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Green roofs: Effects of substrate and vegetation on runoff

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Green roofs are increasingly used as a major nature-based solution worldwide to reduce urban stormater runoff. Substrate and vegetation are the main components of green roofs, which may affect the hydrological performance of green roofs through retention and detention of stormwater. Based on the rainfall-runoff observations of 15 green roofs *(Portulaca grandiflora*, *Sedum lineare*, *Festuca elata*, and bare substrate) located in Beijing for 26 rainfall events in 2017, the impacts of substrate and vegetation cover on the hydrological performance of green roofs were investigated using runoff and peak discharge reduction rates and time-delay of runoff generation and peak discharge as the indices. The recorded rainfall events were divided into four groups, i.e., light rain (0.1∼9.9mm), moderate rain (10∼24.9mm), heavy rain (25∼49.9mm) and rainstorm (50∼99.9mm). For all the 15 green roofs, there is a significantly ($p<0.01$) negative correlation between runoff reduction rate and rainfall event volume, the runoff reduction rate decreased from 100% to about 42%∼62% as the rainfall volume increased from 0 to 81.4mm. However, none significant correlation between peak discharge reduction rate and rainfall volume / intensity were found for the 26 rainfall events. The impacts of substrate and vegetation on the hydrological performance of green roofs changed with rainfall conditions. The differences between runoff reduction rates of green roofs with different types of substrate and vegetation cover were the largest for the heavy rainfall events. For the moderate and rainstorm events, the differences were a little bit lower. For the light rainfall events, however, there were no significant differences were observed among the runoff reduction rates of green roofs with different types of substrate and vegetation cover as very little runoff was generated from them. For the moderate and heavy rainfall events, the hydrological performance of green roofs with local planting soil and engineered soil as substrate is better than that of green roofs with light growing medium as substrate. Increasing the depth of substrate layers from 10 cm to 15 cm for all the three types of substrates could obviously improve the hydrological performance of green roofs. Vegetation cover could enhance the hydrological performance of green roofs as the runoff and peak discharge reduction rates and time-delay of runoff generation and peak discharge of green roofs covered with vegetation were all better than the bare substrate, for all the groups of rainfall events except the light one. Among the vegetation covered green roofs, the ones planted with *Portulaca grandiflora* performed the best as the average height and shoot biomass per unit area of *Portulaca grandiflora* were the largest.