Everything You Always Wanted to Know About Urban Water Networks But Were Afraid to Ask - Extended Abstract

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Abstract

Urban water networks have played a paramount role in the development of human settlements throughout history. Originally designed to supply water, their role has evolved to drainage and, more recently, to gray water reuse. This talk will present a brief overview of the development of urban water networks and highlight their evolution through time. The changes in design rules, data acquisition and exchange standards will be highlighted. Data imperfections will be addressed through examples drawn from the datasets acquired by the consortiums of the STARWARS (STormwAteR and WastewAteR networkS heterogeneous data AI-driven management) and CROQUIS (Collecting, Representing, cOmpleting, merging and Querying heterogeneous and UncertaIn data) projects. Some attempts made in the literature to overcome data limitations will be addressed. Rather than a traditional conclusion, the talk will attempt to incite discussions on possible ways to integrate knowledge and reasoning to address data imperfections.

Keywords

Urban water networks, sewer, stormwater,

1. Extanded abstract

Urban water networks have played a paramount role in the development of human settlements throughout history. The role of water in migration, urbanisation and the dynamics of human civilisations as well as the implications for contemporary water management are part of the 23 unsolved problems in hydrology [1].

Urban water networks include water supply and distribution networks as well as urban drainage and sewer systems that carry rain and waste to wastewater treatment plants (WWTP) and downstream water bodies. The networks consist of natural or artificial open-flow channels and pressurized conduits. The system may also include pumps, gates, weirs and detention tanks. Some authors distinguish between production and transport networks [2]. In this work we will focus mainly on stormwater and wastewater networks *i.e.* urban drainage and sewer systems.

For a long time, once the schemes reached a significant scale, water management was regarded as a matter for the public authorities. Indeed, large workforce and sufficient financial resources were needed to divert hydrographic networks, bring water to farmlands, evacuate the surplus of water and maintain the canals and ditches [3]. Water management paradigms have, of course, greatly evolved throughout time. Originally, the fundamental objective was to secure water supply. Later concerns over public health extended the perimeter to sanitation and flood protection. In the past decades, a more holistic approach has been adopted to consider the entire water cycle within the city [4, 5]. Concerns about water availability in face of growing demand have also prompted gray water reuse.

The management of these networks is a complex task and could certainly benefit from advances in information technologies. However, it appears that compared to sectors like energy, healthcare or transportation, the use of Artifical Intelligence (AI)-based techniques in the water domain is less widespread [6]. The existing applications focus mostly on modelling, optimization or data mining and their encapsulation into functional Decision Support Systems is limited. According to [7], this is not related to the methods themselves but rather to the disassociation between the fields of water and computer engineering, the limited practical experience of academics, and the great inherent complexity [7]. In a recent review, [8] state that two of the limitations of Machine Learning-based surrogate models for urban water networks are the need for large amounts of data and the lack of explainability. The third one is their specificity to each study case [8].

Missing data is a common problem when working on urban water networks [9, 10]. Like other utility networks, statutory records of water networks may be incomplete and inaccurate [11]. However, knowledge is available on these networks through European and national data models [12, 13] and practice guidelines [14]. The question is then how the AI and Knowledge Representation and

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Reasoning (KRR) communities may join forces with the water community to put forward methods and tools to address the data imperfections of urban water networks.

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