



Laboratory testing and in-situ monitoring of the hydrological response of a resin gravel permeable pavement and a bioswale

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The present study investigates the hydrological performance of two Nature Based Solutions (NBS) realised within the urban requalification project of the former military area “Caserma Gavoglio” (now public park), in one of the most heavily urbanized districts of the city of Genoa (Italy). The rapid expansion of urbanization has led to an increase in impervious surfaces and a consequent increase in runoff generation, flood volume and flood peak. Since the required expansion of the stormwater drainage capacity is neither economically nor environmentally sustainable, innovative stormwater management strategies are required. In this context, NBSs represent effective solutions to mitigate runoff generation and peak flows and restore natural infiltration processes.

A resin gravel permeable pavement (PP) was used for the paving of about 40% of the park surfaces while a bioswale was realised alongside the sport field to manage stormwater excess.

The PP was preliminarily tested in the laboratory by monitoring the outflow from a standardized test bed under various rainfall input and slope conditions. The results of the tests were interpreted mathematically using the analogy of the step response function of first- and second-order dynamic systems. This allows to transfer the laboratory results for comparison with field conditions, even if these were not precisely reproduced in the laboratory tests.

Both NBSs were monitored in the field with the objective to measure the outflow rate, representing the inflow to the urban drainage system, and to compare it with the corresponding rainfall input.

Two hydrometric measurement stations and one rain gauge station were installed. Since the stormwater drainage system was already in place, water stage probes were housed inside existing manholes equipped with suitable “V-shaped” weirs. Due to non-standard operational conditions, the measurement stations were preliminarily tested in the laboratory to verify their accuracy prior to field installation.

From the monitored rainfall events, direct comparisons between the measured precipitation and the outflow hydrographs were performed. These analyses enabled the quantification of the retention and detention effects due to the NBSs and their improvement relative to typical

impervious paving solutions. The following performance indicators were derived for each significant precipitation event that exceeded the retention capacity of the NBS: (i) the outflow coefficient, defined as the ratio between total outflow and rainfall volumes, (ii) the peak reduction coefficient, i.e. the ratio between peak discharge and peak rainfall intensity and (iii) the system response delay, i.e. the time lag between the centre of mass of the flow hydrograph and that of the rainfall.

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