EGU23-5974, updated on 10 May 2023
https://doi.org/10.5194/egusphere-egu23-5974
EGU General Assembly 2023

Monitoring and modeling the hydrological performance of a rain garden installation for flood risk mitigation at a urban site

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The Rain Garden was built as part of "Proterina 3 Evolution", a strategic project of the Interreg Maritime Italy France program, between 2018 and 2019, commissioned by the partner Città Metropolitana di Genova to the Department of Architecture and Design of the University of Genoa, with the project's scientific directors prof. Adriano Magliocco and prof. Katia Perini, involving arch. Paola Sabbion, as landscape architect and, subsequently as regards to hydrological monitoring, prof. Luca Lanza and dr. Arianna Cauteruccio.

The rain garden was built in a free area facing a school building in the municipality of Campomorone (Genoa, Italy). The goal was to verify the functioning of a NBS in a climatic context characterized by rainfall concentrated in short periods of time, with particularly dry summer seasons.

The rain garden is of the non-infiltrating type. It receives the rainwater directly and from the pavement of a parking lot. The water passes through a container equipped with an overflow and is supplied to the rain garden via a micro-perforated pipe. The Rain Garden is waterproofed on the bottom and has a drainage pipe that takes the water to the measuring device placed inside a control pit.

The pilot site is equipped with a tipping bucket rain gauge, calibrated according to the European Standard EN 17277:2019. The rain gauge provides the inter-tip time stamp as a measurement of precipitation intensity at high temporal resolution. Both direct precipitation over the raingarden area and the flow rate drained from the nearby impervious parking surface act as the forcing input. The output from the raingarden is measured using a water level gauge located in the output control pit, at a one-second resolution. The input and output measurements are then aggregated at the one-minute resolution for post-processing.

In this work, the hydrological behaviour of the raingarden is simulated using a conceptual model involving a cascade of three linear reservoirs: the first one representing the fast response of the impervious surface, the second one the shallow soil layer used by the vegetation and the third one the deep drainage layer. Each reservoir is characterized by a retention and a storage coefficient. Precipitation and outflow events recorded during one year of measurements in the wet period, from autumn to spring, allowed characterizing the hydrological performance of the system. The

value of each parameter was calibrated using part of the measured precipitation and outflow events. The remaining events were used to validate the reliability of the conceptual model using the same parameters. The aim of this work is to verify the role of the implemented NBS to reduce direct runoff in an urban environment for flood risk mitigation purposes.

Results are expressed in terms of non-dimensional performance indices: flow peak attenuation, dead time and retention coefficient. The validation of the model parameters allows extending this NBS model to other sites characterized by a similar rainfall climatology. In that case, performance indices can be derived by measuring the precipitation alone.