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Effectiveness of green areas and impact of the spatial pattern on water infiltration within cities

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Soil is a non-renewable resource subject to increasing degradation favoured by human activities, such as the creation of impervious surfaces. Driven by increasing global population, soil sealing became a major challenge due to growing expansion and its impact on decreasing ability of soil to provide ecosystem services. In order to mitigate the environmental and social impacts of sealing, a worldwide interest in greening the cities have been noticed among politicians and stakeholders. Urban green areas provide benefits for the urban water cycle, namely through reducing stormwater runoff and flood hazard. The effectiveness of green areas inside the cities on runoff reduction, is still not well understood. This is partially due to the role of complex landscapes, including distinct urban types (e.g. residential vs commercial) and spatial patterns, on rainfall-runoff processes. This study aims to investigate the impact of different spatial patterns of sealing and green areas on surface runoff. Inspired on the spatial patterns of green areas observed in several Portuguese city centres crossed by rivers, three spatial patterns were investigated: dispersed gardens with a narrow green strip along the stream (SS); small gardens along contours, with a large green strip downslope (HD); linear gardens along the slope, with a large green strip downslope (VD). The impact of these three patterns was assessed through lysimeter experiments, using concrete blocks to simulate sealed surfaces and turfgrass to mimic gardens. All the configurations included 60% sealing and 40% greening, which is the maximum allowed in several Portuguese municipalities for urban areas. The lysimeters have an area of 1.24 m^2 and a depth of 0.15 m, filled with sandy loam soil (1.4 kg/m^3) bellow the pavement and the turfgrass, and are placed with a 13º-16º slope. The lysimeters were installed in October 2019 and are subject to natural rainfall. After each storm, runoff and leachate measurements have been performed. Three soil moisture sensors were installed per lysimeter, at 10 cm depth, and provide continuous records with 5 min intervals. Rainfall data is collected with a rain gauge installed nearby, with a 5 min resolution. Results show that 40% turfgrass is able to cope with the majority of rainfall and runoff from upslope paved surfaces. Runoff coefficient is typically less than 2% and attained a maximum of 4% during the largest (40 mm) and more intensive storm (9.4 mm/h). Although increasing soil moisture slightly enhances runoff generation, the spatial patterns investigated at small scale did not show significant impacts on rainfall-runoff processes. Turfgrass revealed effective to retain and infiltrate rainfall and runoff from paved surfaces. It may provide an

adequate solution to mitigate the impact of urbanization on the water cycle and flood hazard within cities.