Editorial: Hydroinformatics for water distribution systems analysis and management

Urban water distribution systems (WDS) analysis and management is a very complex challenge for researchers and technicians. Such a labyrinth contains numerous processes, sub-processes, states of being with their associated causative factors, feedback loops and interrelationships (Colombo & Karney 2003).

This special issue is an occasion to study and analyse specific processes in the broader and stronger view of the entire labyrinth. The selected papers focus on some of the most important problems of urban WDS management, trying to help orientate researchers and planners, like Theseus and the Minotaur, in the labyrinth of the various concerns and processes involved in urban WDS planning (Figure 1).

This issue contains 10 papers that have been selected among those presented at the 16th Conference on Water Distribution System Analysis, WDSA 2014 (Bari, Italy, 14-17 July 2014), as very interesting studies and applications of Hydroinformatics techniques to WDS analysis and management. The selected papers have been fully rewritten, completed and improved and have undergone a rigorous peer-review process.

The key points of the issue are:

- the characterization and quantification of customers' demand;
- the sizing, construction, installation and configuration of the capacity of the WDS;
- the performance evaluation of the WDS in terms of total cost, as a trade-off between demand and capacity.

Two papers in this issue examine the first key point. Specifically, the paper 'Multivariate statistical analysis for

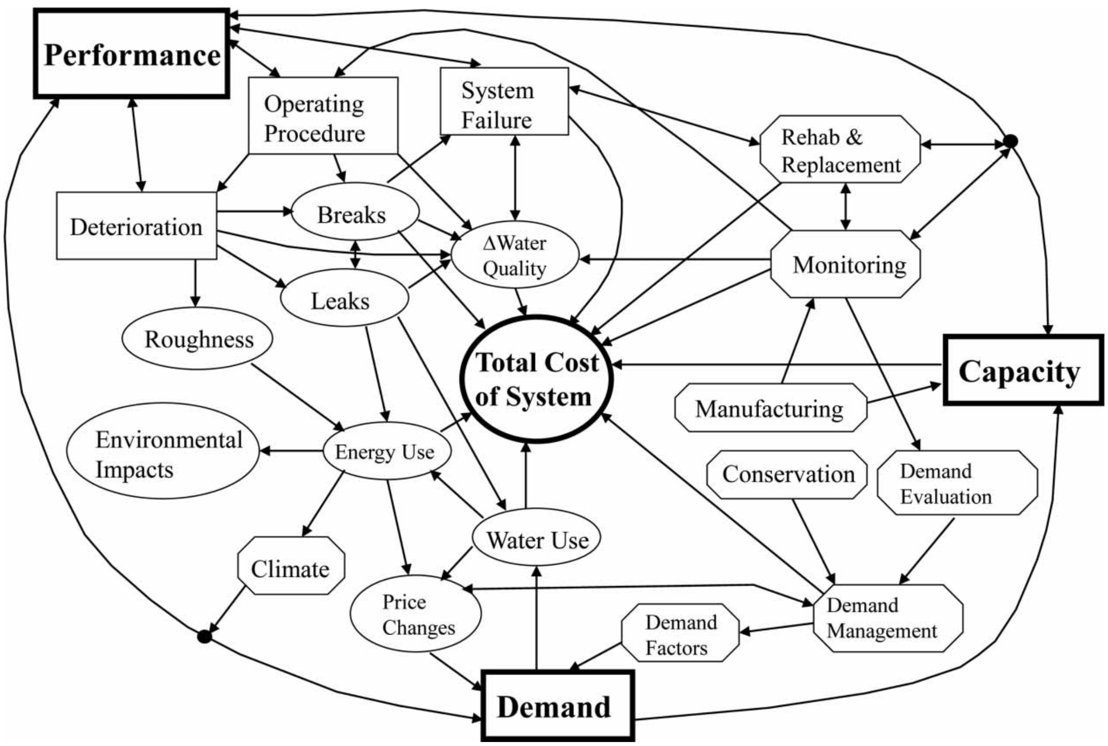

Figure 1 | The labyrinth of WDS (modified by Macaulay 1976).

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water demand modelling: implementation, performance analysis, and comparison with the PRP model' (Fontanazza *et al.* 2016) proposes to predict water demand by using a copula-based multivariate analysis. The analysis is applied to a real case (the WDS of Palermo, Italy) and compared to a classical water demand model, the Poisson Rectangular Pulse. The paper 'Rainwater harvesting as source control option to reduce roof runoff peaks to downstream drainage systems' (Campisano & Modica 2016) analyses the possibility of using the tank-based rainwater harvesting system in free-standing houses for both internal and external non-potable consumption (i.e. toilet flushing, garden irrigation, terrace cleaning, etc.). The paper demonstrates that rainwater harvesting could mitigate roof runoff peaks based on tank size, while saving water for indoor human demand.

The second key point is analysed by four papers. The paper 'Speeding up the water distribution network design optimization using the ΔQ method' (Ivetić *et al.* 2016) explores the possibility to speed up WDS design optimization using variations of the ΔQ method to solve the network hydraulic simulation problem. The ΔQ method is derived from Cross's original moment distribution method. The most significant difference is that in the node-based method, the number of non-linear equations is equal to the number of nodes while in the ΔQ method it is equal to the number of loops in the network. The results obtained for two case study networks show that the ΔQ method is remarkably faster than EPANET2.

The last three papers present methodologies for optimal network sectorisation. In particular, first the paper 'Decision support system for the optimal design of district metered areas' (Galdiero *et al.* 2016) combines a Multi-Objective Evolutionary Algorithm with tools from graph theory to optimize the design of District Metered Areas subjected to constrains related to the network topology, hydraulics and financial issues. The model is validated with regard to a literature case study. The second paper 'A flexible methodology to sectorize water supply networks based on social network theory concepts and on multi-objective optimization' (Campbell *et al.* 2016) proposes to apply a methodology – based on a social network and graph theory and a multi-objective optimization process – to sectorize water supply networks. The methodology is tested on Managua City, Nicaragua.

Finally, the paper 'Water distribution network sectorisation using graph theory and many-objective optimisation' (Hajebi *et al.* 2016) proposes a novel methodology for partitioning a water distribution network (WDN-Partition) to find near-optimal arrangements of nodes into sectors. Numerical simulation shows that WDN-Partition generally achieves its design objectives with a minimal decrease in the performance criteria of the network.

The last four papers are part of the third key point, the performance evaluation of WDS, since the cost of the system includes not only the financial cost of construction and maintenance of the infrastructure, but also the health effects of poor water quality, the environmental impact of energy inefficiency and water losses due to leaks, disruptions due to breaks, and a variety of other burdens associated with the system and its operation.

The first paper 'Multivariate data mining for estimating the rate of discoloration material accumulation in drinking WDSs' (Mounce *et al.* 2016) deals with water quality. In fact, it investigates the various factors that are involved in the accumulation process of particulate material that causes discoloration by means of a data driven modelling approach. Also the second paper 'Chlorate formation in WDSs: a modelling study' (Boano *et al.* 2016) is focused on water quality. In particular, the build-up in chlorate concentration resulting from chlorine-based disinfection is simulated by EPANET2 for the well-known Anytown benchmark network. The simulation results show that the build-up is narrow.

The third paper 'Estimating burst probability of water pipelines with a competing hazard model' (Shin *et al.* 2016) estimates the pipe deterioration by multiple types of failure and focuses on the bursts in pipe body or connection by means of a competing deterioration-hazard model. The applicability of the method is tested on the WDS of S-city in South Korea. Finally, the fourth paper 'Robust sensor placement for leak location: analysis and design' (Blesa *et al.* 2016) presents a robustness analysis of the sensor placement problem for leak location in WDS. The developed methodology takes into account the dependency of the leak location procedure on the network operating point and then it is formulated as a multi-objective optimization for which Pareto optimal solutions are generated. The methodology is tested on a small academic network and on the WDS of Barcelona, Spain.

The Editors hope that the analysis, findings and discussions included in the above-mentioned papers will be a useful contribution to penetrate deeper and deeper in the labyrinth like the unravelling of Princess Ariadne's thread.

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