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Forecast-based operation of smart blue-green roofs to reduce the impacts of extreme weather in cities

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Research shows that climate change will increase the intensity and frequency of extreme summer precipitation events as well as heatwaves, over the coming decades (IPCC, 2014; Russo et al., 2015). Moreover, the impact of heat waves will likely increase in cities due to the urban heat island (UHI) effect (Li & Bou-Zeid, 2013). Green infrastructure (e.g. parks, green roofs, etc.) is generally seen as an effective adaptation measure to address these challenges. The city of Amsterdam has started a project (RESILIO, https://resilio.amsterdam/en/smart-blue-green-roofs) to investigate a new innovation in this field: smart blue-green roofs. These roofs have the advantage over green roofs in that they have an extra water retention layer underneath the green layer, which can be used to buffer peak rainfall or as a capillary irrigation system for the plant layer in hot and dry summer days. The smart valve on the roof can be opened when extreme precipitation is predicted to capture extreme rainfall, but it is yet unknown if this forecast-based drainage provides added value to optimize the operation of the valve.

Therefore, this study evaluates the performance of European Centre for Medium-Range Weather Forecasts (ECMWF) ensemble precipitation forecasts to trigger drainage from blue-green roofs. A conceptual hydrological model of a blue-green roof in Amsterdam is set up to simulate its operation for the last 5 years. Three drainage strategies can be triggered according to different probabilities of precipitation (30th, 60th and 90th percentile) based on ECMWF data. Each strategy is evaluated on how it leads to (1) minimize the overflow during peak rainfall into the city drainage system, and (2) to maintain high water levels during hot summer days to boost evaporative cooling. Preliminary results show that some early drainage strategies result in capturing 50-100% of rainfall (>10mm/hr), while enough water is available on most hot summer days (T>25□) to ensure atmospheric cooling through plant transpiration. This implies that relatively low-resolution (18km) precipitation forecasts from ECMWF are valuable for anticipatory water management on a very local scale. These results also show the high potential of blue-green roofs for urban climate adaptation, and the need for anticipatory management of these nature-based solutions. The next research steps will include a city-scale roof suitability analysis that will reveal the value of this solution when implemented at most flat roofs in the city of Amsterdam.

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