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3 **1 Enhancing Stormwater Control Measures Using Real-Time Control**
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5 **2 Technology: A Review**
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9 **Enhancing Stormwater Control Measures Using Real-Time Control**

10 **Technology: A Review**

11 **Abstract**

12 Stormwater Control Measures (SCMs) are increasingly applied to capture and utilize
13 urban runoff to augment water supply, reduce flood risk, and to restore natural flow
14 regimes in receiving waters. New advances in Real-Time Control (RTC) technology
15 offer the potential to dynamically optimise SCM performance to meet multi-objectives,
16 without the need for major structural upgrades. This paper reviews the application of
17 RTC applied to different types of SCMs at a range of scales, revealing both the benefits
18 and challenges. RTC can improve urban water management both now and into the future,
19 and the applications are vast. SCM performance can be optimised at a single site scale,
20 but its real utility will be in larger collaborative systems, and its potential will increase
21 with improved forecast capability and decreased costs of sensors and control elements.
22 There is a critical need for creating new regulatory environments, governance and
23 business models, to facilitate widespread implementation.

24
25 **Key Words:** Real-Time Control (RTC), Urban Water Management, Stormwater
26 Control Measures, Flow Regime, Smart Control Technology, Water Sensitive Urban
27 Design

1. Introduction

Despite recent advances in urban water management, many old challenges remain, and new ones are emerging. Dwindling freshwater resources threaten human water security (Vörösmarty et al. 2000; Vörösmarty et al. 2010). Flooding is still a major social and economic hazard in many cities (Jongman et al. 2012) and urban stream channels are eroding at alarming rates, driven by excessive flows from urban runoff (Russell et al. 2019; Hawley et al. 2013; Vietz et al. 2017). Untreated impervious runoff contaminates downstream receiving waters through either sewer overflows and exfiltration in combined sewer systems or through direct discharge in systems with separate stormwater and wastewater networks (Sercu et al. 2011; Divers et al. 2013; Kim et al. 2007; Ellis and Hvitved-Jacobsen 1996). These altered water cycles and flow regimes lead to ecological degradation in urban streams and a subsequent loss of ecosystem services (Walsh et al. 2012; Bunn and Arthington 2002; King et al. 2005; Wright et al. 2011).

For years, researchers and practitioners have promoted the use of Stormwater Control Measures (termed here as SCMs; for a full description of related terminology, see Fletcher et al. 2014a) to capture and utilize urban runoff to augment supplies and reduce flood risk and overall load on the combined sewer treatment plant, and to restore more natural flow regimes by promoting infiltration and groundwater recharge (Ashley et al. 2013; Marsalek and Chocat 2002; Hamel et al. 2013; Rhea et al. 2015). Common SCMs include infiltration-based systems (e.g. unlined biofilters, infiltration trenches, basins and porous pavement; Bhaskar et al. 2016; Shuster and Rhea 2013; Bell et al. 2016; Rhea et al. 2015) and retention-based systems (e.g. rainwater harvesting systems, wetlands and green roofs; Burns et al. 2015b; Askarizadeh et al. 2015; Al-Rubaei et al. 2016). Despite the intentions of this move towards more water-sensitive approaches to stormwater management, change to date has arguably been limited (Bedan and Clausen 2009; Bell et al. 2016; Hur et al. 2008), with SCM implementation constrained by a

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3 53 range of factors (Farrelly and Brown 2011; Brown et al. 2011). Given additional stressors of
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5 54 future climate change and population growth, there is a real need to enhance both the
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8 55 performance and adaptability of Stormwater Control Measures.

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10 56 Novel advances in Real-Time Control (RTC) technology offer great promise to
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12 57 improve conventional urban water management. RTC is a collection of sensors,
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14 58 communication devices, actuators and software (Bennett 1994; Brogan 1991), which can be
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17 59 used to actively and automatically operate components of the urban water cycle. RTC can
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19 60 modify the passive operation of conventional SCMs by actively controlling the system
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21 61 processes, including inflow, outflow and detention time, allowing them to cope better with the
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23 62 stochastic nature of stormwater quantity and quality. For a new system, RTC could potentially
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25 63 allow it to be built at a smaller size while delivering the same level of service as a conventional
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27 64 larger design. For existing systems, RTC could improve current performance, without
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29 65 requiring system capacity to be upgraded. Most importantly, RTC could change the way people
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31 66 and organizations manage urban water at a range of scales. Doing so could transform
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33 67 individuals to become active providers of urban water services, utilising new governance
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35 68 models inspired by the increasingly-decentralised energy market (Mah et al. 2012).

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38 69 Applications of real-time control technology in urban water management are numerous.
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40 70 However, harnessing the potential of such technologies requires 1) greater trust in the
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42 71 technology, 2) development and testing of case studies, and 3) overcoming of social,
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44 72 institutional and economical barriers. In this paper we aim to examine use of RTC technology
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46 73 in urban water management by reviewing its application to different types of infrastructure:
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48 74 nature-based SCMs (including wetlands, biofilters and vegetated swales), detention basins and
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50 75 rainwater harvesting systems. Building on this new understanding, we consider how the
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52 76 technology could be used to transform the current urban water management.
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3 77 This review consists of two principal components. The first part discusses how RTC
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5 78 could enhance the hydrologic performance of different types of SCMs—e.g. their ability to
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7 79 improve water quality and attenuate peak flows locally. While the benefits of control might
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9 80 depend on the particular context, several studies suggest that RTC can improve the
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11 81 performance of SCMs at the site scale, but further empirical validation is required to be
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13 82 confident in this hypothesis. The second part investigates the potential of RTC technology to
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15 83 play a major role at larger scales, by operating a range of distributed small-scale systems as a
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17 84 coordinated system. This envisions a future intelligent water management network, where all
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19 85 water related assets will be cooperatively operated. Application across these scales will likely
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21 86 face a number of technical and also social-economic challenges. Without such understanding,
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23 87 adoption may fail due to the inertia inherent in urban water management.
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30 88 **2. Real-time control in stormwater control measures**

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32 89 Real-time control technology is not novel to urban water management. Application can be seen
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34 90 extensively in wastewater systems to monitor and manage sewer overflows (Campisano et al.
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36 91 2016; Dirckx et al. 2011; Ly 2019; Vezzaro et al. 2014; Piro et al. 2019; Ibrahim 2020) or to
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38 92 control water quality (Schütze et al. 2004; Mollerup et al. 2017; Campisano and Modica 2002).
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40 93 Recent advances in sensor technology, however, makes RTC a cost-effective tool to enhance
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42 94 operation of a range of systems (Chee-Yee and Kumar 2003) and scales.
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46 95 Real-time control has been increasingly applied to SCMs. We summarize such
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48 96 application based on the type of SCMs (e.g. detention basins or rainwater harvesting systems)
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50 97 (Table 1). Current investigations predominantly focus on modelling studies, with only a few
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52 98 empirical studies. Most studies to date have focused on single systems at either small or
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54 99 catchment scale, without consideration of network interactions or cooperation. The details of
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56 100 these studies will be discussed in the following sections.
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3 101 Table 1. List of key studies on real-time controlled SCMs. The studies are classified according
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5 102 to the type of SCM (nature-based solution, detention basin, or rainwater harvesting system),
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7 103 the type of approach (modelling or empirical) and with a distinction between single and
8
9 104 multiple systems.

	Single system at small-/catchment scale	Multiple systems at catchment scale
<i>Nature-based solutions</i>		
Modelling	Shen et al. (2018)	-
Empirical	Persaud et al. (2019), Shen et al. (2019)	-
<i>Detention Basins</i>		
Modelling	Gaborit et al. (2013), Muschalla et al. (2014), Carpenter et al. (2014), Gaborit et al. (2016), Bilodeau et al. (2018), Shishegar et al. (2019a), Shishegar et al. (2019b) and Sharior et al. (2019)	-
Empirical	Jacopin et al. (2001), Middleton and Barrett (2008), Gilpin and Barrett (2014) and Poresky et al. (2015)	Mullapudi et al. (2018)
<i>Rainwater Harvesting Systems</i>		
Modelling	Melville-Shreeve et al. (2016), Xu et al. (2018), Roman et al. (2017), Behzadian et al. (2017) and Oberascher et al. (2019)	Di Matteo et al. (2019)
Empirical	Han and Mun (2011), Gee and Hunt (2016)	-

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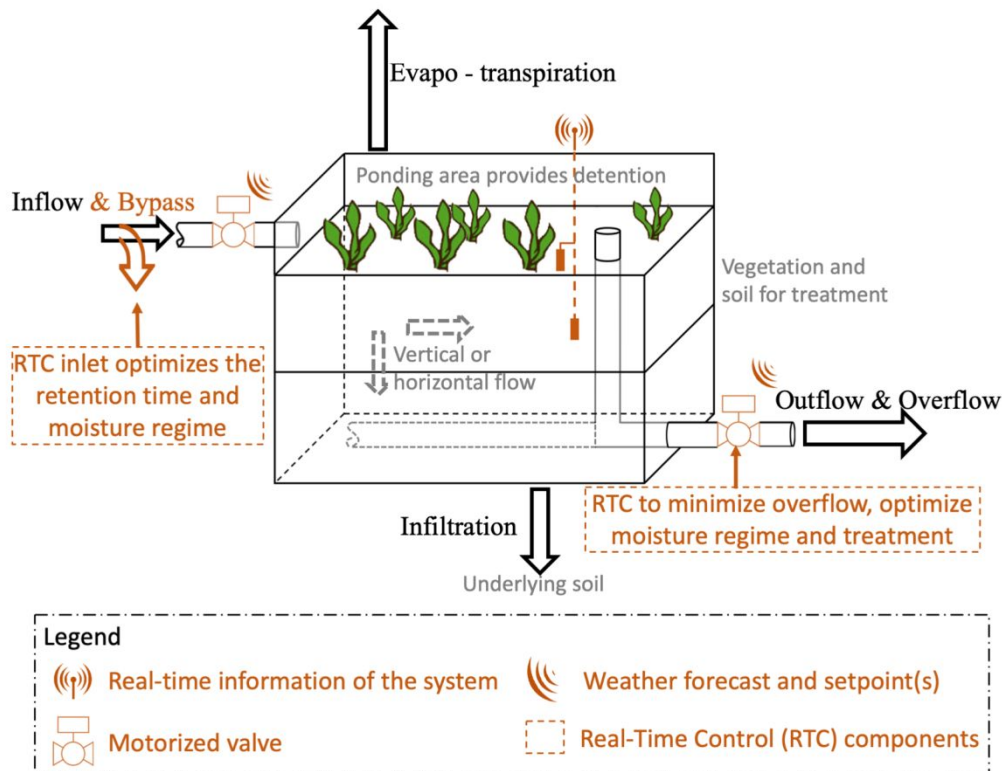
106 **2.1 Nature-Based Stormwater Control Measures**

107 Nature-based SCMs are characterised by their use of soil and vegetation in the retention and
108 treatment of stormwater. Structurally, they often employ stormwater storage and vegetation to
109 enable ponding and biotreatment, with the nature of the water flow within the system varying
110 according to design (Figure 1). For example, in biofilters, the treatment is primarily via vertical
111 percolation through the vegetation-enhanced soil-based filter media (Davis et al. 2009). In
112 surface wetlands, however, treatment occurs predominantly in the water column, where
113 interactions with vegetation, the soil surface, and their associated biofilms, play an important
114 role. Subsurface wetlands have a functioning between these two, with predominantly
115 horizontal flow through the (typically coarse) filtration media.

116 Treatment in nature-based SCMs is provided through a combination of physical (Feng
117 et al. 2012; Shrestha et al. 2018), chemical (Henderson et al. 2007) and biological processes
118 (Payne et al. 2014; Chandrasena et al. 2012) (Figure 1). The ponding provided by nature-based

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3 119 SCMs acts to buffer the stormwater runoff, attenuating peak flows (e.g. wetland; Al-Rubaei et
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5 120 al. 2016) and biofilters (Davis 2008; Hunt et al. 2012; Winston et al. 2016b)).

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7 121 The effectiveness of such systems is closely linked to operating conditions, such as
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9 122 temperature, wetting and drying and the flow regime (Winston et al. 2016a; Ge et al. 2016; Yi
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11 123 et al. 2016). The treatment effect of abiotic and biotic reactions (e.g. anoxia, de-/nitrification
12
13 124 and mineralization) largely depends on *water level* and *retention time*, which determines the
14
15 125 extent and period of contact between the stormwater and the filter media, vegetation and
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17 126 biofilms which mediate treatment processes (Bratieres et al. 2008; Klocker et al. 2009).
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19 127 Hydrologic performance and pollutant removal are thus affected by inflow dynamics resulting
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21 128 from the variability of rainfall and runoff (Hunt et al. 2006). The wet-dry cycle and soil
22
23 129 moisture are also critical for both treatment (e.g. nutrient leaching) and system health (e.g.
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25 130 survival of plants) (Afrooz and Boehm 2017; Hatt et al. 2008; Zinger et al. 2007b; Blecken et
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27 131 al. 2009b). Therefore, maximizing the performance of nature-based solutions depends on
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29 132 maintaining optimal detention time and moisture regime, to support physical and biological
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31 133 treatment processes.
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135 Figure 1. Conceptual representation of conventional nature-based solution, adapted from
 136 Fletcher et al. (2013). The elements in brown are components dedicated to the real-time control
 137 (RTC) of the system. RTC of nature-based stormwater control measures generally control the
 138 inflows and/or outflows for a range of objectives.

139 System performance can be improved by system design. For example, the inclusion of
 140 a carbon-enriched saturated zone in biofilters can mitigate against the impacts of extended dry
 141 periods, providing a more stable anaerobic zone for better nutrient removal and reduced
 142 nutrient leaching after extended dry periods (Zinger et al. 2007b; Zinger et al. 2007a; Blecken
 143 et al. 2009a). Expanding system size could also increase the retention time, but may not always
 144 be feasible in space-constrained urban areas, and may also have the effect of accentuating
 145 impacts of long dry periods on system function. The passive nature of nature-based SCMs thus
 146 intrinsically limits their ability to respond to variations in operating conditions.

147 The effectiveness of such systems could also be enhanced using real-time control
 148 technology (Shen et al. 2017; Persaud et al. 2019; Shen et al. 2019). This involves the
 149 installation of sensors and actuators to monitor and control various system processes, such as

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3 150 the *retention time*, for better treatment (elements in brown in Figure 1). Shen et al. (2017)
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5 151 modelled a controlled biofilter and predicted improved outflow quality when collected runoff
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7 152 was treated by batch. Inlet and outlet valves were kept shut when the system was full, bypassing
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9 153 any inflow, until the desired retention time was reached. This finding was later validated by
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11 154 Shen et al. (2019) through a long-term laboratory experiment. Persaud et al. (2019)
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13 155 experimentally tested similar control strategies in a column study over a 9-week period and
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15 156 concluded that the RTC system can better remove heavy metals and ammonium. Both of the
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17 157 studies also identified the trade-off between retention time and overall capacity to receive
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19 158 inflow, thus requiring further optimisation.

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24 159 The potential of real-time control in nature-based SCMs remains largely untested, in
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26 160 terms of delivering more natural flow regimes and improving the moisture regime. Systems
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28 161 could use a rainfall forecast to create sufficient storage for incoming events through a
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30 162 controlled outlet pre-storm discharge. This outflow could theoretically be regulated to match
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32 163 pre-development flow regimes using real-time flow monitoring of a nearby “reference”
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34 164 waterway (Rode et al. 2016). Furthermore, RTC could optimise the moisture regime of
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36 165 substrate-based SCMs (e.g. biofilter) for plant and microbial community survival during
37
38 166 extended dry periods, and thus minimize subsequent impact on treatment effectiveness. This
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40 167 could be achieved by a controlled outlet to maintain sufficient water within the system (e.g.
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42 168 substrate in biofilter and permanent ponding in wetland) using real-time water monitoring (e.g.
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44 169 water level in wetland and soil moisture in biofilters) (Figure 1). While no studies to date have
45
46 170 demonstrated this for SCMs, a similar idea has been used in operating natural wetlands (Lyons
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48 171 et al. 2008), to provide adequate aquatic habitat for native species and migratory waterbirds.
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50 172 By coupling with evolving real-time or surrogates quality monitoring (Zhang et al. 2015;
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52 173 Chandrasena et al. 2016; Wang et al. 2019), a more reliable nature-based SCM could be
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54 174 delivered for stormwater harvesting (Payne et al. 2019) or even greywater treatment potential
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3 175 (Barron et al. 2019). Future study is required to further understand the effect of RTC on their
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5 176 performance, through both modelling and empirical proof-of-concept. This also includes the
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8 177 development of robust control models to provide accurate performance prediction and real-
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10 178 time operation.
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179 **2.2 Detention basins**

180 A detention basin is a stormwater storage mainly designed to provide attenuation of
181 downstream peak flows. It temporarily stores runoff, discharging at the rates that is matched to
182 the capacity of downstream drainage networks (Figure 2).

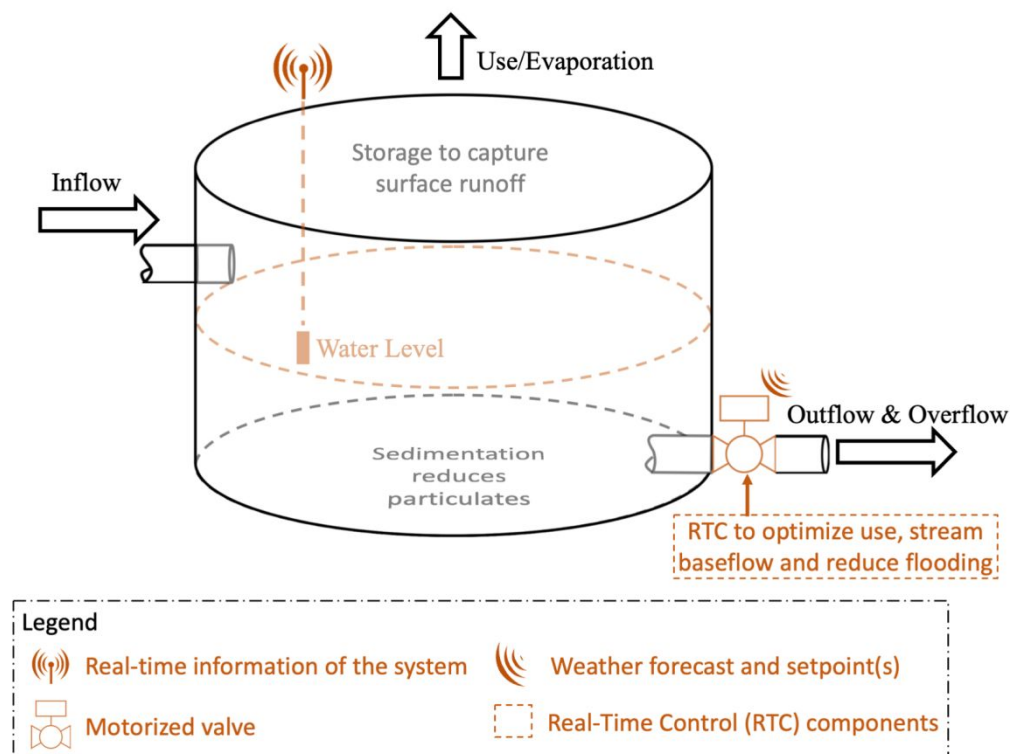
183 Early use of real-time control in detention basins has been focussed on increasing the
184 capacity of flooding control by reducing the frequency and volume of discharge. The outlet
185 hydraulic valves are typically pre-programmed to close during the rain event and only open
186 when storage exceeds a certain level (e.g. 70%), or stormwater has been held for a pre-set
187 period (e.g. 12 hours) (Jacopin et al. 2001; Middleton and Barrett 2008). This results in
188 decreased frequency and volume of runoff discharged to the downstream drainage network
189 during storm events.

190 Several studies have demonstrated the use of control in real-time to adapt to predicted
191 rainfall (Gaborit et al. 2013; Gilpin and Barrett 2014; Bilodeau et al. 2018; Sharior et al. 2019;
192 Shishegar et al. 2019a; Shishegar et al. 2019b). Rainfall forecasts are used to predict the timing
193 and volume of overflow by comparing incoming runoff and available capacity (Figure 2). This
194 allows the system to perform a *pre-storm release* – creating sufficient room before storm events
195 to avoid system overflow. The release rate (i.e. control valve opening percentage) is determined
196 by the time before a forecasted overflow occurs and volume required to hold that inflow. Such
197 modification further increases the detention performance, however, the effect of discharge rate
198 on downstream erosion should also be considered.

199 Reducing channel erosion not only requires the reduction of runoff volume. It requires
200 the attenuation of erosion-inducing flow (Vietz et al. 2017). Large SCMs, such as detention
201 basins, can perversely intensify erosion, by increasing the time flows remain above the
202 mobilisation threshold for downstream bed and bank sediments (Hawley et al. 2013). An
203 appropriate design which limits flows below the threshold can effectively reduce erosion

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3 204 potential (Elliott et al. 2010). The addition of real-time control to an existing detention basin
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5 205 could help to achieve this result, without sacrificing performance in flood events. It can be
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7 206 configured to avoid wet-weather discharge (through both hydraulic valve and overflow) and
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9 207 mimic pre-development peak flow by adaptively limiting outflow, thus substantially reducing
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11 208 erosion potential. For example, Poresky et al. (2015) demonstrated that RTC can reduce the
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13 209 erosive flow by 50% to 60% more than a conventional configuration. Although erosion
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15 210 potential is highly related to a suite of physical attributes and might be ecologically important
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17 211 (Fletcher et al. 2014b), a single threshold is commonly adopted in current applications (Elliott
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19 212 et al. 2010; Poresky et al. 2015). Future design of RTC detention basins could consider multiple
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21 213 ecohydrological metrics to deliver better environmental outcomes for the stream.
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26 214 Detention basins are also used to manage water quality. Temporarily holding
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28 215 stormwater can partially remove pollutants and achieve water quality improvement through
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30 216 sedimentation and biological conversion (Shammaa et al. 2002; Guo and Adams 1999;
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32 217 Carpenter et al. 2014). The treatment effectiveness depends on detention time and outflow rate
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34 218 (Muschalla et al. 2014). Water quality treatment performance can be improved using RTC
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36 219 technology. For example, the detention basin can purge the captured stormwater when the
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38 220 treatment desired is reached. Modulating discharge rate can also reduce the likelihood of
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40 221 pollutant resuspension. Both empirical and modelling evidence showed that, by employing
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42 222 real-time control, the removal efficiency of ammonia-nitrogen and total suspended solids (TSS)
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44 223 were increased by 80% and 50% respectively (Carpenter et al. 2014; Gaborit et al. 2013;
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46 224 Gaborit et al. 2016). The simulation results from Muschalla et al. (2014) also predicted that
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48 225 RTC detention basins improved the removal of small particles by up to 60% compared to the
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50 226 traditional design. Such benefits were also demonstrated for the removal of biological
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52 227 contaminants, such as *Escherichia coli* (Gilpin and Barrett 2014).
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229 Figure 2. Conceptual representation of conventional storage-based stormwater control measure
 230 (i.e. detention basin and rainwater harvesting system) adapted from Fletcher et al. (2013). The
 231 elements in brown present the components required to enable the real-time control (RTC) of
 232 the system. RTC of storage-based stormwater control measures generally control the outflows
 233 for a range of objectives.

234 **2.3 Rainwater Harvesting Systems**

235 Rainwater harvesting systems are designed to capture surface runoff from impervious surfaces
236 (e.g. roofs), to both provide a source of water and to mitigate stormwater runoff (Mikkelsen et
237 al. 1999; Gardner and Vieritz 2010; Ward et al. 2012; Amos et al. 2016). Diversion of rainwater
238 from direct runoff to water supply helps to reduce the excess runoff volume delivered to
239 receiving waters (Fletcher et al. 2007). Deliberately releasing some of the retained water to the
240 receiving water in a temporal pattern close to the natural flow regimes can help to return the
241 hydrograph shape of the remaining runoff (Burns et al. 2012).

242 Reducing excess runoff requires adequate freeboard available to store incoming rainfall
243 events, so that uncontrolled overflows to the downstream drainage network are avoided
244 (Campisano and Modica 2016). In general, most conventional rainwater harvesting systems
245 have frequent uncontrolled overflow (Jones and Hunt 2010; Burns et al. 2015a; Campisano and
246 Modica 2012). This is because they often lack constant and high demand uses for their stored
247 water, and thus often remain at or near full (Burns et al. 2015a; DeBusk et al. 2013).

248 Increasing the type of end-uses (e.g. laundry or hot water usage) may help address the
249 problem, but may not always be feasible. For example, public perceptions of rainwater quality
250 might limit connected end-uses (Gwenzi et al. 2015; Ward et al. 2010), as may cost (Roebuck
251 et al. 2011; Rahman et al. 2011).

252 Uncontrolled overflow could be reduced further using RTC technology, both in new
253 and retrofit situations (Gee and Hunt 2016; Han and Mun 2011). The technology enables the
254 system to receive information on operating conditions (e.g. water level) and weather forecast.
255 This allows pre-storm release before a rainfall event to ensure sufficient storage for incoming
256 runoff (Figure 2). One commonly applied control strategy, for example, opens the valve until
257 enough room is made to contain predicted rainfall.

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3 258 Such a logic can enhance the runoff retention, without substantially compromising
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5 259 water supply performance. Modelling studies predicted that RTC technology reduced
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7 260 uncontrolled overflows by 10-35% (Behzadian et al. 2017; Roman et al. 2017; Oberascher et
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9 261 al. 2019). Han and Mun (2011) reported a 47% reduction of annual runoff at larger scale
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11 262 through empirical evidence. More importantly, Xu et al. (2018) predicted that the active system
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13 263 was able to limit loss of water supply yield to less than 2%, although this depends on the end-
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15 264 use profile of the stored water (Melville-Shreeve et al. 2016).

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19 265 Actively-controlled rainwater harvesting systems are better able to control flow peaks,
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21 266 particularly for small rainfall events. For example, Roman et al. (2017) simulated RTC
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23 267 systems, finding that they could retain all the runoff generated during small events (< 5mm/hr).
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25 268 Similar results can be seen in empirical studies, where Gee and Hunt (2016) demonstrated an
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27 269 average of 93% peak flow rate reduction during 15-month period, including one event with an
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29 270 intensity higher than that of 2-year 5-min storm. Such levels of retention are likely to mitigate
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31 271 nuisance flooding (i.e. low-level inundation).

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35 272 Such peak control by RTC can be extended to large rainfall events. Modelling results
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37 273 by Melville-Shreeve et al. (2016) reported a 33% greater runoff volume reduction compared to
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39 274 conventional systems for a rainfall with depth similar to a 20-year, 24 hour storm. This level
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41 275 of peak reduction could potentially allow the downstream drainage network originally designed
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43 276 for a 10-year rainfall to handle a 50-year rainfall event (Han and Mun 2011). Testing such
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45 277 models with empirical evidence is of course difficult, given the infrequent nature of such large
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47 278 rainfall events. Monitoring studies generally involve a single geographic location and set of
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49 279 design and operating parameters (Gee and Hunt 2016; Han and Mun 2011). There is a need for
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51 280 more empirical experiments to test the long-term ability of RTC in a wider variety of operating
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53 281 conditions, recognising that performance in extreme events may not be able to be observed
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55 282 within a reasonable timeframe.
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3 283 RTC may offer the important ability for multiple systems to operate in a coordinated
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5 284 way, thus overcoming the limitations of a single allotment scale system (Damodaram et al.
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8 285 2010; Schubert et al. 2017). For example, Di Matteo et al. (2019) demonstrated a better peak
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10 286 flow mitigation in a 1 in 100-year, 24-hr storm. This requires two system orifices discharging
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12 287 at different rates and times throughout the event. Such a strategy can potentially be upscaled to
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14 288 deliver catchment-scale benefits, where small-scale systems within the catchments can be
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17 289 operated as an integrated network.

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19 290 Real-time controlled systems are likely to retain more runoff than conventional
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21 291 approaches, such as passive ‘trickle release’ systems, where a slow-release outlet is provided
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23 292 at an intermediate depth to frequently empty the storage above. Both modelling (Xu et al. 2018)
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25 293 and empirical studies have shown that the RTC system (Gee and Hunt 2016) can deliver more
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27 294 natural flow regimes, ensuring that any release can be controlled to not only limit overflows,
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29 295 but to mimic more natural dry weather flows.

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33 296 Both passive and active systems have the potential to address the baseflow component
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35 297 of flow regimes (Mitchell et al. 2007; Fletcher et al. 2007; Askarizadeh et al. 2015). To counter
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37 298 the common (but not ubiquitous) effect of lost baseflows in urban areas (Price 2011) release of
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39 299 tank water can be directed to the adjacent landscape (Walsh et al. 2015; Burns et al. 2012) or
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41 300 to infiltration systems (Hunt et al. 2006) to promote infiltration and thus groundwater recharge.
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43 301 Xu et al. (2018) explored this potential through a modelling study and concluded that the active
44
45 302 release system is capable of simultaneously delivering baseflow contributions (i.e. persistent
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47 303 low rate discharge) and runoff retention (i.e. pre-storm release) with only minor reductions in
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49 304 the reliability of water supply. A similar level of baseflow emulation using passive systems
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52 305 required unrealistically small outlet diameters (Xu et al. 2018).
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3 306 **3. Effect of scale**
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6 307 **3.1 Current decentralized control at local scales**
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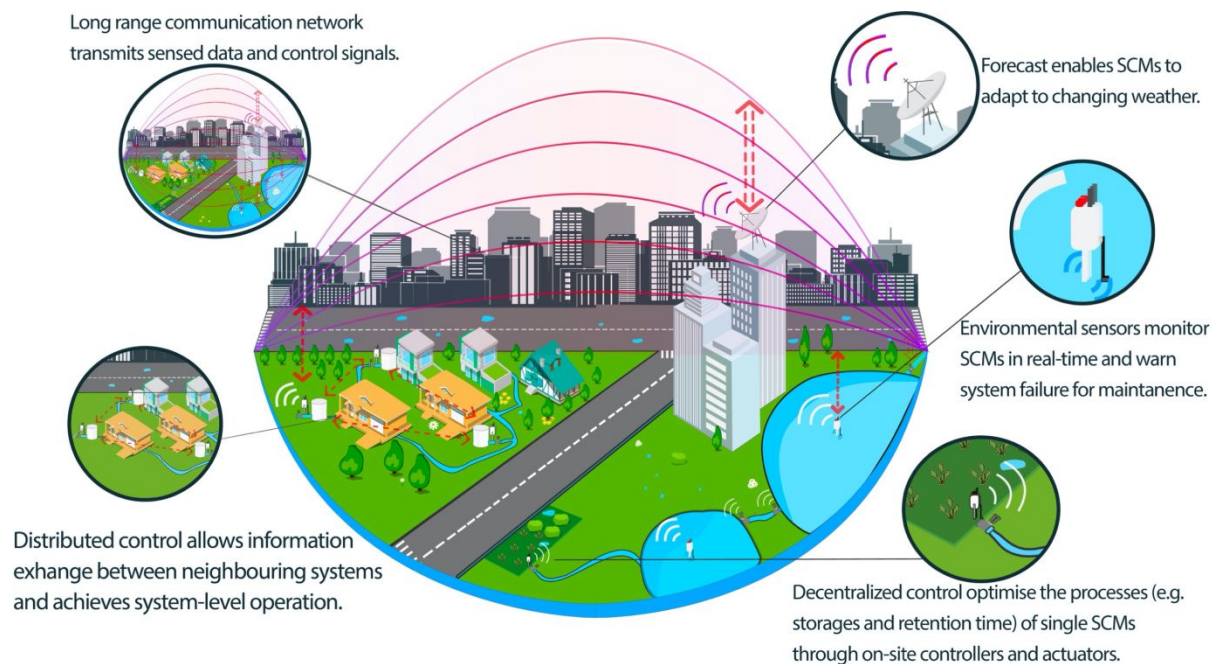
9 308 Despite the increasing number of studies on real-time control for optimising stormwater control
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11 309 measures, the focus to date has mainly been on the decentralised control at local scales (Table
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13 310 1), without consideration of network interactions or cooperation. In such an application, the
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15 311 information held by each system (e.g. water level and valve status) is not shared with other
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17 312 systems within the network. Therefore, control decisions are made independently at a local
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19 313 level, without considering a catchment-level context.
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23 314 Decentralised control of SCMs is a robust solution, as its configuration will not require
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25 315 complex communication and logic structures (Schütze et al. 2004). However, doing so
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27 316 precludes the potential synergies of ‘cooperation’ achieved by network control (Petrucci et al.
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29 317 2013; Emerson et al. 2005).
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3.2 *Distributed control at large scales*

Distributed control of SCMs network needs to be implemented in a way that each system works collaboratively to meet the catchment-scale hydrological objective (Figure 3). The theory of such control has long been established (Bondy and Murty 1977; Camponogara et al. 2002; Dijkstra 1982) and has been demonstrated by a few preliminary studies. Di Matteo et al. (2019) modelled two coordinated rainwater harvesting systems using perfect rainfall forecasts. They concluded that the peak flow can be better mitigated by the centralised control than by the decentralized control. Mullapudi et al. (2018) reported that two cooperatively controlled detention basins could create a hydrograph that prevented erosion-induced flows. The common features for those control strategies are (1) operating multiple local-scale systems, (2) regulating the outflow based on hydrological and hydraulic metrics, and (3) releasing storage required in different patterns.

Real-time distributed control can also play a major role in providing necessary redundancy and increasing resilience. Sensors can detect and report in real-time systems being offline due to failure or maintenance. The underlying neighbouring systems can virtually replace the failed systems, and so remain a well-functioning network (e.g. distributed control in Figure 3). A similar strategy could be used in the case of RTC rainwater harvesting to ensure that adequate contributions are made to stream baseflow, even if some systems are empty at any given time. This might also be applied to RTC biofilters, where the emptying of the systems can start from those with longer treatment (i.e. detention time). Such an application offers a new possibility for real-time asset management, which could potentially address the major problem of poor system function due to inadequate maintenance of SCMs (Blecken et al. 2017).



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341 Figure 3. Real-time control of SCMs network, including current decentralized control at
 342 small scale and future potential of distributed control at large scale.

343 ***3.3 Future vision of integrated water management***

344 Overall, real-time control offers a real opportunity to advance conventional water systems
 345 (Table 2). The control of SCM networks could be jointly operated with other water systems,
 346 such as water distribution networks (Cembrano et al. 2000; Leirens et al. 2010) and combined
 347 sewer systems (Garofalo et al. 2017). For stormwater systems, SCMs could coordinate with
 348 the overall drainage network, and so manage storages and outflows to best use the capacity of
 349 all system nodes to avoid overflow (Lund et al. 2019). Future water supply could use a hybrid
 350 system that integrates stormwater harvesting to supplement mains water (or vice versa). The
 351 real-time prediction of spatial-temporal demand could inform optimal use of tank storage (i.e.
 352 rather than using when needed by each household) and mains water at a system level to ensure
 353 overall water network reliability. Improved monitoring and removal of contaminants could
 354 promote such hybrid supply and even achieve on-site grey water reuse (Barron et al. 2019),
 355 thus significantly reducing the resources required for downstream centralized treatment (e.g.

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3 356 wastewater treatment plant in combined systems). The states of all these assets could be
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5 357 visualized and managed in a central control system, where a universally integrated water
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8 358 system is then formed to deliver sustainable future in smart cities.
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10 359 In addition to its impact on operation of the urban water system, real-time technology
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12 360 could change the relationship between people and water management. Real-time information
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14 361 triggers feedback from private householders, giving them the ability to proactively choose to
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16 362 coordinate their systems with the overarching network. This coordination can avoid major
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18 363 infrastructure upgrades and reduce problems of water scarcity. Financial incentives could be
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20 364 used to illicit such contributions, inspired, for example by economic innovations pioneered in
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22 365 the energy market (Giordano and Fulli 2012; Rodríguez-Molina et al. 2014). Doing so could
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24 366 transform the private householder from passive consumers to active providers of urban water
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26 367 service, envisioning new governance models. Such application will, however, be confronted
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30 368 by challenges from both technical and socio-economical perspectives.
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369 Table 2. Advantage and drawbacks of passive versus active control of SCMs. RTC = Real-
 370 Time Control

Objectives	Passive Control	Active (RTC) Control
Flooding and runoff control	Design based solely on historical data	Real-time monitoring and anticipating flood hazard
	Capacity matched to design event (thus over-designed for many situations)	Adaptive system to create storage for each storm event
	Each system works individually	Distributed control to enable synergy effect
Combined sewer overflow	No ability to adapt to an event	Flow bypass the predicted overflow area
	Require often oversized drainage network or detention basin	Enhance storage efficiency without structural change
Stream baseflow	No ability to ensure spatial and temporal variability of flow regimes	Emulate baseflow based on real-time river monitoring
Supply	Mains supply with passive supplement of rainwater. No mechanisms ensure the integration of hybrid system.	A monitored and controlled hybrid system that can be optimally integrated and coordinated. Rainwater supply can also be optimised by other objectives, such as flooding mitigation.
Maintenance	No ability to check remotely system state	Real-time monitoring and failure detection
	Regular visit depending on expertise and diligent	Site visit only when maintenance is needed
	Manual maintenance	Semi-/automated process (e.g. flush out sediments using control valve)
Irrigation	Irrigate on a routine base	Monitor soil moisture and irrigate whenever needed
	Require regular visit to adapt irrigation to the need	Full remote control
Cyber Security	N/A	Need regulation and standard for privacy protection
Economics	Higher capital expenditure due to oversized systems	Costs of monitoring and RTC to add but system size can be decrease with adaptive response to events
	Higher operational expenditure due to reactive maintenance and routine inspection	Allows remote monitoring and proactive maintenance
		Increase of energy consumption
Redundancy and resilience	No mechanism to ensure resilience	High resilience and adaptative system(s)

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372 4. Barriers to implementation of RTC on SCMs

373 4.1 Technical challenges

374 *Model for Real-Time Control*

375 Real-time control systems applied to SCMs (Stormwater Control Measures) can be based on
376 pre-defined rules (termed here as heuristic algorithms; Persaud et al. 2019; Carpenter et al.
377 2014; García et al. 2015). Such rules are often expressed in the form of binary logic (i.e. “if-
378 then-else”) and generally require simple operational devices such as microcontrollers.
379 However, the robustness of such control has not been appropriately tested. It might be robust
380 in operating a small number of decentralised small-scale systems, but may demand a too
381 complex number of rules and scenarios when operating complex multi-scale systems.
382 Furthermore, the establishment of rules requires expertise on system mechanisms and
383 operational context. The understanding of spatio-temporal dynamics that govern water quality
384 and flow across different scales in the urban environment is the key to avoid perverse impacts
385 introduced by real-time control when applied to SCMs (e.g. erosion-induced flow from
386 controlled detention basins). Only a few preliminary studies have investigated the theoretical
387 framework for such operation (Mullapudi et al. 2017; Rimer et al. 2019).

388 Future operation can be advanced using optimization-based control, especially for
389 complex multi-scale SCMs networks. Compared to rule-based control, such a strategy turns
390 the pre-defined logic into an objective function that is solved continuously to represent the
391 desired system behaviour. This is generally achieved by a process model which anticipates the
392 performance of a number of control scenarios. The optimal scenario is then selected, based on
393 predefined objective metrics. The objectives often aim to minimize the resource cost when
394 meeting the compulsory demand for operation, while simultaneously maximising the
395 performance for the entire system. This approach can be seen in the operation of SCMs at site-

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3 396 scale. For example, Shishegar et al. (2019a) and Shishegar et al. (2019b) utilized an
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5 397 optimisation-based control to minimize the total outflow discharge from a detention basin for
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7 398 flood control, while preventing unnecessary movement of the outlet gate. Therefore, such a
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10 399 control can also potentially operate complex distributed systems in a cooperative and optimised
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12 400 way, not only achieving optimal performance, but minimising long-term maintenance
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14 401 requirements by minimising operation of system components. Large-scale applications can be
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16 402 widely found in other water networks, such as water distribution networks (Cembrano et al.
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18 403 2000; Miyaoka and Funabashi 1984; Joalland and Cohen 1980; Fallside and Perry 1975) and
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20 404 combined sewer networks (Garofalo et al. 2017).

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24 405 Appropriate selection and design of control strategies is vital to the implementation of
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26 406 RTC-based SCMs. Control strategies have received significant attention in the urban drainage
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28 407 literature. Heuristic-based control can be appealing because no control-oriented model is
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30 408 required and the resulting control seems rational (García et al. 2015). However, as mentioned
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32 409 previously, heuristic-based control depends on expert knowledge, and so might not be
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34 410 considered formally as achieving an optimal solution (Cen and Xi 2009; Mollerup et al. 2013).
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36 411 One of the most common heuristic algorithms used in urban drainage systems is Rule-Based
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38 412 Control (Klepiszewski and Schmitt 2002), with increasing popularity of using a particular rule
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40 413 that specifies the output parameters in a non-binary way (i.e. ranging between 0 and 1, allowing
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42 414 partial states between true and false), known as Fuzzy Logic Control (Tang et al. 2010;
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44 415 Seggelke et al. 2013; Chiang et al. 2011). In contrast, while optimisation-based control delivers
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46 416 more objectivity, it can be difficult to implement due to more complex control-oriented models
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48 417 and consequential challenges in terms of the computational power required, especially in large-
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50 418 scale systems (García et al. 2015). Model Predictive Control, which recursively recalculates
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52 419 the optimal control using newly available information on system states and other data (e.g.
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54 420 rainfall forecast), has shown to be the most successful optimisation-based technique applied in
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3 421 urban drainage systems due to its capacity in handling multi-variable systems (for further
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5 422 detail, extensive review can be found in Lund et al. (2018)). Other approaches also include the
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7 423 linear-quadratic regulator (Bemporad et al. 2002; Marinaki and Papageorgiou 2003),
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9 424 evolutionary strategies (Savic and Walters 1997; Bernard et al. 2001; Martínez et al. 2007; Fu
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11 425 et al. 2008), and Population Dynamics-based control (Ramírez-Llanos and Quijano 2010;
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13 426 Barreiro-Gomez et al. 2015). Additionally, the type of RTC strategies (e.g. rule-based or
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15 427 optimisation-based) and process model used (e.g. fast or detailed, linear or non-linear,
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17 428 stochastic or deterministic) intimately link to the selection of controllers. Therefore, there is a
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19 429 critical need to test different control approaches in operating RTC SCMs. By improving such
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21 430 understanding, it will then be possible to posit the most robust ways to operate SCMs at a range
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23 431 of scales and levels of complexity.
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432 *Role of Forecast Accuracy*

433 When RTC is based on weather forecasts, there is the potential for performance loss due to
434 inaccurate forecasts. The effectiveness of forecast accuracy on RTC has been considered in a
435 range of studies in urban drainage systems (Löwe et al. 2016; Achleitner et al. 2009). This
436 issue, however, has only been addressed by a few studies in RTC SCMs (Gee and Hunt 2016;
437 Xu et al. 2018; Xu et al. 2020), and has generally been ignored in RTC modelling studies,
438 where perfect forecasts (i.e. use of historical precipitation as forecast) are typically used
439 (Roman et al. 2017; Di Matteo et al. 2019). This is widely recognized as a major knowledge
440 gap for future investigation (Gee and Hunt 2016; Kerkez et al. 2016; Xu et al. 2018).

441 Several methods exist to mitigate the impact of forecast error on RTC performance.
442 There may, for example, be potential to improve performance by strategically using different
443 forecast horizons. The pre-storm release to avoid flooding could be determined based on both
444 long-term (e.g. weekly) forecasts, and then refined using short-term (e.g. sub-daily) rainfall
445 forecasts, taking advantage of improved forecast accuracy as the forecast window shortened.
446 Another approach to improve performance is to use accumulated knowledge on past forecasts
447 and their associated error to include them in the future management strategy.

448 *Monitoring*

449 Real-time control relies on the knowledge of the system and its surroundings. Such knowledge
450 of the system includes input (inflows), output (outflows), but also its present state (pump flow,
451 volume in storage, valve status) and environmental conditions (rainfall, streamflow, etc.).
452 While economic and technological complexity have acted in the past as barriers to
453 incorporation of sensors into RTC-based systems, the recent possibilities offered by new
454 monitoring technologies are substantial: user-friendly deployment and interfaces, lower cost,
455 lower power consumption, enhanced communication capabilities, open-source and high

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3 456 modularity (Cherqui et al. 2019). Such cost-effective technologies have been successfully
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5 457 implemented in other fields such as agriculture (Fisher 2007) and air quality (Morawska et al.
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7 458 2018). This technology is also increasing in the water sector, such as for water quality
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9 459 monitoring (Rao et al. 2013), sewer overflow monitoring (Montserrat et al. 2013) and pipe
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11 460 inspection (Romanova et al. 2012).
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16 461 *Data Platform and Communication*

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18 462 Future large-scale deployment of controlled SCMs networks will need to consider suitable data
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20 463 platforms and communications (Figure 3). Central to the question is how to collect, transmit,
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22 464 store and use the data. This has been extensively addressed in networked control systems (Yang
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24 465 2006; Hespanha et al. 2007; Gupta and Chow 2010) and smart cities (Kitchin 2014; Cocchia
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26 466 2014; Zanella et al. 2014). Such advances drive the technological movement of continuous
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28 467 environmental monitoring at large-scale (Crawford et al. 2015; Pellerin et al. 2016; Lefkowitz
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30 468 et al. 2016). Therefore, it is now feasible to build a platform that conducts environmental
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32 469 monitoring and control simultaneously (Bartos et al. 2018; Lefkowitz et al. 2016). Future work
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34 470 will be needed to develop agreed data exchange standards and different platform architecture
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36 471 to handle the operation of SCMs network. This need will become even greater as operations of
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38 472 water networks and other urban infrastructure become increasingly integrated.
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473 **4.2 Social-economic Challenges**

474 *Institutional Inflexibility*

475 The broader adoption of RTC largely depends on the regulatory environment and whether it
476 hinders or facilitates adoption. This is because water-related services are often centrally
477 provided by government, semi-government agencies or private companies operating as natural
478 monopolies (Marques 2010). The research on RTC is arguably focussed primarily on the
479 technological invention, with less attention paid to the need for institutional innovation. Such
480 a phenomenon can be widely found in the water sector (Mitchell 2006; Farrelly and Brown
481 2011; Kiparsky et al. 2013). This is likely to create inertia, impeding or delaying adoption
482 (Brown and Farrelly 2009; Brown 2005). There will be a need to address the regulatory
483 environment and governance of real-time controlled systems, so that innovation and
484 competition are facilitated, but that the benefits of centralised control can be realised.

485 *Ownership*

486 One key tension impacting the adoption of RTC is who owns the right for control. Unlike
487 wastewater systems, SCMs equipped with RTC are deployed at a variety of scales and on land
488 owned by a variety of actors, therefore involving both public and private spaces and actors.
489 Centralised control by a government agency could conflict with private property or interest,
490 resulting in potential social impediments. Similarly, the distributed control may fail to deliver
491 a collective optimal outcome due to simultaneous intervention from different stakeholders.
492 Furthermore, there could be potential conflict of interests even within the public sector.
493 Therefore, such an obscure ownership and operational jurisdiction could slow down the
494 development of the investment model for the deployment and ongoing effort for maintenance.

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3 495 *Cyber insecurity*
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6 496 RTC potentially creates new concerns for cyber security and data privacy. Failure to identify,
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8 497 prevent and manage cyber attacks can lead to large-scale system disfunction (Ebersold and
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10 498 Glass 2016; Brous and Janssen 2015), introducing new risks to public health and safety.
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12 499 Vulnerabilities can also increase the risk of information leakage, resulting from potential
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14 500 exposure of private information (e.g. the diurnal pattern of rainwater usage). These
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16 501 consequences may also affect user risk perception and could undermine trust and usage
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18 502 behaviour. Future study must focus on the standards of data protection that minimize the risk
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20 503 of cyber security problems during system design.
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26 504 *Lack of market incentives*
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28 505 Investment in RTC-based SCM networks will only happen if there is regulatory obligation or
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30 506 a market incentive. Research is needed to identify suitable business models to drive such
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32 507 investment, potentially drawing on ideas that have been applied to increasingly decentralised
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34 508 or hybrid energy markets (Giordano and Fulli 2012). This may include the positioning of RTC
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36 509 in the existing water management market as well as an economic model that captures and
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38 510 appropriately shares the benefits for different stakeholders.
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511 **5. Conclusions**

512 Use of RTC technology has the real potential to improve current urban water management and
513 overcome existing barriers. RTC can improve the performance of various type of SCMs at the
514 site scale, in terms of both runoff quality and quantity. There is an untested potential to tackle
515 the mix of scales, where RTC could gather the decentralised small-scale systems into a virtually
516 connected network, achieving much greater control of urban runoff at catchment scale. More
517 importantly, such a strategy could transform the relationship between people and the urban
518 water cycle, such that private householders could proactively supply urban water services in
519 coordination with major water companies, creating a new governance models for future urban
520 water management.

521 Applications of RTC technology in urban water management are vast. Building on the
522 previous research, we therefore suggest the following future exploration to underpin the use of
523 RTC:

- 524 (1) testing the effect of rule-based and optimization-based control in operating SCMs at
525 different scales;
- 526 (2) investigating the role of forecast accuracy;
- 527 (3) developing low-cost sensor technology and promoting widespread monitoring of
528 SCMs;
- 529 (4) developing agreed data exchange standards and different platform architecture to
530 handle the operation of SCMs network;
- 531 (5) creating new regulatory environment and governance models for implementation;
- 532 (6) identify ownership and operational jurisdiction for deployment and maintenance;
- 533 (7) developing data protection technique to minimize the risk of cyber security;
- 534 (8) developing a suitable business model to drive the investment.

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548 **Reference**

- 549 Achleitner, S., Fach, S., Einfalt, T., and Rauch, W. 2009. "Nowcasting of rainfall and of
550 combined sewage flow in urban drainage systems." *Water Science and Technology*
551 59 (6):1145-51. doi: 10.2166/wst.2009.098.
- 552 Afrooz, A. R. M. N., and Boehm, A. B. 2017. "Effects of submerged zone, media aging, and
553 antecedent dry period on the performance of biochar-amended biofilters in removing
554 fecal indicators and nutrients from natural stormwater." *Ecological Engineering*
555 102:320-30. doi: <https://doi.org/10.1016/j.ecoleng.2017.02.053>.
- 556 Al-Rubaei, A. M., Engström, M., Viklander, M., and Blecken, G.-T. 2016. "Long-term
557 hydraulic and treatment performance of a 19-year old constructed stormwater
558 wetland—Finally matured or in need of maintenance?" *Ecological Engineering*
559 95:73-82. doi: <https://doi.org/10.1016/j.ecoleng.2016.06.031>.
- 560 Amos, C. C., Rahman, A., and Gathenya, J. M. 2016. "Economic Analysis and Feasibility of
561 Rainwater Harvesting Systems in Urban and Peri-Urban Environments: A Review of
562 the Global Situation with a Special Focus on Australia and Kenya." *Water* 8 (4):149.
563 doi: <https://doi.org/10.3390/w8040149>.
- 564 Ashley, R., Lundy, L., Ward, S., Shaffer, P., Walker, L., Morgan, C., Saul, A., Wong, T., and
565 Moore, S. 2013. "Water-sensitive urban design: opportunities for the UK."
566 *Proceedings of the Institution of Civil Engineers-Municipal Engineer* 166 (2):65-76.
567 doi: 10.1680/muen.12.00046.

- 1
2
3 568 Askarizadeh, A., Rippey, M. A., Fletcher, T. D., Feldman, D. L., Peng, J., Bowler, P.,
4
5 569 Mehring, A. S., et al. 2015. "From Rain Tanks to Catchments: Use of Low-Impact
6
7 570 Development To Address Hydrologic Symptoms of the Urban Stream Syndrome."
8
9 571 *Environmental Science & Technology* 49 (19):11264-80. doi:
10
11 572 10.1021/acs.est.5b01635.
- 12 573 Barreiro-Gomez, J., Obando, G., Riaño-Briceño, G., Quijano, N., and Ocampo-Martinez, C.
13
14 574 2015. Decentralized Control for Urban Drainage Systems via population dynamics:
15
16 575 Bogotá case study. Paper presented at the 2015 European Control Conference (ECC),
17
18 576 15-17 July 2015. doi: 10.1109/ECC.2015.7330902
- 19 577 Barron, N. J., Deletic, A., Jung, J., Fowdar, H., Chen, Y., and Hatt, B. E. 2019. "Dual-mode
20
21 578 stormwater-greywater biofilters: The impact of alternating water sources on treatment
22
23 579 performance." *Water Research* 159:521-37. doi:
24
25 580 <https://doi.org/10.1016/j.watres.2019.04.020>.
- 26 581 Bartos, M., Wong, B., and Kerkez, B. 2018. "Open storm: a complete framework for sensing
27
28 582 and control of urban watersheds." *Environmental Science: Water Research &*
29
30 583 *Technology* 4 (3):346-58. doi: 10.1039/C7EW00374A.
- 31 584 Bedan, E. S., and Clausen, J. C. 2009. "Stormwater Runoff Quality and Quantity From
32
33 585 Traditional and Low Impact Development Watersheds1." *JAWRA Journal of the*
34
35 586 *American Water Resources Association* 45 (4):998-1008. doi: 10.1111/j.1752-
36
37 587 1688.2009.00342.x.
- 38 588 Behzadian, K., Kapelan, Z., Mousavi, S. J., and Alani, A. 2017. "Can smart rainwater
39
40 589 harvesting schemes result in the improved performance of integrated urban water
41
42 590 systems?" *Environmental Science and Pollution Research*. doi: 10.1007/s11356-017-
43
44 591 0546-5.
- 45 592 Bell, C. D., McMillan, S. K., Clinton, S. M., and Jefferson, A. J. 2016. "Hydrologic response
46
47 593 to stormwater control measures in urban watersheds." *Journal of Hydrology*
48
49 594 541:1488-500. doi: <https://doi.org/10.1016/j.jhydrol.2016.08.049>.
- 50 595 Bemporad, A., Morari, M., Dua, V., and Pistikopoulos, E. N. 2002. "The explicit linear
51
52 596 quadratic regulator for constrained systems." *Automatica* 38 (1):3-20. doi:
53
54 597 [https://doi.org/10.1016/S0005-1098\(01\)00174-1](https://doi.org/10.1016/S0005-1098(01)00174-1).
- 55 598 Bennett, S. 1994. *Real-time computer control : an introduction*. 2nd ed. ed, Prentice-Hall
56
57 599 *international series in systems and control engineering*: Prentice Hall.
- 58 600 Bernard, T., Sajidman, M., and Kuntze, H.-B. 2001. A New Fuzzy-Based Multi-Objective
59
60 601 Optimization Concept for Process Control Systems. Paper presented at the

- 1
2
3 602 Computational Intelligence. Theory and Applications, Berlin, Heidelberg. doi:
4 https://doi.org/10.1007/3-540-45493-4_66
5 603
- 6 604 Bhaskar, A. S., Hogan, D. M., and Archfield, S. A. 2016. "Urban base flow with low impact
7 development." *Hydrological Processes* 30 (18):3156-71. doi: 10.1002/hyp.10808.
8 605
- 9 606 Bilodeau, K., Pelletier, G., and Duchesne, S. 2018. "Real-time control of stormwater
10 detention basins as an adaptation measure in mid-size cities." *Urban Water Journal*
11 15 (9):858-67. doi: 10.1080/1573062X.2019.1574844.
12 607
- 13 608 Blecken, G.-T., Hunt, W. F., Al-Rubaei, A. M., Viklander, M., and Lord, W. G. 2017.
14 "Stormwater control measure (SCM) maintenance considerations to ensure designed
15 functionality." *Urban Water Journal* 14 (3):278-90. doi:
16 10.1080/1573062X.2015.1111913.
17 609
- 18 610 Blecken, G.-T., Zinger, Y., Deletić, A., Fletcher, T. D., and Viklander, M. 2009a. "Impact of
19 a submerged zone and a carbon source on heavy metal removal in stormwater
20 biofilters." *Ecological Engineering* 35 (5):769-78. doi:
21 <https://doi.org/10.1016/j.ecoleng.2008.12.009>.
22 611
- 23 612 Blecken, G.-T., Zinger, Y., Deletić, A., Fletcher, T. D., and Viklander, M. 2009b. "Influence
24 of intermittent wetting and drying conditions on heavy metal removal by stormwater
25 biofilters." *Water Research* 43 (18):4590-8. doi:
26 <https://doi.org/10.1016/j.watres.2009.07.008>.
27 613
- 28 614 Bondy, J. A., and Murty, U. S. R. 1977. *Graph theory with applications*. U.S.A.: Elsevier
29 Science Publishing Co., Inc.
30 615
- 31 616 Bratieres, K., Fletcher, T. D., Deletic, A., and Zinger, Y. 2008. "Nutrient and sediment
32 removal by stormwater biofilters: A large-scale design optimisation study." *Water*
33 *Research* 42 (14):3930-40. doi: <https://doi.org/10.1016/j.watres.2008.06.009>.
34 617
- 35 618 Brogan, W. L. 1991. *Modern control theory*. 3rd ed. ed: Prentice Hall.
36 619
- 37 620 Brous, P., and Janssen, M. 2015. A Systematic Review of Impediments Blocking Internet of
38 Things Adoption by Governments. Paper presented at the Open and Big Data
39 Management and Innovation, Cham. doi: [https://doi.org/10.1007/978-3-319-25013-](https://doi.org/10.1007/978-3-319-25013-7_7)
40 [7_7](https://doi.org/10.1007/978-3-319-25013-7_7)
41 621
- 42 622 Brown, R., Ashley, R., and Farrelly, M. 2011. "Political and Professional Agency
43 Entrapment: An Agenda for Urban Water Research." *Water Resources Management*
44 25 (15):4037-50. doi: 10.1007/s11269-011-9886-y.
45 623
46 624
47 625
48 626
49 627
50 628
51 629
52 630
53 631
54 632
55 633
56
57
58
59
60

- 1
2
3 634 Brown, R. R. 2005. "Impediments to Integrated Urban Stormwater Management: The Need
4 for Institutional Reform." *Environmental Management* 36 (3):455-68. doi:
5 635 <https://doi.org/10.1007/s00267-004-0217-4>.
6 636
7
8 637 Brown, R. R., and Farrelly, M. A. 2009. "Delivering sustainable urban water management: a
9 review of the hurdles we face." *Water Science & Technology* 59 (5):839-46. doi:
10 638 <https://doi.org/10.2166/wst.2009.028>.
11 639
12
13 640 Bunn, S. E., and Arthington, A. H. 2002. "Basic Principles and Ecological Consequences of
14 Altered Flow Regimes for Aquatic Biodiversity." *Environmental Management* 30
15 641 (4):492-507. doi: <https://doi.org/10.1007/s00267-002-2737-0>.
16 642
17
18 643 Burns, M. J., Fletcher, T. D., Duncan, H. P., Hatt, B. E., Ladson, A. R., and Walsh, C. J.
19 644 2012. The stormwater retention performance of rainwater tanks at the landparcel
20 645 scale. Paper presented at the Proceedings of the 7th International Conference on
21 646 Water Sensitive Urban Design, Melbourne, Australia.
22
23 647 Burns, M. J., Fletcher, T. D., Duncan, H. P., Hatt, B. E., Ladson, A. R., and Walsh, C. J.
24 648 2015a. "The performance of rainwater tanks for stormwater retention and water
25 649 supply at the household scale: an empirical study." *Hydrological Processes* 29
26 650 (1):152-60. doi: 10.1002/hyp.10142.
27
28 651 Burns, M. J., Schubert, J. E., Fletcher, T. D., and Sanders, B. F. 2015b. "Testing the impact
29 652 of at-source stormwater management on urban flooding through a coupling of
30 653 network and overland flow models." *Wiley Interdisciplinary Reviews: Water* 2
31 654 (4):291-300. doi: 10.1002/wat2.1078.
32
33 655 Campisano, A., Creaco, E., and Modica, C. 2016. "Application of Real-Time Control
34 656 Techniques to Reduce Water Volume Discharges from Quality-Oriented CSO
35 657 Devices." *Journal of Environmental Engineering* 142 (1):1-8. doi:
36 658 [https://doi.org/10.1061/\(ASCE\)EE.1943-7870.0001013](https://doi.org/10.1061/(ASCE)EE.1943-7870.0001013).
37
38 659 Campisano, A., and Modica, C. 2002. "PID and PLC units for the real-time control of sewer
39 660 systems." *Water Sci Technol* 45 (7):95-104. doi:
40 661 <https://doi.org/10.2166/wst.2002.0121>.
41
42 662 Campisano, A., and Modica, C. 2012. "Optimal sizing of storage tanks for domestic
43 663 rainwater harvesting in Sicily." *Resources, Conservation and Recycling* 63:9-16. doi:
44 664 10.1016/j.resconrec.2012.03.007.
45
46 665 Campisano, A., and Modica, C. 2016. "Rainwater harvesting as source control option to
47 666 reduce roof runoff peaks to downstream drainage systems." *Journal of*
48 667 *Hydroinformatics* 18 (1):23-32. doi: 10.2166/hydro.2015.133.

- 1
2
3 668 Camponogara, E., Jia, D., Krogh, B. H., and Talukdar, S. 2002. "Distributed model predictive
4 control." *IEEE Control Systems Magazine* 22 (1):44-52. doi: 10.1109/37.980246.
5 669
6 670 Carpenter, J. F., Vallet, B., Pelletier, G., Lessard, P., and Vanrolleghem, P. A. 2014.
7 "Pollutant removal efficiency of a retrofitted stormwater detention pond." *Water*
8 *Quality Research Journal of Canada (IWA Publishing)* 49 (2):124-34. doi:
9 <https://doi.org/10.2166/wqrjc.2013.020>.
10 672
11 673
12 674 Cembrano, G., Wells, G., Quevedo, J., Pérez, R., and Argelaguet, R. 2000. "Optimal control
15 of a water distribution network in a supervisory control system." *Control*
16 *Engineering Practice* 8 (10):1177-88. doi: [https://doi.org/10.1016/S0967-](https://doi.org/10.1016/S0967-0661(00)00058-7)
17 676 [0661\(00\)00058-7](https://doi.org/10.1016/S0967-0661(00)00058-7).
18 677
19 678 Cen, L., and Xi, Y. 2009. Aggregation-based model predictive control of urban combined
20 sewer networks. Paper presented at the 2009 7th Asian Control Conference, 27-29
21 Aug. 2009.
22 679
23 680
24 681 Chandrasena, G. I., Deletic, A., Ellerton, J., and McCarthy, D. T. 2012. "Evaluating
27 Escherichia coli removal performance in stormwater biofilters: a laboratory-scale
28 study." *Water Science and Technology* 66 (5):1132-8. doi: 10.2166/wst.2012.283.
29 683
30 684 Chandrasena, G. I., Deletic, A., and McCarthy, D. T. 2016. "Biofiltration for stormwater
32 harvesting: Comparison of *Campylobacter* spp. and *Escherichia coli* removal under
33 normal and challenging operational conditions." *Journal of Hydrology* 537:248-59.
34 686 doi: <https://doi.org/10.1016/j.jhydrol.2016.03.044>.
35 687
36 688 Chee-Yee, C., and Kumar, S. P. 2003. "Sensor networks: evolution, opportunities, and
39 challenges." *Proceedings of the IEEE* 91 (8):1247-56. doi:
40 689 10.1109/JPROC.2003.814918.
41 690
42 691 Cherqui, F., Szota, C., James, R., Poelsma, P., Perigaud, T., Burns, M. J., Fletcher, T., and
44 Bertrand-Krajewski, J.-L. 2019. Toward proactive management of stormwater control
45 measures using low-cost technology. Paper presented at the 10th international
46 693 conference NOVATECH, 1-5 July, Lyon, France.
47 694
48 695 Chiang, Y. M., Chang, L. C., Tsai, M. J., Wang, Y. F., and Chang, F. J. 2011. "Auto-control
51 of pumping operations in sewerage systems by rule-based fuzzy neural networks."
52 696 *Hydrol. Earth Syst. Sci.* 15 (1):185-96. doi: 10.5194/hess-15-185-2011.
53 697
54 698 Cocchia, A. 2014. "Smart and Digital City: A Systematic Literature Review." In *Smart City:*
56 *How to Create Public and Economic Value with High Technology in Urban Space*,
57 699 edited by Dameri and Rosenthal-Sabroux, 13-43. Cham: Springer International
58 700 Publishing. doi: 10.1007/978-3-319-06160-3_2
59 701
60

- 1
2
3 702 Crawford, J. T., Loken, L. C., Casson, N. J., Smith, C., Stone, A. G., and Winslow, L. A.
4
5 703 2015. "High-Speed Limnology: Using Advanced Sensors to Investigate Spatial
6
7 704 Variability in Biogeochemistry and Hydrology." *Environmental Science &*
8
9 705 *Technology* 49 (1):442-50. doi: 10.1021/es504773x.
- 10 706 Damodaram, C., Giacomoni, M. H., Prakash Khedun, C., Holmes, H., Ryan, A., Saour, W.,
11
12 707 and Zechman, E. M. 2010. "Simulation of Combined Best Management Practices and
13
14 708 Low Impact Development for Sustainable Stormwater Management." *Journal of the*
15
16 709 *American Water Resources Association* 46 (5):907-18. doi: 10.1111/j.1752-
17
18 710 1688.2010.00462.x.
- 19 711 Davis, A. P. 2008. "Field Performance of Bioretention: Hydrology Impacts." *Journal of*
20
21 712 *Hydrologic Engineering* 13 (2):90-5. doi: 10.1061/(ASCE)1084-0699(2008)13:2(90).
- 22 713 Davis, A. P., Hunt, W. F., Traver, R. G., and Clar, M. 2009. "Bioretention Technology:
23
24 714 Overview of Current Practice and Future Needs." *Journal of Environmental*
25
26 715 *Engineering* 135 (3):109-17. doi: 10.1061/(ASCE)0733-9372(2009)135:3(109).
- 27 716 DeBusk, K. M., Hunt, W. F., and Wright, J. D. 2013. "Characterizing Rainwater Harvesting
28
29 717 Performance and Demonstrating Stormwater Management Benefits in the Humid
30
31 718 Southeast USA." *Journal of the American Water Resources Association* 49 (6):1398-
32
33 719 411. doi: <https://doi.org/10.1111/jawr.12096>.
- 34 720 Di Matteo, M., Liang, R., Maier, H. R., Thyer, M. A., Simpson, A. R., Dandy, G. C., and
35
36 721 Ernst, B. 2019. "Controlling rainwater storage as a system: An opportunity to reduce
37
38 722 urban flood peaks for rare, long duration storms." *Environmental Modelling &*
39
40 723 *Software* 111:34-41. doi: <https://doi.org/10.1016/j.envsoft.2018.09.020>.
- 41 724 Dijkstra, E. W. 1982. "Self-Stabilization in Spite of Distributed Control." In *Selected*
42
43 725 *Writings on Computing: A personal Perspective*, 41-6. New York, NY: Springer New
44
45 726 York. doi: 10.1007/978-1-4612-5695-3_7
- 46 727 Dirckx, G., Schutze, M., Kroll, S., Thoeye, C., De Gueldre, G., and Van De Steene, B. 2011.
47
48 728 "Cost-efficiency of RTC for CSO impact mitigation." *Urban Water Journal* 8
49
50 729 (6):367-77. doi: 10.1080/1573062x.2011.630092.
- 51 730 Divers, M. T., Elliott, E. M., and Bain, D. J. 2013. "Constraining Nitrogen Inputs to Urban
52
53 731 Streams from Leaking Sewers Using Inverse Modeling: Implications for Dissolved
54
55 732 Inorganic Nitrogen (DIN) Retention in Urban Environments." *Environmental Science*
56
57 733 *& Technology* 47 (4):1816-23. doi: 10.1021/es304331m.
- 58 734 Ebersold, K., and Glass, R. 2016. "The Internet of Things: A Cause for Ethical Concern."
59
60 735 *Issues in Information Systems* 17 (4):145-51.

- 1
2
3 736 Elliott, A. H., Spigel, R. H., Jowett, I. G., Shankar, S. U., and Ibbitt, R. P. 2010. "Model
4 737 application to assess effects of urbanisation and distributed flow controls on erosion
5 738 potential and baseflow hydraulic habitat." *Urban Water Journal* 7 (2):91-107. doi:
6 739 10.1080/15730620903447605.
7
8
9 740 Ellis, J. B., and Hvitved-Jacobsen, T. 1996. "Urban drainage impacts on receiving waters."
10 741 *Journal of Hydraulic Research* 34 (6):771-83. doi: 10.1080/00221689609498449.
11
12 742 Emerson, C. H., Welty, C., and Traver, R. G. 2005. "Watershed-Scale Evaluation of a System
13 743 of Storm Water Detention Basins." *Journal of Hydrologic Engineering* 10 (3):237-
14 744 42. doi: doi:10.1061/(ASCE)1084-0699(2005)10:3(237).
15
16
17 745 Fallside, F., and Perry, P. F. 1975. "Hierarchical optimisation of a water-supply network."
18 746 *Proceedings of the Institution of Electrical Engineers* 122 (2):202-8. doi:
19 747 10.1049/piee.1975.0048.
20
21
22 748 Farrelly, M., and Brown, R. 2011. "Rethinking urban water management: Experimentation as
23 749 a way forward?" *Global Environmental Change* 21 (2):721-32. doi:
24 750 <https://doi.org/10.1016/j.gloenvcha.2011.01.007>.
25
26
27 751 Feng, W., Hatt, B. E., McCarthy, D. T., Fletcher, T. D., and Deletic, A. 2012. "Biofilters for
28 752 Stormwater Harvesting: Understanding the Treatment Performance of Key Metals
29 753 That Pose a Risk for Water Use." *Environmental Science & Technology* 46 (9):5100-
30 754 8. doi: 10.1021/es203396f.
31
32
33 755 Fisher, D. K. 2007. "Automated Collection of Soil-Moisture Data with a Low-Cost
34 756 Microcontroller Circuit." *Applied Engineering in Agriculture* 23 (4):493-500. doi:
35 757 <https://doi.org/10.13031/2013.23488>.
36
37
38 758 Fletcher, T. D., Mitchell, G. V., Deletic, A., Ladson, T. R., and Seven, A. 2007. "Is
39 759 stormwater harvesting beneficial to urban waterway environmental flows?" *Water*
40 760 *Science and Technology* 55 (4):265-72. doi: <https://doi.org/10.2166/wst.2007.117>.
41
42
43 761 Fletcher, T. D., Shuster, W., Hunt, W. F., Ashley, R., Butler, D., Arthur, S., Trowsdale, S., et
44 762 al. 2014a. "SUDS, LID, BMPs, WSUD and more – The evolution and application of
45 763 terminology surrounding urban drainage." *Urban Water Journal* 12 (7):525-42. doi:
46 764 10.1080/1573062x.2014.916314.
47
48
49 765 Fletcher, T. D., Vietz, G., and Walsh, C. J. 2014b. "Protection of stream ecosystems from
50 766 urban stormwater runoff: The multiple benefits of an ecohydrological approach."
51 767 *Progress in Physical Geography* 38 (5):543-55. doi: 10.1177/0309133314537671.
52
53
54
55
56
57
58
59
60

- 1
2
3 768 Fu, G., Butler, D., and Khu, S.-T. 2008. "Multiple objective optimal control of integrated
4 769 urban wastewater systems." *Environmental Modelling & Software* 23 (2):225-34. doi:
5 770 <https://doi.org/10.1016/j.envsoft.2007.06.003>.
- 6
7
8 771 Gaborit, E., Anctil, F., Pelletier, G., and Vanrolleghem, P. A. 2016. "Exploring forecast-
9 772 based management strategies for stormwater detention ponds." *Urban Water Journal*
10 773 13 (8):841-51. doi: 10.1080/1573062X.2015.1057172.
- 11
12
13 774 Gaborit, E., Muschalla, D., Vallet, B., Vanrolleghem, P. A., and Anctil, F. 2013. "Improving
14 775 the performance of stormwater detention basins by real-time control using rainfall
15 776 forecasts." *Urban Water Journal* 10 (4):230-46. doi:
16 777 10.1080/1573062x.2012.726229.
- 17
18
19 778 García, L., Barreiro-Gomez, J., Escobar, E., Téllez, D., Quijano, N., and Ocampo-Martinez,
20 779 C. 2015. "Modeling and real-time control of urban drainage systems: A review."
21 780 *Advances in Water Resources* 85:120-32. doi:
22 781 <https://doi.org/10.1016/j.advwatres.2015.08.007>.
- 23
24
25 782 Gardner, T., and Vieritz, A. 2010. "The role of rainwater tanks in Australia in the twenty first
26 783 century." *Architectural Science Review* 53 (1):107-25. doi:
27 784 <http://dx.doi.org/10.3763/asre.2009.0074>.
- 28
29
30 785 Garofalo, G., Giordano, A., Piro, P., Spezzano, G., and Vinci, A. 2017. "A distributed real-
31 786 time approach for mitigating CSO and flooding in urban drainage systems." *Journal*
32 787 *of Network and Computer Applications* 78 (Supplement C):30-42. doi:
33 788 <https://doi.org/10.1016/j.jnca.2016.11.004>.
- 34
35
36 789 Ge, Z., Feng, C., Wang, X., and Zhang, J. 2016. "Seasonal applicability of three vegetation
37 790 constructed floating treatment wetlands for nutrient removal and harvesting strategy
38 791 in urban stormwater retention ponds." *International Biodeterioration &*
39 792 *Biodegradation* 112:80-7. doi: <https://doi.org/10.1016/j.ibiod.2016.05.007>.
- 40
41
42 793 Gee, K. D., and Hunt, W. F. 2016. "Enhancing stormwater management benefits of rainwater
43 794 harvesting via innovative technologies." *Journal of Environmental Engineering* 142
44 795 (8):04016039. doi: [https://doi.org/10.1061/\(ASCE\)EE.1943-7870.0001108](https://doi.org/10.1061/(ASCE)EE.1943-7870.0001108).
- 45
46
47 796 Gilpin, A., and Barrett, M. 2014. "Interim Report on the Retrofit of an Existing Flood Control
48 797 Facility to Improve Pollutant Removal in an Urban Watershed." In *World*
49 798 *Environmental and Water Resources Congress 2014*, 65-74. doi:
50 799 10.1061/9780784413548.009
- 51
52
53
54
55
56
57
58
59
60

- 1
2
3 800 Giordano, V., and Fulli, G. 2012. "A business case for Smart Grid technologies: A systemic
4 perspective." *Energy Policy* 40:252-9. doi:
5 801 <https://doi.org/10.1016/j.enpol.2011.09.066>.
6 802
7
8 803 Guo, Y., and Adams, B. J. 1999. "Analysis of detention ponds for storm water quality
9 control." *Water Resources Research* 35 (8):2447-56. doi:
10 804 doi:10.1029/1999WR900124.
11 805
12 806 Gupta, R. A., and Chow, M. 2010. "Networked Control System: Overview and Research
13 Trends." *IEEE Transactions on Industrial Electronics* 57 (7):2527-35. doi:
14 807 10.1109/TIE.2009.2035462.
15 808
16 809 Gwenzi, W., Dunjana, N., Pisa, C., Tauro, T., and Nyamadzawo, G. 2015. "Water quality and
17 public health risks associated with roof rainwater harvesting systems for potable
18 supply: Review and perspectives." *Sustainability of Water Quality and Ecology*
19 810 6:107-18. doi: <https://doi.org/10.1016/j.swaqe.2015.01.006>.
20 811
21 812
22 813 Hamel, P., Daly, E., and Fletcher, T. D. 2013. "Source-control stormwater management for
23 mitigating the impacts of urbanisation on baseflow: A review." *Journal of Hydrology*
24 814 485:201-11. doi: 10.1016/j.jhydrol.2013.01.001.
25 815
26 816 Han, M. Y., and Mun, J. S. 2011. "Operational data of the Star City rainwater harvesting
27 system and its role as a climate change adaptation and a social influence." *Water*
28 *Science & Technology* 63 (12):2796-801. doi: 10.2166/wst.2011.597.
29 818
30 819 Hatt, B. E., Fletcher, T. D., and Deletic, A. 2008. "Hydraulic and Pollutant Removal
31 Performance of Fine Media Stormwater Filtration Systems." *Environmental Science*
32 *& Technology* 42 (7):2535-41. doi: <https://doi.org/10.1021/es071264p>.
33 821
34 822 Hawley, R., R. MacMannis, K., and S. Wooten, M. 2013. "How Poor Stormwater Practices
35 Are Shortening the Life of Our Nation's Infrastructure--Recalibrating Stormwater
36 Management for Stream Channel Stability and Infrastructure Sustainability." In *World*
37 *Environmental and Water Resources Congress 2013*, 193-207. American Society of
38 Engineers, Reston, Virginia, USA, Cincinnati, Ohio, May 19–23. doi:
39 824 10.1061/9780784412947.019
40 825
41 826 Henderson, C., Greenway, M., and Phillips, I. 2007. "Removal of dissolved nitrogen,
42 phosphorus and carbon from stormwater by biofiltration mesocosms." *Water Science*
43 *and Technology* 55 (4):183-91. doi: 10.2166/wst.2007.108.
44 829
45 830 Hespanha, J. P., Naghshtabrizi, P., and Xu, Y. 2007. "A Survey of Recent Results in
46 Networked Control Systems." *Proceedings of the IEEE* 95 (1):138-62. doi:
47 831 10.1109/JPROC.2006.887288.
48 832
49 833

- 1
2
3 834 Hunt, W. F., Davis, A. P., and Traver, R. G. 2012. "Meeting Hydrologic and Water Quality
4 835 Goals through Targeted Bioretention Design." *Journal of Environmental Engineering*
5 836 138 (6):698-707. doi: 10.1061/(ASCE)EE.1943-7870.0000504.
6
7
8 837 Hunt, W. F., Jarrett, A. R., Smith, J. T., and Sharkey, L. J. 2006. "Evaluating Bioretention
9 838 Hydrology and Nutrient Removal at Three Field Sites in North Carolina." *Journal of*
10 839 *Irrigation and Drainage Engineering* 132 (6):600-8. doi: 10.1061/(ASCE)0733-
11 840 9437(2006)132:6(600).
12
13 841 Hur, J., Schlautman, M. A., Templeton, S. R., Karanfil, T., Post, C. J., Smink, J. A., Song, H.,
14 842 Goddard, M. A., Klaine, S. J., and Hayes, J. C. 2008. "Does current management of
15 843 storm water runoff adequately protect water resources in developing catchments?"
16 844 *Journal of Soil and Water Conservation* 63 (2):77-90. doi: 10.2489/jswc.63.2.77.
17
18 845 Ibrahim, Y. A. 2020. "Real-Time Control Algorithm for Enhancing Operation of Network of
19 846 Stormwater Management Facilities." *Journal of Hydrologic Engineering* 25
20 847 (2):04019065. doi: doi:10.1061/(ASCE)HE.1943-5584.0001881.
21
22 848 Jacopin, C., Lucas, E., Desbordes, M., and Bourgoigne, P. 2001. "Optimisation of operational
23 849 management practices for the detention basins." *Water science and technology : a*
24 850 *journal of the International Association on Water Pollution Research* 44 (2-3):277-
25 851 85. doi: 10.2166/wst.2001.0780.
26
27 852 Joalland, G., and Cohen, G. 1980. "Optimal control of a water distribution network by two
28 853 multilevel methods." *Automatica* 16 (1):83-8. doi: [https://doi.org/10.1016/0005-](https://doi.org/10.1016/0005-1098(80)90089-8)
29 854 [1098\(80\)90089-8](https://doi.org/10.1016/0005-1098(80)90089-8).
30
31 855 Jones, M. P., and Hunt, W. F. 2010. "Performance of rainwater harvesting systems in the
32 856 southeastern United States." *Resources, Conservation and Recycling* 54 (10):623-9.
33 857 doi: <https://doi.org/10.1016/j.resconrec.2009.11.002>.
34
35 858 Jongman, B., Ward, P. J., and Aerts, J. C. J. H. 2012. "Global exposure to river and coastal
36 859 flooding: Long term trends and changes." *Global Environmental Change* 22 (4):823-
37 860 35. doi: <https://doi.org/10.1016/j.gloenvcha.2012.07.004>.
38
39 861 Kerkez, B., Gruden, C., Lewis, M., Montestruque, L., Quigley, M., Wong, B., Bedig, A., et
40 862 al. 2016. "Smarter Stormwater Systems." *Environmental Science & Technology* 50
41 863 (14):7267-73. doi: <https://doi.org/10.1021/acs.est.5b05870>.
42
43 864 Kim, G., Yur, J., and Kim, J. 2007. "Diffuse pollution loading from urban stormwater runoff
44 865 in Daejeon city, Korea." *Journal of Environmental Management* 85 (1):9-16. doi:
45 866 <https://doi.org/10.1016/j.jenvman.2006.07.009>.
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 867 King, R. S., Baker, M. E., Whigham, D. F., Weller, D. E., Jordan, T. E., Kazyak, P. F., and
4
5 868 Hurd, M. K. 2005. "Spatial Considerations for Linking Watershed Land Cover to
6
7 869 Ecological Indicators in Streams." *Ecological Applications* 15 (1):137-53. doi:
8
9 870 <https://doi.org/10.1890/04-0481>.
- 10 871 Kiparsky, M., Sedlak, D. L., Barton H. Thompson, J., and Truffer, B. 2013. "The Innovation
11
12 872 Deficit in Urban Water: The Need for an Integrated Perspective on Institutions,
13
14 873 Organizations, and Technology." *Environmental Engineering Science* 30 (8):395-
15
16 874 408. doi: 10.1089/ees.2012.0427.
- 17 875 Kitchin, R. 2014. "The real-time city? Big data and smart urbanism." *GeoJournal* 79 (1):1-
18
19 876 14. doi: 10.1007/s10708-013-9516-8.
- 20 877 Klepiszewski, K., and Schmitt, T. G. 2002. "Comparison of conventional rule based flow
21
22 878 control with control processes based on fuzzy logic in a combined sewer system."
23
24 879 *Water Science and Technology* 46 (6-7):77-84. doi: 10.2166/wst.2002.0665.
- 25 880 Klocker, C. A., Kaushal, S. S., Groffman, P. M., Mayer, P. M., and Morgan, R. P. 2009.
26
27 881 "Nitrogen uptake and denitrification in restored and unrestored streams in urban
28
29 882 Maryland, USA." *Aquatic Sciences* 71 (4):411-24. doi: 10.1007/s00027-009-0118-y.
- 30 883 Lefkowitz, J. R., Sarmanian, A. K., and Quigley, M. 2016. "Continuous monitoring and
31
32 884 adaptive control--the internet of things transforms stormwater management." *Journal*
33
34 885 *of New England Water Environment Association* 50 (1):44-51.
- 35 886 Leirens, S., Zamora, C., Negenborn, R. R., and Schutter, B. D. 2010. Coordination in urban
36
37 887 water supply networks using distributed model predictive control. Paper presented at
38
39 888 the Proceedings of the 2010 American Control Conference, 30 June-2 July 2010. doi:
40
41 889 10.1109/ACC.2010.5530635
- 42 890 Löwe, R., Vezzaro, L., Mikkelsen, P. S., Grum, M., and Madsen, H. 2016. "Probabilistic
43
44 891 runoff volume forecasting in risk-based optimization for RTC of urban drainage
45
46 892 systems." *Environmental Modelling & Software* 80:143-58. doi:
47
48 893 <https://doi.org/10.1016/j.envsoft.2016.02.027>.
- 49 894 Lund, N. S. V., Borup, M., Madsen, H., Mark, O., Arnbjerg-Nielsen, K., and Mikkelsen, P. S.
50
51 895 2019. "Integrated stormwater inflow control for sewers and green structures in urban
52
53 896 landscapes." *Nature Sustainability*. doi: 10.1038/s41893-019-0392-1.
- 54 897 Lund, N. S. V., Falk, A. K. V., Borup, M., Madsen, H., and Steen Mikkelsen, P. 2018.
55
56 898 "Model predictive control of urban drainage systems: A review and perspective
57
58 899 towards smart real-time water management." *Critical Reviews in Environmental*
59
900 900 *Science and Technology* 48 (3):279-339. doi: 10.1080/10643389.2018.1455484.

- 1
2
3 901 Ly, D. K. 2019. "Water Quality-Based Real Time Control of Combined Sewer Systems."
4
5 902 Université de Lyon - INSA Lyon.
6
7 903 Lyons, J. E., Runge, M. C., Laskowski, H. P., and Kendall, W. L. 2008. "Monitoring in the
8
9 904 Context of Structured Decision-Making and Adaptive Management." *The Journal of*
10
11 905 *Wildlife Management* 72 (8):1683-92. doi: 10.2193/2008-141.
12
13 906 Mah, D. N.-y., van der Vleuten, J. M., Hills, P., and Tao, J. 2012. "Consumer perceptions of
14
15 907 smart grid development: Results of a Hong Kong survey and policy implications."
16
17 908 *Energy Policy* 49:204-16. doi: <https://doi.org/10.1016/j.enpol.2012.05.055>.
18
19 909 Marinaki, M., and Papageorgiou, M. 2003. Linear-quadratic regulators applied to sewer
20
21 910 network flow control. Paper presented at the 2003 European Control Conference
22
23 911 (ECC), 1-4 Sept. 2003. doi: 10.23919/ECC.2003.7085327
24
25 912 Marques, R. C. 2010. *Regulation of water and wastewater services : an international*
26
27 913 *comparison*: IWA Publishing. doi: 10.2166/9781780401492
28
29 914 Marsalek, J., and Chocat, B. 2002. "International Report: Stormwater management." *Water*
30
31 915 *Science and Technology* 46 (6-7):1-17. doi: 10.2166/wst.2002.0657.
32
33 916 Martínez, F., Hernández, V., Alonso, J. M., Rao, Z., and Alvisi, S. 2007. "Optimizing the
34
35 917 operation of the Valencia water-distribution network." *Journal of Hydroinformatics* 9
36
37 918 (1):65-78. doi: <https://doi.org/10.2166/hydro.2006.018>.
38
39 919 Melville-Shreeve, P., Ward, S., and Butler, D. 2016. "Rainwater Harvesting Typologies for
40
41 920 UK Houses: A Multi Criteria Analysis of System Configurations." *Water* 8 (4):129.
42
43 921 doi: 10.3390/w8040129.
44
45 922 Middleton, J. R., and Barrett, M. E. 2008. "Water Quality Performance of a Batch-Type
46
47 923 Stormwater Detention Basin." *Water Environment Research* 80 (2):172-8. doi:
48
49 924 10.2175/106143007X220842.
50
51 925 Mikkelsen, P., Adeler, O., Albrechtsen, H., and Henze, M. 1999. "Collected rainfall as a
52
53 926 water source in danish households — what is the potential and what are the costs?"
54
55 927 *Water Science and Technology* 39 (5):49-56. doi: 10.1016/s0273-1223(99)00086-4.
56
57 928 Mitchell, V. G. 2006. "Applying Integrated Urban Water Management Concepts: A Review
58
59 929 of Australian Experience." *Environmental Management* 37 (5):589-605. doi:
60
930 10.1007/s00267-004-0252-1.
931 Mitchell, V. G., Deletic, A., Fletcher, T. D., Hatt, B. E., and McCarthy, D. T. 2007.
932 "Achieving multiple benefits from stormwater harvesting." *Water Science &*
933 *Technology* 55 (4):135-44. doi: <https://doi.org/10.2166/wst.2007.103>.

- 1
2
3 934 Miyaoka, S., and Funabashi, M. 1984. "Optimal control of water distribution systems by
4 network flow theory." *IEEE Transactions on Automatic Control* 29 (4):303-11. doi:
5 10.1109/TAC.1984.1103524.
6 936
7
8 937 Mollerup, A. L., Mikkelsen, P. S., Thornberg, D., and Sin, G. 2017. "Controlling sewer
9 systems – a critical review based on systems in three EU cities." *Urban Water
10 Journal* 14 (4):435-42. doi: <https://doi.org/10.1080/1573062X.2016.1148183>.
11 938
12 939
13 940 Mollerup, A. L., Thornberg, D., Mikkelsen, P. S., Johansen, N. B., and Sin, G. 2013. 16
14 Years of Experience with Rule Based Control of Copenhagen's Sewer System. Paper
15 presented at the Proceedings of the 11th International Conference on Instrumentation,
16 Control and Automation (ICA), Narbonne, France, 18 September 2013 - 20
17 942
18 943
19 944
20 944
21 September 2013.
22 945
23 945 Montserrat, A., Gutierrez, O., Poch, M., and Corominas, L. 2013. "Field validation of a new
24 946 low-cost method for determining occurrence and duration of combined sewer
25 947 overflows." *Science of The Total Environment* 463-464:904-12. doi:
26 948
27 948 <https://doi.org/10.1016/j.scitotenv.2013.06.010>.
28
29 949
30 949 Morawska, L., Thai, P. K., Liu, X., Asumadu-Sakyi, A., Ayoko, G., Bartonova, A., Bedini,
31 950 A., et al. 2018. "Applications of low-cost sensing technologies for air quality
32 951 monitoring and exposure assessment: How far have they gone?" *Environment
33 952 International* 116:286-99. doi: <https://doi.org/10.1016/j.envint.2018.04.018>.
34 952
35 953
36 953 Mullapudi, A., Bartos, M., Wong, B., and Kerkez, B. 2018. "Shaping Streamflow Using a
37 954 Real-Time Stormwater Control Network." *Sensors* 18 (7):2259. doi:
38 955
39 955 <https://doi.org/10.3390/s18072259>.
40
41 956
42 956 Mullapudi, A., Wong, B., and Kerkez, B. 2017. "Emerging investigators series: building a
43 957 theory for smart stormwater systems." *Environmental Science: Water Research &
44 958 Technology* 3 (1):66-77. doi: 10.1039/C6EW00211K.
45
46 959
47 959 Muschalla, D., Vallet, B., Anctil, F., Lessard, P., Pelletier, G., and Vanrolleghem, P. A. 2014.
48 960 "Ecohydraulic-driven real-time control of stormwater basins." *Journal of Hydrology*
49 961 511:82-91. doi: <https://doi.org/10.1016/j.jhydrol.2014.01.002>.
50 961
51 962
52 962 Oberascher, M., Zischg, J., Palermo, S. A., Kinzel, C., Rauch, W., and Sitzenfrei, R. 2019.
53 963 Smart Rain Barrels: Advanced LID Management Through Measurement and Control.
54 964 Paper presented at the UDM2018, Cham. doi: [https://doi.org/10.1007/978-3-319-
55 964 99867-1_134](https://doi.org/10.1007/978-3-319-99867-1_134)
56 965
57 965
58 966
59 966 Payne, E. G. I., Fletcher, T. D., Cook, P. L. M., Deletic, A., and Hatt, B. E. 2014. "Processes
60 967 and Drivers of Nitrogen Removal in Stormwater Biofiltration." *Critical Reviews in*

- 1
2
3 968 *Environmental Science and Technology* 44 (7):796-846. doi:
4 10.1080/10643389.2012.741310.
5 969
6
7 970 Payne, E. G. I., McCarthy, D. T., Deletic, A., and Zhang, K. 2019. "Biotreatment
8 971 technologies for stormwater harvesting: critical perspectives." *Current Opinion in*
9 972 *Biotechnology* 57:191-6. doi: <https://doi.org/10.1016/j.copbio.2019.04.005>.
10
11 973 Pellerin, B. A., Stauffer, B. A., Young, D. A., Sullivan, D. J., Bricker, S. B., Walbridge, M.
12 974 R., Clyde, G. A., and Shaw, D. M. 2016. "Emerging Tools for Continuous Nutrient
13 975 Monitoring Networks: Sensors Advancing Science and Water Resources Protection."
14 976 *Journal of the American Water Resources Association* 52 (4):993-1008. doi:
15 977 <https://doi.org/10.1111/1752-1688.12386>.
16
17 978 Persaud, P. P., Akin, A. A., Kerkez, B., McCarthy, D. T., and Hathaway, J. M. 2019. "Real
18 979 time control schemes for improving water quality from bioretention cells." *Blue-*
19 980 *Green Systems*. doi: 10.2166/bgs.2019.924.
20
21 981 Petrucci, G., Rioust, E., Deroubaix, J.-F., and Tassin, B. 2013. "Do stormwater source control
22 982 policies deliver the right hydrologic outcomes?" *Journal of Hydrology* 485:188-200.
23 983 doi: <https://doi.org/10.1016/j.jhydrol.2012.06.018>.
24
25 984 Piro, P., Turco, M., Palermo, S. A., Principato, F., and Brunetti, G. 2019. "A Comprehensive
26 985 Approach to Stormwater Management Problems in the Next Generation Drainage
27 986 Networks." In *The Internet of Things for Smart Urban Ecosystems*, edited by Cicirelli,
28 987 Guerrieri, Mastroianni, Spezzano and Vinci, 275-304. Cham: Springer International
29 988 Publishing. doi: 10.1007/978-3-319-96550-5_12
30
31 989 Poresky, A., Boyle, R., and Cadwalader, O. 2015. "Piloting Real Time Control Retrofits of
32 990 Stormwater Facilities: Two Oregon Case Studies and Beyond." In *Proceedings of the*
33 991 *Pacific Northwest Clean Water Association*.
34
35 992 Price, K. 2011. "Effects of watershed topography, soils, land use, and climate on baseflow
36 993 hydrology in humid regions: A review." *Progress in Physical Geography: Earth and*
37 994 *Environment* 35 (4):465-92. doi: <https://doi.org/10.1177/0309133311402714>.
38
39 995 Rahman, A., Dbais, J., Mitchell, C., Ronaldson, P., and Shrestha, S. 2011. "Study of
40 996 Rainwater Tanks as a Source of Alternative Water Supply in a Multistory Residential
41 997 Building in Sydney, Australia." In *World Environmental and Water Resources*
42 998 *Congress 2007*, 1-10. doi:10.1061/40927(243)596
43
44 999 Ramírez-Llanos, E., and Quijano, N. 2010. "A population dynamics approach for the water
45 1000 distribution problem." *International Journal of Control* 83 (9):1947-64. doi:
46 1001 10.1080/00207179.2010.501389.
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 1002 Rao, A. S., Marshall, S., Gubbi, J., Palaniswami, M., Sinnott, R., and Pettigrovet, V. 2013.
4
5 1003 Design of low-cost autonomous water quality monitoring system. Paper presented at
6
7 1004 the 2013 International Conference on Advances in Computing, Communications and
8
9 1005 Informatics (ICACCI), 22-25 Aug. 2013. doi: 10.2166/hydro.2006.015
10
11 1006 Rhea, L., Jarnagin, T., Hogan, D., Loperfido, J. V., and Shuster, W. 2015. "Effects of
12
13 1007 urbanization and stormwater control measures on streamflows in the vicinity of
14
15 1008 Clarksburg, Maryland, USA." *Hydrological Processes* 29 (20):4413-26. doi:
16
17 1009 doi:10.1002/hyp.10505.
18
19 1010 Rimer, S. P., Mullapudi, A., Troutman, S. C., and Kerkez, B. 2019. "A benchmarking
20
21 1011 framework for control and optimization of smart stormwater networks: demo
22
23 1012 abstract." In *Proceedings of the 10th ACM/IEEE International Conference on Cyber-*
24
25 1013 *Physical Systems*, 350–1. Montreal, Quebec, Canada: Association for Computing
26
27 1014 Machinery. doi: 10.1145/3302509.3313336
28
29 1015 Rode, M., Wade, A. J., Cohen, M. J., Hensley, R. T., Bowes, M. J., Kirchner, J. W.,
30
31 1016 Arhonditsis, G. B., et al. 2016. "Sensors in the Stream: The High-Frequency Wave of
32
33 1017 the Present." *Environmental Science & Technology* 50 (19):10297-307. doi:
34
35 1018 10.1021/acs.est.6b02155.
36
37 1019 Rodríguez-Molina, J., Martínez-Núñez, M., Martínez, J.-F., and Pérez-Aguilar, W. 2014.
38
39 1020 "Business Models in the Smart Grid: Challenges, Opportunities and Proposals for
40
41 1021 Prosumer Profitability." *Energies* 7 (9):6142-71. doi:
42
43 1022 <https://doi.org/10.3390/en7096142>.
44
45 1023 Roebuck, R. M., Oltean-Dumbrava, C., and Tait, S. 2011. "Whole life cost performance of
46
47 1024 domestic rainwater harvesting systems in the United Kingdom." *Water and*
48
49 1025 *Environment Journal* 25 (3):355-65. doi: 10.1111/j.1747-6593.2010.00230.x.
50
51 1026 Roman, D., Braga, A., Shetty, N., and Culligan, P. 2017. "Design and Modeling of an
52
53 1027 Adaptively Controlled Rainwater Harvesting System." *Water* 9 (12):974. doi:
54
55 1028 <https://doi.org/10.3390/w9120974>.
56
57 1029 Romanova, A., Tait, S., and Horoshenkov, K. V. 2012. "Local head loss monitoring using
58
59 1030 acoustic instrumentation in partially full sewer pipes." *Water Science and Technology*
60
1031 65 (9):1639-47. doi: 10.2166/wst.2012.058.
1032
1033 Russell, K. L., Vietz, G. J., and Fletcher, T. D. 2019. "Urban sediment supply to streams from
1034
<https://doi.org/10.1016/j.scitotenv.2018.10.374>.

- 1
2
3 1035 Savic, D. A., and Walters, G. A. 1997. "Genetic Algorithms for Least-Cost Design of Water
4 1036 Distribution Networks." *Journal of Water Resources Planning and Management* 123
5 1037 (2):67-77. doi: 10.1061/(ASCE)0733-9496(1997)123:2(67).
6
7 1038 Schubert, J. E., Burns, M. J., Fletcher, T. D., and Sanders, B. F. 2017. "A framework for the
8 1039 case-specific assessment of Green Infrastructure in mitigating urban flood hazards."
9 1040 *Advances in Water Resources* 108:55-68. doi:
10 1041 <https://doi.org/10.1016/j.advwatres.2017.07.009>.
11
12 1042 Schütze, M., Campisano, A., Colas, H., Schilling, W., and Vanrolleghem, P. A. 2004. "Real
13 1043 time control of urban wastewater systems—where do we stand today?" *Journal of*
14 1044 *Hydrology* 299 (3–4):335-48. doi: <http://dx.doi.org/10.1016/j.jhydrol.2004.08.010>.
15
16 1045 Seggelke, K., Löwe, R., Beeneken, T., and Fuchs, L. 2013. "Implementation of an integrated
17 1046 real-time control system of sewer system and waste water treatment plant in the city
18 1047 of Wilhelmshaven." *Urban Water Journal* 10 (5):330-41. doi:
19 1048 10.1080/1573062X.2013.820331.
20
21 1049 Sercu, B., Van De Werfhorst, L. C., Murray, J. L. S., and Holden, P. A. 2011. "Sewage
22 1050 Exfiltration As a Source of Storm Drain Contamination during Dry Weather in Urban
23 1051 Watersheds." *Environmental Science & Technology* 45 (17):7151-7. doi:
24 1052 10.1021/es200981k.
25
26 1053 Shammaa, Y., Zhu, D. Z., Gyürék, L. L., and Labatiuk, C. W. 2002. "Effectiveness of dry
27 1054 ponds for stormwater total suspended solids removal." *Canadian Journal of Civil*
28 1055 *Engineering* 29 (2):316-24. doi: 10.1139/102-008.
29
30 1056 Sharior, S., McDonald, W., and Parolari, A. J. 2019. "Improved reliability of stormwater
31 1057 detention basin performance through water quality data-informed real-time control."
32 1058 *Journal of Hydrology* 573:422-31. doi: <https://doi.org/10.1016/j.jhydrol.2019.03.012>.
33
34 1059 Shen, P., Deletic, A., Bratieres, K., and McCarthy, D. T. 2019. "Real time control of
35 1060 biofilters delivers stormwater suitable for harvesting and reuse." *Water*
36 1061 *Research*:115257. doi: <https://doi.org/10.1016/j.watres.2019.115257>.
37
38 1062 Shen, P., Deletic, A., and McCarthy, D. T. 2018. Model testing and laboratory validation of
39 1063 real-time control strategy for stormwater biofilters. Paper presented at the 11th
40 1064 International Conference on Urban Drainage Modelling. 2018.
41
42 1065 Shen, P., Deletic, A., Urich, C., and McCarthy, D. T. 2017. A preliminary study of real-time
43 1066 monitoring and control of biofilters for stormwater harvesting. Paper presented at the
44 1067 12th IWA Specialized Conference on Instrumentation, Control & Automation,
45 1068 Québec, Canada.

- 1
2
3 1069 Shishegar, S., Duchesne, S., and Pelletier, G. 2019a. "An Integrated Optimization and Rule-
4 based Approach for Predictive Real Time Control of Urban Stormwater Management
5 1070 Systems." *Journal of Hydrology*:124000. doi:
6 1071 <https://doi.org/10.1016/j.jhydrol.2019.124000>.
7
8 1072
9
10 1073 Shishegar, S., Duchesne, S., and Pelletier, G. 2019b. Predictive Real-Time Control
11 Optimization of a Stormwater Management System. Paper presented at the 2019
12 1074 IEEE 15th International Conference on Control and Automation (ICCA), 16-19 July
13 1075 2019. doi: 10.1109/ICCA.2019.8899726
14 1076
15 1077 Shrestha, P., Hurley, S. E., and Wemple, B. C. 2018. "Effects of different soil media,
16 vegetation, and hydrologic treatments on nutrient and sediment removal in roadside
17 1078 bioretention systems." *Ecological Engineering* 112:116-31. doi:
18 1079 <https://doi.org/10.1016/j.ecoleng.2017.12.004>.
19 1080
20 1081 Shuster, W., and Rhea, L. 2013. "Catchment-scale hydrologic implications of parcel-level
21 stormwater management (Ohio USA)." *Journal of Hydrology* 485:177-87. doi:
22 1082 <https://doi.org/10.1016/j.jhydrol.2012.10.043>.
23 1083
24 1084 Tang, W., Wang, Z., Feng, Q., and Wang, M. 2010. Application of fuzzy expert control to
25 APMP Pulping Wastewater treatment process of aerobic. Paper presented at the 2010
26 1085 IEEE International Conference on Mechatronics and Automation, 4-7 Aug. 2010. doi:
27 1086 10.1109/ICMA.2010.5589054
28 1087
29 1088 Vezzaro, L., Christensen, M. L., Thirsing, C., Grum, M., and Mikkelsen, P. S. 2014. "Water
30 Quality-based Real Time Control of Integrated Urban Drainage Systems: A
31 1089 Preliminary Study from Copenhagen, Denmark." *Procedia Engineering* 70:1707-16.
32 1090 doi: <https://doi.org/10.1016/j.proeng.2014.02.188>.
33 1091
34 1092 Vietz, G. J., Lintern, A., Webb, J. A., and Straccione, D. 2017. "River Bank Erosion and the
35 Influence of Environmental Flow Management." *Environmental Management*. doi:
36 1093 10.1007/s00267-017-0857-9.
37 1094
38 1095 Vörösmarty, C. J., Green, P., Salisbury, J., and Lammers, R. B. 2000. "Global Water
39 Resources: Vulnerability from Climate Change and Population Growth." *Science* 289
40 1096 (5477):284-8. doi: 10.1126/science.289.5477.284.
41 1097
42 1098 Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P.,
43 1099 Glidden, S., et al. 2010. "Global threats to human water security and river
44 biodiversity." *Nature* 467 (7315):555-61. doi: <https://doi.org/10.1038/nature09440>.
45 1100
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 1101 Walsh, C. J., Fletcher, T. D., Bos, D. G., and Imberger, S. J. 2015. "Restoring a stream
4 through retention of urban stormwater runoff: a catchment-scale experiment in a
5 1102 social–ecological system." *Freshwater Science* 34 (3):1161-8. doi: 10.1086/682422.
6 1103
7
8 1104 Walsh, C. J., Fletcher, T. D., and Burns, M. J. 2012. "Urban Stormwater Runoff: A New
9 Class of Environmental Flow Problem." *PLoS ONE* 7 (9):1-10. doi:
10 1105
11 <https://doi.org/10.1371/journal.pone.0045814>.
12 1106
13 1107 Wang, R., Zhang, X., and Li, M.-H. 2019. "Predicting bioretention pollutant removal
14 efficiency with design features: A data-driven approach." *Journal of Environmental*
15 1108 *Management* 242:403-14. doi: <https://doi.org/10.1016/j.jenvman.2019.04.064>.
16 1109
17 1110 Ward, S., Memon, F. A., and Butler, D. 2010. "Harvested rainwater quality: the importance
18 of appropriate design." *Water Science and Technology* 61 (7):1707-14. doi:
19 1111
20 1112 10.2166/wst.2010.102.
21
22 1113 Ward, S., Memon, F. A., and Butler, D. 2012. "Performance of a large building rainwater
23 harvesting system." *Water Res* 46 (16):5127-34. doi: 10.1016/j.watres.2012.06.043.
24 1114
25 1115 Winston, R. J., Davidson-Bennett, K. M., Buccier, K. M., and Hunt, W. F. 2016a. "Seasonal
26 Variability in Stormwater Quality Treatment of Permeable Pavements Situated Over
27 Heavy Clay and in a Cold Climate." *Water, Air, & Soil Pollution* 227 (5):140. doi:
28 1116
29 1117 10.1007/s11270-016-2839-6.
30 1118
31 1119 Winston, R. J., Dorsey, J. D., and Hunt, W. F. 2016b. "Quantifying volume reduction and
32 peak flow mitigation for three bioretention cells in clay soils in northeast Ohio."
33 *Science of The Total Environment* 553:83-95. doi:
34 1120
35 1121 <https://doi.org/10.1016/j.scitotenv.2016.02.081>.
36 1122
37 1123 Wright, I. A., Davies, P. J., Findlay, S. J., and Jonasson, O. J. 2011. "A new type of water
38 pollution: concrete drainage infrastructure and geochemical contamination of urban
39 waters." *Marine and Freshwater Research* 62 (12):1355-61. doi:
40 1124
41 1125 <https://doi.org/10.1071/MF10296>.
42 1126
43 1127 Xu, W., Fletcher, T., Duncan, H., Bergmann, D., Breman, J., and Burns, M. 2018.
44 "Improving the Multi-Objective Performance of Rainwater Harvesting Systems Using
45 Real-Time Control Technology." *Water* 10 (2):147. doi:
46 1128
47 1129 <https://doi.org/10.3390/w10020147>.
48 1130
49 1131 Xu, W. D., Fletcher, T. D., Burns, M. J., and Cherqui, F. 2020. "Real Time Control of
50 Rainwater Harvesting Systems: The Benefits of Increasing Rainfall Forecast
51 Window." *Water Resources Research* 56 (9):e2020WR027856. doi:
52 1132
53 1133 10.1029/2020wr027856.
54 1134
55
56
57
58
59
60

- 1
2
3 1135 Yang, T. C. 2006. "Networked control system: a brief survey." *IEE Proceedings - Control*
4
5 1136 *Theory and Applications* 153 (4):403-12. doi: <http://dx.doi.org/10.1049/ip->
6
7 1137 [cta:20050178](http://dx.doi.org/10.1049/ip-cta:20050178).
- 8
9 1138 Yi, X.-H., Jing, D.-D., Wan, J., Ma, Y., and Wang, Y. 2016. "Temporal and spatial variations
10 1139 of contaminant removal, enzyme activities, and microbial community structure in a
11 1140 pilot horizontal subsurface flow constructed wetland purifying industrial runoff."
12
13 1141 *Environmental Science and Pollution Research* 23 (9):8565-76. doi: 10.1007/s11356-
14
15 1142 016-6083-9.
- 16
17 1143 Zanella, A., Bui, N., Castellani, A., Vangelista, L., and Zorzi, M. 2014. "Internet of Things
18 1144 for Smart Cities." *IEEE Internet of Things Journal* 1 (1):22-32. doi:
19
20 1145 10.1109/JIOT.2014.2306328.
- 21
22 1146 Zhang, K., Deletic, A., Page, D., and McCarthy, D. T. 2015. "Surrogates for herbicide
23 1147 removal in stormwater biofilters." *Water Research* 81:64-71. doi:
24
25 1148 <https://doi.org/10.1016/j.watres.2015.05.043>.
- 26
27 1149 Zinger, Y., Fletcher, T., and Deletic, A. 2007a. "The effect of various intermittent dry-wet
28 1150 cycles on nitrogen removal capacity in biofilters systems." In *Proceedings of the 13th*
29
30 1151 *International Conference on Rain Water Catchment Systems*, edited by Dahlenburg.
31
32 1152 Australia: University of Newcastle.
- 33
34 1153 Zinger, Y., Fletcher, T., Deletic, A., Blecken, G.-T., and Viklander, M. 2007b. "Optimisation
35 1154 of the nitrogen retention capacity of stormwater biofiltration systems." In
36
37 1155 *NOVATECH 2007 : 24/06/2007 - 29/06/2007*. Villeurbanne: Graie.
38
39 1156
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60