increase biodiversity and ecological connectivity, and create more liveable and attractive public spaces for residents.

4 CONCLUSIONS

The project is currently ongoing. The first experimental campaigns on water quantity and quality performance of the monitored bioretention section are planned for January, using both controlled tanker tests and natural rainfall events. Subsequently, the assessment of regulating and cultural ecosystem services will be carried out, combining field measurements (biodiversity and microclimate) with questionnaire surveys, in order to provide an integrated evaluation of the multi-functional benefits delivered by the SuDS located in Bovisio Masciago.

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