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Integrated Modelling and Performance Analysis of Green Roof Technologies in Urban Environments

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As a result of the changing global climate and increase in urbanisation, the behaviour of the urban environment has been significantly altered, causing an increase in both the frequency of extreme weather events, such as flooding and drought, and also the associated costs. Moreover, uncontrolled or inadequately planned urbanisation can exacerbate the damage. The Blue-Green Dream (BGD) project therefore develops a series of components for urban areas that link urban vegetated areas (green infrastructure) with existing urban water (blue) systems, which will enhance the synergy of urban blue and green systems and provide effective, multifunctional BGD solutions to support urban adaptation to future climatic changes. Coupled with new urban water management technologies and engineering, multifunctional benefits can be gained.

Some of the technologies associated with BGD solutions include green roofs, swales that might deal with runoff more effectively and urban river restoration that can produce benefits similar to those produced from sustainable urban drainage systems (SUDS). For effective implementation of these technologies, however, appropriate tools and methodologies for designing and modelling BGD solutions are required to be embedded within urban drainage models. Although several software packages are available for modelling urban drainage, the way in which green roofs and other BGD solutions are integrated into these models is not yet fully developed and documented.

This study develops a physically based mass and energy balance model to monitor, test and quantitatively evaluate green roof technology for integrated BGD solutions. The assessment of environmental benefits will be limited to three aspects: (1) reduction of the total runoff volume, (2) delay in the initiation of runoff, and (3) reduction of building energy consumption, rather than water quality, visual, social or economic impacts. This physically based model represents water and heat dynamics in a layered soil profile covered with vegetation which can be used to simulate the physical behaviour of different green roof systems in response to rainfall under various climatic conditions. Because it is a physically based model, this model could be generalised to other atmosphere-plant-soil systems. The validity of this mass and energy balance approach will be demonstrated by comparing its outcomes with observations from a green roof experimental site in London, UK.