Editorial: Utilizing hydroinformatics for efficient water systems management

This special issue of *Journal of Hydroinformatics* presents a collection of fully peer reviewed papers initially presented at the 3rd EWaS International Conference 'Insights on the Water-Energy-Food Nexus'. The conference was held from 27th to 30th of June 2018, in Lefkada Island/Greece (http://ewas3.civ.uth.gr/). This conference (EWaS3) was organized by the University of Thessaly/Civil Engineering Department (chairman: Prof. V. Kanakoudis-University of Thessaly/Founder of EWaS Series of Conferences; vice chairman: Assist. Prof. E. Keramaris-University of Thessaly). EWaS series of conferences started in 2013, when the 1st EWaS (EWaS1) Conference was held in Thessaloniki/Greece and continued in 2016 when the 2nd EWaS (EWaS2) Conference was held in Crete/Greece.

The EWaS3 conference managed to bring together scientists dealing with challenges faced throughout the entire water cycle. A special focus was given to efficient water systems, addressing, among others, issues related to hydraulics, hydrology, water resources systems management, climate change and environmental systems. Special emphasis was given to the latest developments, strategies, techniques and applications in urban water and wastewater management, along with environmental protection.

One of the topics EWaS3 Conference attempted to highlight was the need to improve the efficiency and sustainability of water resources and water supply systems throughout the entire urban water supply chain, from the point of water abstraction from the water resource, up to the water user's tap. The Water-Energy Nexus was also boosted to a leading role as power/energy production (advanced hydropower plants) and energy recovery (PATs) techniques and technologies were extensively presented. This complex Water-Energy bond is too crucial under the climate change and the economic suffocating conditions (long depression periods) almost the entire world is facing the last decade. Climate change, or even more 'smoothly' stated, climate variation, is considered today as the main cause of water related problems. The urban water systems need to grow to smart ones offering a reliable environment regarding the minimization of physical (real) water losses, high-quality water supplied and low energy waste. These sorts of efficiency and sustainability urgently need the incorporation of ICT innovative solutions in the everyday life of the water managers.

The current special issue of the *Journal of Hydroinformatics* was guest-edited by Professor Vasilis Kanakoudis (University of Thessaly, Volos, Greece), Associate Professor Francesco De Paola (University of Naples, Napoli, Italy) and Associate Professor Stefano Alvisi (University of Ferrara, Italy). The papers included in this special issue are based on the initial presentations made at the EWaS3 conference. However, they have been extended and revised by at least 50% having gone through the regular peer-review process of *Journal of Hydroinformatics*. The topics the papers included in the current issue deal with are briefly being presented below:

In the paper by Padulano & Del Giudice (2020), a procedure aiming to control the overall quality of water consumption time series and solving possible reliability issues concerning both the time series as a whole and single data is being proposed. Problems of either inappropriate data quality or inconsistencies observed usually result from technological or behavioral issues leading to significant amounts of missing or anomalous values. To overcome these shortcomings a nonparametric, unsupervised approach is used to investigate the reliability of a consumption database, applied to the dataset of a district metering area in the city of Naples in Italy, especially focusing on the detection of suspicious amounts of zero or outlying data. Results proved that the methodology can reliably identify unreliable time series (i.e. time series having huge amounts of invalid data), but also unreliable single data (i.e. data values suspiciously different from some suitable central parameters), regardless of the cause of the 'anomaly' observed. As such, the proposed approach is suitable for large databases when no prior information is known about the underlying probability distribution of data, and it can also be coupled with other nonparametric, pattern-based methods in order to guarantee that the database to be analyzed is homogeneous in terms of water uses.

doi: 10.2166/hydro.2020.100

The paper by Morosini *et al.* (2020) deals with the problem to properly select the isolation (shut-off) valves in a water distribution network (WDN) that need to be closed during an emergency (e.g. pipe break) guaranteeing its safe seal-off, thus allowing its repair and restoration works to take place. Under these abnormal operating conditions, the pressure-driven analysis (PDA) of a WDN is the most efficient approach, as it considers whether the available nodal head is adequate to ensure the water supply (during the isolation phase) or not. Using three different size real-case WDNs in Italy (cities of Praia a Mare, Marano Marchesato and Cosenza) the specific study proved that the predominant approaches based on the analysis of the network's behavior under normal operating conditions are rather misleading, as during an emergency, it is possible to measure the WDN's reliability by forming an objective function (OF) that helps defining the optimal number of additional valves that need to close to get an adequate control of the entire WDN. The OF considers the actual configuration (rerouting) and tolpology of the remaining network (after the closing of the shut-off valves) by excluding the zone where the broken pipe is located. The results proved that the solution did not get significantly improved when the number of valves needed to be closed reached a certain threshold. Moreover, for the case study WDNs analyzed, the results revealed that the position of additional valves does not significantly change the values of the OF and the solution is, for these cases, independent from the location of the additional valves.

Both the papers by Fecarotta *et al.* (2020) and Cimorelli *et al.* (2020) deal with application of pumps as turbines (PATs) in pipe systems. Installation of PATs has become more attractive because they are able to effectively combine the pressure regulation of the system to reduce leakages with the small-scale hydropower generation.

Fecarotta *et al.* (2020) focus on a specific aspect concerning the application of PATs in situations where a high suspended sediment concentration, or presence of hard mineral particles lead to hydro-abrasive erosion. These situations occur for example, when the PAT is used before the inlet of a water purifying plant, in irrigation systems, or in water distribution systems located in some sites in mountains regions. In particular, the paper provides a comprehensive analysis of the vulnerability to wear of a PAT working in variable conditions. In fact, a real case study concerning the installation of a PAT in an existing control station of a water supply system in southern Italy is considered and a CFD model is used to simulate the particle-laden flow inside the machine and to assess the dependence between the vulnerability to wear and the flow rate. As a result, the points at higher risk of wear failure are identified and the actual influence of the flow rate on the vulnerability to wear of all PAT components is established.

Cimorelli *et al.* (2020) deal with the topic of identifying the optimal setting of PATs within water distribution systems considering both the energy production and water volumes saved through pressure reduction. To this end a derivative free non-linear programming method is presented and applied to a hypothetical complex water distribution system taken from literature. The results highlight that the presence of leakages makes the objective function noisier than the case where no leakages are considered, making this optimization problem particularly challenging. However, given the direction, position, and type of a prescribed number of PATs, the proposed method seems to be capable of maximizing the sum of energy and saved water volume costs and it is well suited for utilization in hybrid genetic algorithms aiming at providing the optimal number, position, direction, type, and setting of PATs within a water distribution system.

Georgescu *et al.* (2020) address the important topic concerning a complex multi-reservoir hydropower development (HPD) from the point of view of energy production. The Gâlceag HPD system consists of three reservoirs, a high head hydropower plant (HPP) powered by two Francis turbines of 75 MW each, and a pumping station (PS) equipped with two centrifugal pumps of 10 MW each. The hydraulic system configuration is unusual: the PS discharge pipe conveys the water directly into HPP's penstock. Three operation scenarios were investigated by authors. The results show that for some predefined ranges of water levels in the HPP upstream and downstream reservoirs, more energy is generated if turbines and pumps work simultaneously. The achieved results can be usefully proposed within a decision support system, to assess the overall operation of the HPD upon the water availability (water levels in reservoirs), in order to evaluate the amount of power that can be used for power generation.

Caloiero *et al.* (2020) have carried out an investigation on the temporal variability of seasonal and annual rainfall in the Calabria region (southern Italy) using a homogeneous and gap-filled monthly huge rainfall dataset of 129 rain gauges in the period 1951–2006. In particular, possible trends have been assessed by means of the Innovative Trend Analysis (ITA) technique, which allows the identification of a trend in the low, medium and high values of a *series*. The results obtained with the ITA approach have been compared with the ones obtained with the Mann Kendall (MK) test, evidencing that the ITA method has some advantages just because it provides details about the trends of annual and seasonal total precipitation data in terms of evaluation of different values (low, medium and high values). Moreover as a result of the MK analysis, a negative trend of the annual rainfall has been evidenced, mainly due to the negative tendencies of the winter and autumn rainfall which, in the Mediterranean area, constitute the seasons with the highest rainfall.

Guest Editors
Vasilis Kanakoudis
University of Thessaly, Volos, Greece

Francesco De Paola
University of Naples, Napoli, Italy

Stefano Alvisi
University of Ferrara, Ferrara, Italy

REFERENCES

Caloiero, T., Coscarelli, R. & Ferrari, E. 2020 Assessment of seasonal and annual rainfall trend in Calabria (southern Italy) with the ITA method. *Journal of Hydroinformatics* **22** (4), 738–748.

Cimorelli, L., D'Aniello, A., Cozzolino, L. & Pianese, D. 2020 Leakage reduction in WDNs through optimal setting of PATs with a derivative free optimizer. *Journal of Hydroinformatics* **22** (4), 713–724.

Fecarotta, O., Messa, G. V. & Pugliese, F. 2020 Numerical assessment of the vulnerability to impact erosion of a pump as turbine in a water supply system. *Journal of Hydroinformatics* **22** (4), 691–712.

Georgescu, A.-M., Georgescu, S.-C., Dunca, g., Bucur, D. M. & Alexandru, A. 2020 Energy production assessment in a complex hydropower development. *Journal of Hydroinformatics* **22** (4), 725–737.

Morosini, A. F., Caruso, O. & Veltri, P. 2020 Management of water distribution systems in PDA conditions using isolation valves: case studies of real networks. *Journal of Hydroinformatics* **22** (4), 681–690.

Padulano, R. & Del Giudice, G. 2020 A nonparametric framework for water consumption data cleansing: an application to a smart water network in Naples (Italy). *Journal of Hydroinformatics* **22** (4), 666–680.