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Analysis of green roof's water balance components using Universal Multifractal (UM) framework

Filip Stanic (1,2), Pierre-Antoine Versini (1), Ioulia Tchiguirinskaia (1), Daniel Schertzer (1), Pierre Delage (2), and Yu-Jun Cui (2)

(1) Ecole des Ponts ParisTech, HMCo, Champs-sur-Marne, France, (2) Ecole des Ponts ParisTech, Navier, Champs-sur-Marne, France

Implementation of green roofs in highly urbanized areas is becoming more and more required in recent years for variety of reasons. Besides the urban heat island (UHI) effect that is characteristic for large metropolitan areas where temperature can be significantly higher compare to surrounding rural areas, there is one more important aspect of green roofs utilization: mitigation and delay of urban runoff peak. The retention and detention capacities of green roofs' substrate and vegetation layer were proved to be the main advantage of this particular type of Nature Based Solutions (NBS) for cities. However, dynamic physical processes involved in green roofs are highly non linear and variable. In order to accurately assess green roof performances in terms of thermo-hydraulic behavior and to better understand influence of roofs' inclination on space time variability of water content, detailed in situ monitoring is required.

The 1 ha wavy-form green roof of the Bienvenüe building, called the Green Wave, has been monitored in Champs-sur-Marne (France), in front of Ecole des Ponts. Several measuring devices have been accurately capturing all components of urban water balance. For instance, the rainfall intensity is estimated using data collected by the onsite Parsivel disdrometer. Wireless network of TDR water content and temperature sensors, distributed at different slope positions over the Green Wave, has been specially installed for characterizing spatial and temporal variability of infiltration and retention processes. Also, drained discharge measurements are carried out in the storm-water pipes and tanks that are collecting drained water.

We first will present the current monitoring results, regarding different urban water balance components, then the results of data analysis using Universal Multifractals (UM). UM has been extensively used to analyse and simulate numerous geophysical fields, in particular the rainfall that is extremely variable over wide range of scales. However, to our knowledge, this is the first time the UM approach has been used to assess the space-time variability of the water content, and more generally, of the green roof behavior. A particular attention will be devoted to quantifying the impact of roofs' inclination on the scaling of hydrological responses of green roofs, by comparing and cross-referring the UM parameters of the rainfall with those of the drained discharge and of water content data provided by the spatially distributed TDR sensors.
This work can be considered as the initial stage for developing the through scale understanding of urban water cycle, leading to a more reliable estimations in terms of its components, to support urban stormwater polices.