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Green roof rainfall-runoff modelling: is the comparison between conceptual and physically based approaches relevant?

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Green roofs are commonly considered as efficient tools to mitigate urban runoff as they can store precipitation, and consequently provide retention and detention performances. Designed as a compromise between water holding capacity, weight and hydraulic conductivity, their substrate is usually an artificial media differentiating significantly from a traditional soil. In order to assess green roofs hydrological performances, many models have been developed. Classified into two categories (conceptual and physically based), they are usually applied to reproduce the discharge of a particular monitored green roof considered as homogeneous. Although the resulted simulations could be satisfactory, the question of robustness and consistency of the calibrated parameters is often not addressed.

Here, a modeling framework has been developed to assess the efficiency and the robustness of both modelling approaches (conceptual and physically based) in reproducing green roof hydrological behaviour. SWMM and VS2DT models have been used for this purpose. This work also benefits from an experimental setup where several green roofs differentiated by their substrate thickness and vegetation cover are monitored. Based on the data collected for several rainfall events, it has been studied how the calibrated parameters are effectively linked to their physical properties and how they can vary from one green roof configuration to another.

Although both models reproduce correctly the observed discharges in most of the cases, their calibrated parameters exhibit a high inconsistency. For a same green roof configuration, these parameters can vary significantly from one rainfall event to another, even if they are supposed to be linked to the green roof characteristics (roughness, residual moisture content for instance). They can also be different from one green roof configuration to another although the implemented substrate is the same. Finally, it appears very difficult to find any relationship between the calibrated parameters supposed to represent similar characteristics in both models (porosity, hydraulic conductivity). These results illustrate the difficulty to reproduce the hydrological behaviour of such an artificial media constituting green roof substrate. They justify the development of new methods able to take to into account the spatial heterogeneity of the substrate for instance.