Potential benefits of real-time control to reduce urban flooding using distributed smart stormwater storage systems

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Stormwater infrastructure will require investments in the order of $100s of millions per local government area to maintain current levels of urban flood protection. This investment is likely to increase in the future as a result of the impact of climate change, population growth and increased urban densification. Traditional solutions aimed at increasing the capacity of stormwater systems have been directed towards pipe upgrades. An alternative approach is the use of smart storages, which have the following advantages:

- Extension of the lifespan of existing stormwater systems
- Provision of water supply
- Reduction in pollution levels in receiving waters.

The development of smart technologies enables the use of real-time control for increasing the effectiveness of storages. If forecasts of the timing and magnitude of impending rainfall events are available, storage outlet controls can be optimised to release stored water prior to and during the rainfall event to enable the peak flows to be reduced. In addition, by jointly controlling the outflows from multiple, distributed storages, rather than using a single storage or controlling multiple storages independently, coincident flood peaks from different sub-catchments can be minimised, further reducing peak flows at critical locations.

In this study, the potential benefits of real-time time control for distributed storages are compared with a system that uses storages without real-time controls. The impacts were assessed using a two-storage system, which is modelled using the software package SWMM with the real-time control schemes of the storages being optimised using a genetic algorithm. The case study was conducted for two storage sizes (2 and 10 m³) under a wide range of design rainfall conditions, with storm durations ranging from short (30mins) to long (24hrs), and annual exceedance probability ranging from frequent (50%AEP), to rare (1%AEP) for three different Australian climates (sub-tropical/Mediterranean). This results in a total of 75 different combinations. Results show there is a generic relationship between percentage peak flow reduction and the ratio of storage size to storm runoff volume irrespective of location and storm characteristics. The benefits of real-time control of smart storage systems identified were:
- Significant peak flow reductions ranging from 85% (for a larger storage size of 80% of storm volume) to 35% (for small storages size of 15% of runoff volume).
- Importantly, real-time control of storages significantly outperforms storages without real-time control, with additional peak flow reduction of between 35% to 50%.

These results highlight the potential for using distributed storages for mitigating urban flooding, even for extreme events. The potential benefits of smart storages in more realistic cases studies (uncertain rainfall forecasts and larger scales) are also discussed.