Environmental Engineering and Management Journal

September 2015, Vol.14, No. 9, 2003-2005
http://omicron.ch.tuiasi.ro/EEMJ/

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EDITORIAL

A SPECIAL ISSUE ON

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) FOR WATER MANAGEMENT

This special issue of the *Environmental Engineering and Management Journal (EEMJ)* is dedicated to the field of Information and Communication Technology (ICT) for water management. It is introduced as part of the dissemination activities of the ICeWater project (ICT solutions for *e*fficient *Water* Resources Management - http://www.icewater-project.eu), co-funded by the European Union's Seventh Framework Programme (EU FP7) for research, technological development and demonstration. ICeWater is in fact only one out of ten sister projects co-funded by this programme in the period of 2012-2017, which jointly form the ICT4Water cluster of the EU (http://ict4water.eu/). The formation of this research cluster follows EU's clear recognition of the need for further research and innovative ICT solutions for improved and more efficient water management in urban environments as well as at larger river basin scales.

As the pressures on available water resources increase globally, simultaneous efforts are needed on both water supply and demand side that lead to increased water and energy efficiencies, while providing high levels of water services and protecting the natural aquatic environments. Pervasive ICT technologies such as existing networking technologies, wireless technologies (including mobile phone networks) combined with advances in computational intelligence and sophisticated models of various water systems open up new possibilities for realizing these tasks. These technologies can provide continuous connectivity of devices (sensors, controllers and actuators) introduced in natural water systems (e.g. rivers) as well as man-made water infrastructure (e.g. water distribution and drainage systems). When such connectivity is achieved it can be combined with novel computational solutions (e.g. machine learning, simulation and optimization algorithms) to provide superior decision support components for operational, design and long-term planning of water resources and systems.

Even if the ICT capabilities are available, significant research is still required, primarily for purposes of providing systems, environments and platforms for easy integration of diverse components, such as sensors, computational modules, databases, and user interfaces for web and mobile phone applications. The rapid development of ICT technologies often results in a diversity of available solutions, lack of standards and fragmented developments, which hampers the provision of integration platforms and environments. This is evident in all application areas of ICT, including the fields of water and the environment.

In recent years, however, several development have emerged, primarily on the front of harmonization and standardization of environmental data exchange over electronic networks, which offer better possibilities for realizing integrated solutions. Examples of such developments include the INSPIRE framework of the EU for exchanging spatial data, the standards introduced by the Open Geospatial Consortium (OGC), such as the mapping services (Web Mapping Service, Web Feature Service etc), Sensor Observation Service (SOS) and WaterML as the standard for exchanging water-related time series data. When these are combined with the latest technologies and frameworks for general web communication, particularly for web services design and deployment, a new set of building blocks becomes available for developing platforms and environments for integrated, but flexible and extensible water-related applications.

Significant part of the efforts in the ICT4Water cluster of EU, including the ICeWater project, are devoted to innovative usage of these new building blocks for addressing various water management tasks.

Another, more difficult challenge for the field of ICT for water is the increasing need for applications that would lead to behavioral and social changes regarding water management, leading to changing attitudes about overconsumption of water, introducing more participatory decision making processes and overall improvements of water governance practices and institutions. Furthermore, diverse stakeholder groups and citizens are increasingly seen as 'sensors' that can contribute relevant environmental data, either organized as 'citizens observatories' or in an unstructured way, via social networks. Development of ICT applications that can utilize this heterogeneous data, or have goals of individual and social transformations, requires involvement of much broader groups of users and expertise, beyond water and ICT experts. Although the need for integration environments and platform remains, the diversity of knowledge needs of users/contributors in such applications presents new challenges that necessarily require mobilization of diverse expertise.

Finally, when seen from the perspective of spatial- and especially urban planning and development, water infrastructure is only one part of the whole urban infrastructure that needs to be managed in an integrated manner. The established term 'smart cities' reflects exactly this challenge of ICT to enable integrated management of water networks with energy, mobility and transport networks, in a more efficient and sustainable manner, while still providing high quality services to the inhabitants and businesses. Here the field of ICT for water again faces the challenges of creating open environments and platform that allow integration of diverse knowledge from different application areas.

This special issue of EEMJ introduces first 10 articles that address the above mentioned aspects of the field of ICT for water. The first four articles originate from the research work carried out in the ICeWater project. The first article introduces the ICeWater solution for providing Service Oriented Architecture (SOA) - based communication platform that harmonizes proprietary standards and formats of sensor data and metadata that other applications and components can utilize this data in transparent and standardized manner (using OGC standards such as SOS and WaterML). The next two articles introduce two novel applications developed in ICeWater, one for the purpose of water demand forecasting using machine learning (based on clustering and Support Vector Machines – SVM algorithms) and another on pump scheduling optimization using coupled Epanet hydraulic simulation models with Multi Objective Genetic Algorithms (MOGA).

The fourth article of this group introduces the architecture and the implementation of one web-based Decision Support System (DSS) of ICeWater intended for hydraulic simulation and pump scheduling optimization. The three articles of the next group report research work on development and implementation of integration platforms for addressing typical water management problems. The *MyWater* platform is intended for using heterogeneous data (earth observations, weather predictions and in situ measurements) for setting up hydrological models, the *CyberWater* platform demonstrates water quality monitoring application that integrates river water quality sensors with wireless connectivity, and the third article in this group introduces platform that integrates multiple modeling paradigms for managing accidental river pollution. A group of two articles then follows, addressing the area of behavioral and social changes by ICT for water solutions and applications.

The *Watercity* social persuasion application is intended for behavioral change towards residential water conservation. This is followed by an evidence-based research on potential changes in water governance practices following introduction of citizens' observatories in three water-related case studies from the ongoing EU FP7 research project *WeSenseIt*. The last article in this special issue addresses the long term perspective for data science in 'smart cities', primarily building on experiences from two recently finished projects (*LENVIS* – EU funded project on information systems in the area of health and environment and finally *TAM-TAM* – an Italian project focused on urban mobility).

The field of ICT for water is very broad and the research articles presented in this special issue touch only on some aspects and current challenges, by presenting results from resent and current projects. As we have mentioned, most of the challenges ahead are in flexible *integration* of existing and newly developed applications and components. However, this requires mobilization of diverse expertise and in this special issue the readers will see contributions from water engineers, computer scientists, GIS specialists and social scientists. Sometimes this brings difficulties with the same vocabularies used differently by different disciplines in different contexts, or vice versa; different language being used for very similar concepts by different experts. For example, the readers of this special issue may be amused (hopefully not overly confused!) that *models*, can be data models, mathematical models, business models, hydraulic, hydrologic or meteorological models, domain models, UML models, user models, radio environment or network models and many others! This should not stop us from working together though, across disciplines, because it is exactly through this interaction that breakthroughs of understanding take place.

Those who work in the field of ICT for Water have learned (sometimes the hard way) that this is the only way forward.

We are extremely grateful to the whole Editorial team of EEMJ, but particularly to Prof. Maria Gavrilescu. We are also grateful to the reviewers of the articles who have spent their time and effort for checking the manuscripts and provided very useful suggestions for improving their quality.

Guest Editors:

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Andreja Jonoski is an Associate Professor of Hydroinformatics at UNESCO-IHE Institute for water education. He has teaching and research responsibilities in the fields of hydroinformatics, groundwater modeling, hydrological and hydraulic modeling, water distribution modeling, coupling of simulation models with optimization models, and web- and mobile phone-based decision support systems and applications. Within ICeWater project he has been involved in the research on developing DSS components for simulation and optimization of water distribution systems, integrated within the ICeWater architecture.

Tim Farnham is a chief Research Fellow within the Telecommunication Research Lab. of Toshiba Research Europe Ltd. His recent research activities have included cognitive radio and radio environment mapping techniques for heterogeneous wireless networking. Evaluation of such techniques have been performed within various scenarios, such as video distribution in visitor attractions (zoos and wildlife parks), indoor home media distribution and automatic meter reading networks within the ICeWater project. Also, within the ICeWater project he has developed techniques for failure and anomaly detection and diagnosis, in particular related to wireless performance issues.