Real-Time Control of Rainwater Harvesting Systems: The Benefits of Increasing Rainfall Forecast Window

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Abstract

Use of Real-Time Control (RTC) technology in Rainwater Harvesting Systems (RWH) can improve performance across water supply, flood protection, and environmental flow provision. Such systems make the most of rainfall forecast information, to release water prior to storm events and thus minimise uncontrolled overflows. To date, most advanced applications have adopted 24-hr forecast information, leaving longer-term forecasts largely untested. In this study, we aimed to predict the performance of four different RTC strategies, based on different forecast lead-time and preferred objectives. RTC systems were predicted to yield comparatively slightly less harvested rainwater than conventional passive systems, but delivered superior performance in terms of flood mitigation and delivery of environmental water for streamflow restoration. More importantly, using a 7-day rainfall forecast, the longest commercially available prediction window, was shown to enhance the ability of RTC in mitigating flood risks and delivering an outflow regime that is close to the natural (reference) streamflow. Such a finding suggests that RTC combined with 7-day forecast can enhance the functionality of rainwater harvesting systems to restore and even mimick the entire natural flow regimes in receiving streams. This also opens up a new opportunity for practitioners to implement smart technology in managing urban stormwater in a range of contexts and for a range of stream health objectives.

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Key Points:

- Four contrasting Real-Time Control strategies were applied to simulated rainwater harvesting systems
- Long lead-time rainfall forecast (7-day) enhanced the ability to reduce flood risk and restore baseflow, with little impact on water supply efficiency
- Using long lead-time rainfall forecast has the potential to holistically restore natural flow regimes.

Abstract

Use of Real-Time Control (RTC) technology in Rainwater Harvesting Systems (RWH) can improve performance across water supply, flood protection, and environmental flow provision. Such systems make the most of rainfall forecast information, to release water prior to storm events and thus minimise uncontrolled overflows. To date, most advanced applications have adopted 24-hr forecast information, leaving longer-term forecasts largely untested. In this study, we aimed to predict the performance of four different RTC strategies, based on different forecast lead-time and preferred objectives. RTC systems were predicted to yield comparatively slightly less harvested rainwater than conventional passive systems, but delivered superior performance in terms of flood mitigation and delivery of environmental water for streamflow restoration. More importantly, using a 7-day rainfall forecast, the longest commercially available prediction window, was shown to enhance the ability of RTC in mitigating flood risks and delivering an outflow regime that is close to the natural (reference) streamflow. Such a finding suggests that RTC combined with 7-day forecast can enhance the functionality of rainwater harvesting systems to restore and even mimick the entire natural flow regimes in receiving streams. This also opens up a new opportunity for practitioners to implement smart technology in managing urban stormwater in a range of contexts and for a range of stream health objectives.

Plain Language Summary

'Smart tanks' based on Real-Time Control (RTC) is increasingly used in rainwater harvesting systems to address water shortages, urban flooding and streams depleted of flow. Smart tanks, controlled by RTC, can use a range of digital information (e.g. rainfall forecast) to make optimal decisions to release some tank water before heavy rain, to reduce flood risks, while still supply water to households. Globally, most uses of this technology use 1-day forecasts of rainfall. To understand the effect of longer prediction window, we compared four strategies using either 1-day or 7-day rainfall forecast and modelled their performance using specialized computer code. We found that smart tanks using 7-day rainfall forecasts are superior in reducing urban flood risks and restoring baseflows to streams. More importantly, they can release the tank water in a pattern that is similar to natural streamflow, thus helping to restore and sustain healthy waterway habitats. Our study is the first reported application of 7-day forecast information in smart control rainwater tanks. It opens up a new opportunity in managing urban water in a range of contexts and for a range of stream health objectives.