Rainwater runoff from green roofs with construction and demolition waste

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Abstract

Green roofs are one the nature-based solution that are increasingly being implemented worldwide to assist on stormwater management in urban spaces. They, however, entail a much wider range of benefits both at the building scale (improved thermal and sound insulation performance, longer durability of the roof waterproof layers, increased property valuation) and at the city scale (noise reduction, heat island effect reduction, air quality improvement, carbon sequestration, increased biodiversity). These benefits have direct and/or indirect impacts at economic (lower overall life-cycles cost of the urban structures), environmental (air and water quality improvement, resources consumption reduction) and social (e.g., improved health and wellbeing, job creation) levels.

However, the installation of a green roof system implies the consumption of resources. If some, namely the substrate and plants are natural and entail only the burden of transportation and installation, others require the consumption of resources for their production (mats and drainage layer). Regarding the latter group, herein we assess the hydrologic performance of using construction and demolition waste (CDW) for the drainage layer. At the onset, the only identifiable disadvantage is the weight, since CDW is also a porous product and the presence of cimentious and lime products may even enhance carbon sequestration.

To test the hydrological performance of green roofs with CDW, 8 experimental trays were assembled, 4 with CDW and 4 without with different systems, and submitted to simulated rainfall events. The simulated rainfall events had a duration of 20 minutes and constant intensities ranging from 25 to 90 mm/h This corresponds to a total rainfall of up to 31 mm. At an hourly time scale, only 2.5% of the hours with rain recorded more than 31 mm (Figure 1 top). Even at the precipitation event time scale, considering natural rainfall events independent if there is at least on calendar day without rain, roughly 80% of the events have a total rainfall less than the maximum tested (Figure 1 bottom). Furthermore, the largest rainfall are also the longest events, with a Pearson correlation of 0.83 between the total rainfall and the duration, in days, of the event.

The runoff differences between green-roofs without and with CDW are favourable towards the latter, except in the G2 solution. In the remaining solutions the runoff is lower from the green roofs with CDW and the differences are roughly the same order of magnitude for all rainfall intensities (Figure 2 top). This translates in higher relative differences for the lower rainfall intensities (Figure 2 bottom), because the average runoff increases with the rainfall amount. The results for the rainfall intensity are not present, since no runoff was observed in any experiment for all solution.

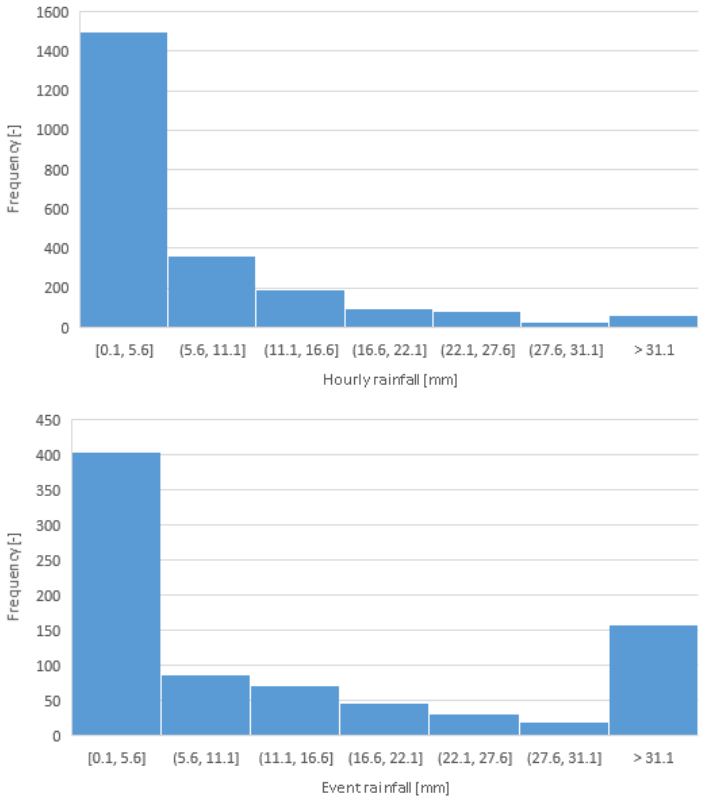

Figure 1 – Histogram of the rainfall amount per hour (top) and per precipitation event (bottom) in Lisbon between 2000 and 2021

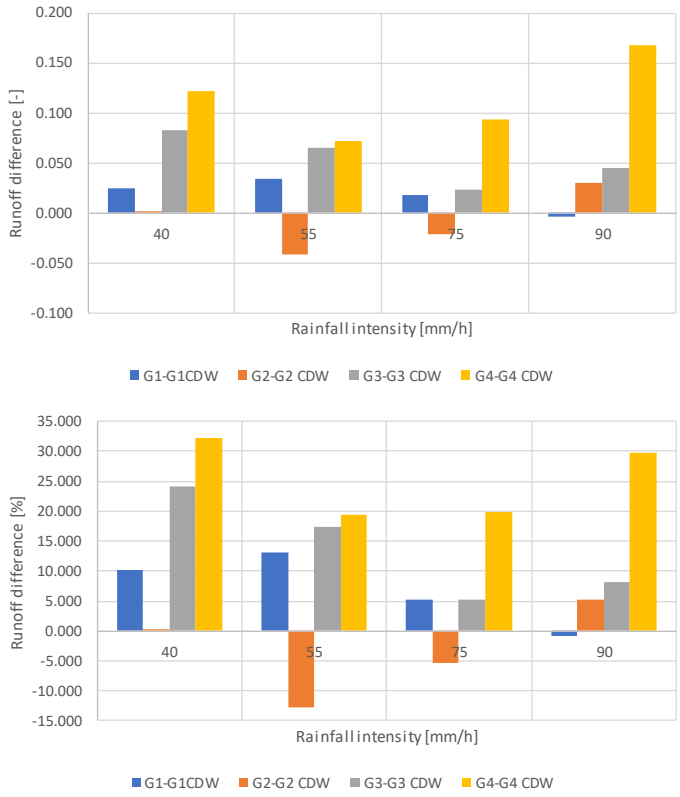

Figure 2 – Runoff difference in absolute (top) and relative values (bottom)