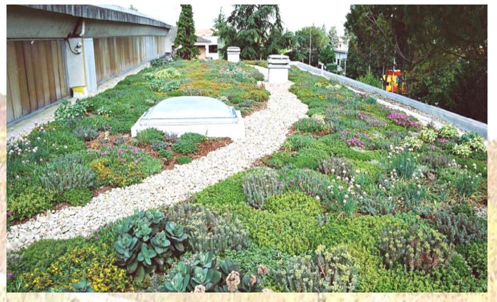
Roof storage systems: Modelling and performance's comparison

E. Beckers[1]* and A. Degré[1]

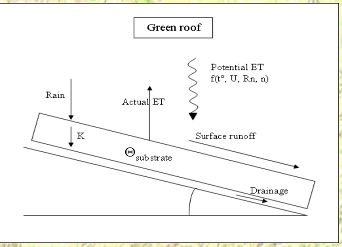
1 Hydrology and Agricultural Eng., Environmental Science and Technology Department, Gembloux Agricultural University, 2 Passage des Déportés, 5030 Gembloux, Belgium (mail:beckers.e@fsagx.ac.be)

Introduction

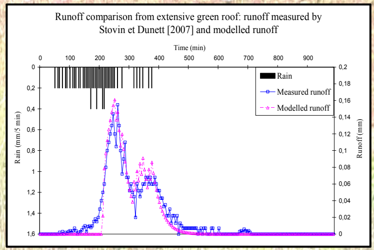


Rainwater runoff problems have become critical in large cities because of the increasing imperviousness of surfaces. Best practices to manage urban runoff improve water infiltration and evaporation through green areas establishment and, therefore, natural hydrological cycle restoration. Roofs, representing about 40–50% of the impermeable surfaces in urban areas, are a significant unused surface and could therefore represent a great tool for urban water management. The aim is to evaluate rainwater runoff from different types of roof storage systems and to conclude about their own interests to manage urban runoff production.

Model establishment

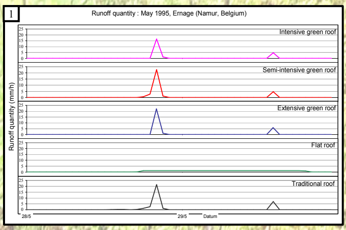


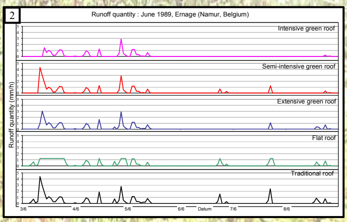
We established a model concerning three types of green roofs and a flat roof storage system based on a physical approach. The water balance's terms were estimated: evapotranspiration depending on vegetation layer (sedums, grass, shrubs, trees…), runoff and interflows (via hydraulic conductivity, albedo)… The hourly meteorological data were recorded at Ernage (Namur, Belgium) and covered 7 years (1989-95). The simulation gives the amount of runoff per hour for each roof and compares the result with a traditional roof. A first validation test compared results from the model and measurements on an extensive green roof in Sheffield, UK [Stovin and Dunett, 2007]. The results from our model coincide rather well with in-situ measurements.



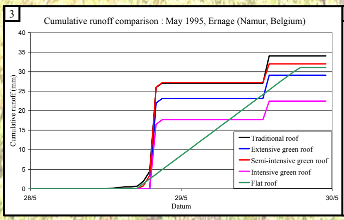
Results

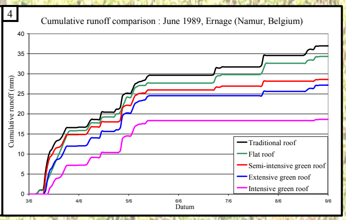
To illustrate existing differences between roof types, we compared each roof's outlet during two rain events: a short intensive rainfall event (May 1995 [1]), and small successive rainfalls events (June 1989 [2]). Outcomes showed that the intensive and extensive green roofs caused some delays of the initial time of runoff and reduced or retained some rain events depending on the soil moisture level when it started raining. The semi-intensive green roof was less efficient. Flat roof reduced peak flows and distributed runoff over a long time period.





These behaviour differences appear more distinctly with the representation of the cumulative runoff along the time for both rain events. For May 1995 [3], differences between green roofs and flat roof storage systems are obvious. Flat roofs will generate runoff over the whole day while green roofs retain a relatively small quantity at the beginning of the rainfall. However, for the total quantity of runoff, intensive and extensive green roofs are the more efficient. They mainly reduce the runoff at the beginning of the rainfall event. For June 1989 [4] the curves tend to present a similar evolution. As a result, differences between roofs are less significant or even inexistent for runoff distribution. However, roofs are classified in the same order as before in the view of the total amount of runoff.





Conclusion

According to the model's results, we can draw the first lines of a conclusion about peak flow reductions, initial times of runoff and annual runoff volumes reductions. Flat roof can reduce peaks flows and regulate rate of runoff over a long time period when the rain intensity exceeds its calibrated outlet. However, this roof type doesn't delay the initial time of runoff and the annual runoff reduction is negligible compared to green roofs. Green roof's performance is connected to water retention capacity of the substrate layer (porosity and depth) and rain event's succession.

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