Digitalisation in the drinking water sector

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The need to obtain more precise and timely information to ensure a safe and reliable water supply has driven water utilities to embrace digitalisation. This article presents some of the technologies behind smart water supply management and identifies a number of challenges that come along with digitalisation in the drinking water sector.

Introduction

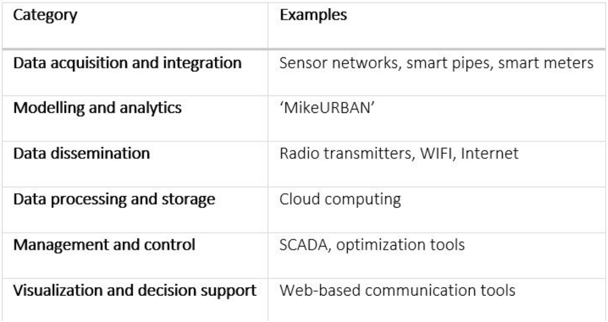
Water supply is one of the most critical network industries, given its direct link with basic human needs. Ensuring the availability and sustainable management of water and sanitation is, indeed, one of the goals (the number 6) in the United Nations 2030 Agenda for Sustainable Development. Achieving this goal does not come without difficulties, as there are certain factors that compromise, increasingly, the availability, the quality and the accessibility of water. The steady growth in global population and climate-change-related extreme weather conditions risk water scarcity. In addition, water infrastructure is ageing and will require repair or replacement in the coming decades. Water quality is, more and more, threatened by pollution resulting from industrial and agricultural activities, as well as by the higher temperatures, flooding and drought caused by climate change.

The need to obtain more precise and timely information to tackle the abovementioned challenges has motivated water utilities to embrace digitalisation. This has been facilitated by the growing availability of sensing tools and computing capabilities at a cost that, conversely, tends to decrease (Lloyd Owen 2018 p. 76).

The technologies behind digitalisation in the drinking water sector

The term ‘smart water management’ is commonly used to encapsulate the digitalisation of the drinking water sector. Smart water management is understood as the use or integration of Information Communication Technologies (ICT) in water management (International Telecommunication Union 2014 p. 4; K-water 2018 p. 25). Smart water management encompasses an array of technologies that allow for data acquisition and integration, modelling and analytics, data dissemination, data processing and storage, management and control and visualization and decision support (International Telecommunication Union 2014 p. 4).

In its 2014 report, the International Telecommunication Union classified smart water management tools in six main categories, with possible overlapping areas. These categories are shown in Table 1.



Category	Examples
Data acquisition and integration	Sensor networks, smart pipes, smart meters
Modelling and analytics	‘MikeURBAN’
Data dissemination	Radio transmitters, WIFI, Internet
Data processing and storage	Cloud computing
Management and control	SCADA, optimization tools
Visualization and decision support	Web-based communication tools

Table 1. Types of smart water management tools
Source: author’s own compilation, based on International Telecommunication Union (2014, p. 4)

A detailed description of all the technologies used for smart water management is not within the remit of this article. The most common technologies will be briefly explained.

Smart water metering

In general terms, smart meters are “a component of the smart grid that allows a utility to obtain meter readings on demand (daily, hourly or more frequently) without the need of manual meter readers to transmit information” (Arniella 2017 p. 15). While traditional (mechanical accumulation) meters require manual readings taken usually once or twice per year, smart water meters allow for more frequent, higher resolution and remotely accessible (consumption) data (March et al. 2017 p. 2). As such smart meters open up a number of possibilities for water utilities and consumers: precise consumption measurement; facilitating leak detection or other causes of water loss; improved data to balance water demand; application of

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dynamic prices; and water conservation initiatives, among others (see Espinosa Apráez and Lavrijssen (2018 p. 162)).

The literature usually distinguishes between two types of smart meters: (1) automated meter reading (AMR); and (2) automated or advanced metering infrastructure (AMI) (see e.g. Arniella 2017; Lloyd Owen 2018). AMR was the first approach taken to make water meters smarter. Mechanical ('dumb') meters were "complemented with a system with datalogger and communication equipment, which allows readings to be taken using portable equipment (walk-by) or using vehicles (drive-by) which circulate through the streets of a city, scanning the nearby meters" (Sempere-Payá et al. 2013 pp. 248–9). AMI goes one step further and allows for two-way communication between the meter and the utility company, allowing meter readings to be directly sent to the utility (Sempere-Payá et al. 2013 p. 249). Some authors report that only AMI can be truly considered smart metering, to the extent that what makes metering 'smart' is the connection of the meter to the communication network (Lloyd Owen 2018, p. 86). Other authors consider true smart metering to be only the evolved versions of AMI, which allow for real time communication using private communication networks combined with a new generation of meters, "interval water meters" (Sempere-Payá et al. 2013 p. 249).

Sensor networks

Guaranteeing the quality of drinking water is a vital obligation of water utilities. Water quality is assessed against certain standards related to, among others, microbiological, chemical and organoleptic parameters. The monitoring of water quality has been traditionally carried out by collecting samples at given points of the network, which are then analysed in a laboratory to assess whether they meet the relevant standards. This approach has its limitations: it does not allow for real-time monitoring of water quality (i.e., there is a time gap between the sampling and the detection of contamination); the samples are taken at a small number of locations and sampling is labour-intensive (Lambrou et al. 2014 p. 2765).

Sensor networks mitigate these limitations. They entail the installation of different types of wireless sensors inside the water pipes, to measure, in real-time, parameters such as temperature, conductivity, pH, pressure, turbidity, dissolved oxygen, etc. (Lambrou et al. 2014). The data collected with these sensors are sent to the utility company which can then take prompt action if there are contamination issues. The data can also be used to create models to predict changes in the water quality and/or the need for pipe maintenance, and to optimise water treatment processes (Carminati et al. 2020 p. 4).

District metered areas (DMAs)

DMAs are a method of measuring water loss where the water distribution network is divided into several subsystems, where water supply and consumption are measured separately from the rest of the system (Arniella, 2017 p. 18). They are a combination of several tools (hardware and software), including: (smart) water meters; geographical information systems; different types of sensors (pressure, temperature, etc.); hydraulic models; and algorithms. DMAs can be used to identify deviations from normal flows and pressures. They enhance pressure management and pinpoint leakages along the distribution network (Arniella 2017 p. 20). Some sources refer to further subdivisions within DMAs, which, with the help of smart meter data, can help to find leakage points, not only in the distribution network, but also in the home of the consumer, allowing utilities to proactively communicate this to the consumer (K-water 2018 p. 93).

Modelling

Developing models and algorithms based on the data collected with smart meters and other sensing technologies can help water utilities on several fronts. For example, hydraulic modelling can be used for pipe network analysis, which helps to plan future infrastructure expansion and to validate the design of new or rehabilitated pipelines (Arniella 2017 p. 28). Modelling can also be used to predict changes in water quality in the distribution network, caused by chemical or biological factors, loss of system integrity, etc. (Arniella 2017 p. 29). Another use of modelling in the management of the drinking-water infrastructure are water demand forecasts.

Supervisory Control and Data Acquisition (SCADA)

SCADA is a technology that enables the remote monitoring of a system or parts of the same. By means of processing information, SCADA can generate reports or alarms useful for operation and maintenance (Temido et al. 2014 p. 1631). With the help of sensors and other data-collecting devices, SCADA can monitor and control various assets and processes involved in water supply from source to tap (Arniella 2017 p. 27; Temido et al. 2014 p. 1634).

The previous paragraphs provided a brief description of some of the most common technologies used for smart water management in the drinking water sector. All these technologies allow for better-quality data about the condition and functioning of infrastructure and drinking water quality. Having more accurate and (near-to) real time data allows infrastructure managers to perform better assessments of the present situation, and means that they can react faster to problems and disruption, while predicting and preparing for future scenarios. Hence, digitalisation is expected to have a positive impact on the design, monitoring and maintenance of infrastructure, as well as other benefits, such as the enhanced management of water demand, improved water quality monitoring and better customer service.

Although digitalisation is growing in the drinking water sector, some sources note that the level of maturity and the openness to innovation is lower than in other sectors, such as energy and telecommunications (see e.g. Lloyd Owen 2018 p. 58). It is, nevertheless, likely that digitalisation in the drinking water sector will keep growing. Smart water technologies offer more efficient ways to deal with the challenges posed by water scarcity, water pollution and ageing infrastructure, compared to non-digitalised approaches. In addition, it is expected that the price of smart water technologies will decrease as their development and use becomes more widespread. Finally, yet importantly, smart water management is climbing up the agenda of national and supra-national policymakers, as a key strategy to tackle the threats to the sufficient and safe supply of water,[2] contributing to the achievement of Sustainable Development Goals.

New challenges

Digitalisation brings interesting opportunities for improving the provision of drinking water, but at the same time, it brings challenges for utilities and policymakers. Key challenges from a public policy perspective are outlined here.

Financial challenges

Even if the cost of smart water technologies tends to decrease over time, the initial investments required to fully digitalise the management of drinking water infrastructures are high compared to less ‘smart’ approaches. This is more challenging when utilities are only financed by the tariffs they charge to consumers, and the price of water is rather low (K-water 2018 p. 99). Against that background, access to additional sources of financing, in particular public funding, seems to be crucial for spurring digitalisation in the drinking water sector (K-water 2018 pp. 459–460).

Privacy and data protection

Smart meters are a key component of smart water management. Since they are installed at the homes of consumers and since they capture personal data,[3] water utilities must pay close attention to the limitations and requirements arising from privacy and personal data protection regimes. Thus, digitalisation comes along with the need for technical and organizational measures to safeguard the rights to privacy and personal data protection of consumers; there is also the challenge of reconciling these rights with the requirements of a smart water supply.

Cybersecurity

Digitalisation creates or worsens exposure to cyber-attacks, compromising the availability, the confidentiality and the integrity of the data and the infrastructures used to process data. For example, when using ICT to monitor, but also to remotely operate drinking water infrastructure, the absence of such systems can lead to the absence of water supply, with disastrous consequences. In view of such risks, water utilities will have to put in place technical and organizational measures to prevent and effectively overcome cybersecurity incidents.

Interoperability and (data) standardization

Ensuring that the different components of the water system are interoperable and that data from different internal and external sources can be combined and used properly is key for smart water management. Interoperability and standardisation in the drinking water sector are less developed than in other sectors. This stands in the way of achieving the potential for the digitalisation of drinking water utilities and hinders collaboration among utilities and between utilities and other actors in the broader water sector by means of data sharing (Lloyd Owen 2018 p. 215).

Conclusions

With the help of smart meters, sensors, DMAs, modelling, SCADA and other technological developments, water utilities can obtain better-quality information on the conditions and functioning of the infrastructure that they manage and the quality of the water that they supply. This helps water utilities to improve the design, monitoring and maintenance of infrastructure, as well as ensuring that the water they supply meets the required quality standards for human consumption. In addition, smart water technolo-

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[2] See e.g. K-water (2018).

[3] According to the General Data Protection Regulation (Regulation (EU) 2016/679) applicable in the European Union, ‘personal data’ means “any information relating to an identified or identifiable natural person” (Art. 4 (1)).

gies enhance the interaction between water utilities and consumers.

There is already a significant amount of research on the technical feasibility and opportunities for digitalisation in this sector. However, a broader adoption of smart water technologies will be for the future. It is expected that digitalisation in the drinking water sector will keep growing as technologies become more widespread and cheaper, and as governments start to actively support smart water management.

Digitalisation in the drinking water sector offers interesting opportunities, but comes along with certain challenges related to financial aspects, cybersecurity, data protection and privacy and interoperability, among other matters. These challenges ought to be considered and addressed by water utilities and policymakers to steer smart water management in the right direction.

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