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Large-scale rainfall simulation to study overland flow and transport of diffusive pollutants in urban areas

Jorge Isidoro (1,3), Alexandre Silveira (2), and Bruno Lima (2)

(1) Department of Civil Engineering, Institute of Engineering, University of Algarve (ISE/UAlg), Faro, Portugal, (2) Institute of Science and Technology, Federal University of Alfenas (UNIFAL-MG), Poços de Caldas-MG, Brazil, (3) Marine and Environmental Sciences Centre (MARE), Coimbra, Portugal.

The urbanization process leads to a reduction of infiltration and detention capacity of natural soil, thus augmenting runoff and pollutant transport. The future will bring more stress to the “urban” hydrological cycle, and so, further knowledge on how the urbanization processes changes the “natural” hydrological cycle is therefore needed.

Objective of presentation is a large-scale rainfall simulator that was developed and used to study the rainfall-runoff process and associated pollutant transport in urban impervious areas. The rainfall simulator equipped with a set of 16 full-cone nozzles can produce artificial rainfall with different rainfall intensities over a 100.0 m^2 impervious v-shaped square drainage basin. An acrylic structure eliminates the influence of wind and natural rainfall from the v-shaped square basin. Blocks of polystyrene were used to simulate buildings, where three different scenarios of urban occupation were set: without blocks, with 12.8% and with 25.6% of the impervious basin occupied by blocks. Sodium chloride placed in two positions simulating a farther and a nearer origin of the diffusive pollutant source from the outlet of the experimental basin. Simulations of rainfall-runoff and diffusive pollutant transport processes were then performed with a constant rainfall intensity of 44 mm/h for a rainfall event duration of 240 s.

The large-scale rainfall simulator and the use of physical models showed to be an important tool for simulating rainfall-runoff and diffusive pollutants transport processes. The resultant hydrographs are similar (rising limb, peak, recession limb), regardless of the different building occupancy scenarios. Nonetheless, the scenario without buildings lead to a faster initiation of runoff. The position of the source of the pollutant and the building occupancy scenarios lead to pollutographs with differences in the initial and final time of transport, time to peak, peak value and total mass of transported pollutant.