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Leveraging the Potential of Bioretention Cells to Tackle Urban Flooding through an Innovative Web-GIS Approach

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Abstract

Urban flooding has become a prominent concern due to the inadequacy of existing grey infrastructure in effectively managing the adverse effects of urbanization and climate change. Low-impact development (LID) is an increasingly popular strategy to manage urban stormwater for individual properties, but the aggregate effect on runoff control at the urban catchment scale is nowadays an open issue among researchers (Palla and Gnecco, 2022). Among LID practices Bioretention Cells (BRCs) are promising solutions commonly used in urban settings to improve the water quality and mitigate the hydrological effects of stormwater runoff (e.g. Lisenbee et al., 2021; Nazarpour et al., 2023).

This study aims to examine the effectiveness of BRCs () at the catchment scale by means of a Decision Support Tool (DST) implemented in the web-GIS application namely TRIG Eau platform recently developed within the homonymous INTERREG IT-FR Maritime Programme project (Palla and Gnecco, 2021). The web-GIS application (available online at http://www.trigeau.servergis.it/) refers to a non-specific urban area that is simplified into two typologies of sub-catchments (streets and residential) with an extension of 2 ha. In the framework of Res-Eau project (the capitalisation project of TRIG Eau), the platform is updated in order to include the BRC solution as mitigation strategy. Modelling scenarios include four degrees of urbanization, four precipitation regimes, three drainage network configurations, and a specific BRC conversion scenario. Furthermore, for each precipitation regime, three return periods of the rainfall event are investigated.

The evaluation of the BRC's effectiveness is conducted by analysing both the system and hydrologic performance based on the following indexes: the Network Stress Reduction (NSR), the Node Flooding Reduction (NFR), the Volume Reduction (VR) and the Peak Reduction (PR). The simulations are carried on implementing the BRCs to manage solely on road surface runoff with a ratio between the BRC and the contribution drainage area equal to 18%. Based on such conversion scenario, the results reveal that the BRC is highly effective in mitigating the negative impacts of extreme rainfall events. As an example, in the 90% degrees of urbanization the BRC conversion scenario provide the following performance: the NFR, VR and PR are equal to 28%, 23% and 10% respectively for a 10-year return period rainfall event.

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