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Abstract (for dissemination)	This report presents the first iteration of ICT for Water literature review, including ICT4Water cluster projects publications, conference papers, journal papers, books and books chapters, and other reports. The objective of this report is to collect all these sources, and classify each document taking in consideration topics and tags. This information will be uploaded to the different platforms that support the IWO when possible.
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List of Acronyms

AMR	Automatic Meter Reading
ANN	Artificial Neural Networks
CFD	Computational Fluid Dynamics
DEM	Digital Elevation Models
DMA	District Metered Area
DMS	Demand Management System
DSS	Decision Support System
EC	European Community
EFA	Exploratory Factor Analysis
EGU	European Geosciences Union
EIP	European Innovation Partnership
EU	European Union
FAVAD	Fixed and Variable Area Discharges
FMECA	Failure Mode Effects and Criticality Analysis
FTCs	Flow Through Curves
GHG	Greenhouse Gas
GIS	Geographic information system
H2020	Horizon 2020 EU Framework Programme for Research and Innovation
ICT	Information and Communication Technologies
ISO	International Standards Organization
IWA	International Water Association
IWO	ICT for Water Observatory
LAGA	Linear Adaptive Genetic Algorithm
LID	
	Low Impact Development
MaaS	Low Impact Development Marketplace as a service
MaaS MAD	Low Impact Development Marketplace as a service Measurement Analysis Decision
MaaS MAD MPC	Low Impact Development Marketplace as a service Measurement Analysis Decision Model predictive control
MaaS MAD MPC nDP	Low Impact Development Marketplace as a service Measurement Analysis Decision Model predictive control Nested Dynamic Programing
MaaS MAD MPC nDP OMP	Low Impact Development Marketplace as a service Measurement Analysis Decision Model predictive control Nested Dynamic Programing Open Management Platform
MaaS MAD MPC nDP OMP QA/QC	Low Impact Development Marketplace as a service Measurement Analysis Decision Model predictive control Nested Dynamic Programing Open Management Platform Quality Assurance / Quality Control
MaaS MAD MPC nDP OMP QA/QC RPN	Low Impact Development Marketplace as a service Measurement Analysis Decision Model predictive control Nested Dynamic Programing Open Management Platform Quality Assurance / Quality Control Risk Priority Number
MaaS MAD MPC nDP OMP QA/QC RPN RWSS	Low Impact Development Marketplace as a service Measurement Analysis Decision Model predictive control Nested Dynamic Programing Open Management Platform Quality Assurance / Quality Control Risk Priority Number Regional Water Supply System
MaaS MAD MPC nDP OMP QA/QC RPN RWSS SME	Low Impact Development Marketplace as a service Measurement Analysis Decision Model predictive control Nested Dynamic Programing Open Management Platform Quality Assurance / Quality Control Risk Priority Number Regional Water Supply System Small and medium-sized enterprises

UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
URL	Uniform Resource Locator
WDN	Water Distribution Network
WDS	Water Distribution System





Executive Summary

This report is part of WIDEST (<u>www.widest.eu</u>), a H2020 funded project – Coordination and Support Action (Ref. Number 642423). Deliverable "D1.3 Reports containing Literature reviews 1st release" focuses on selecting the most relevant projects, books, scientific journals, international conferences and reports and white papers regarding ICT for Water publications.

The projects selected are the project members of the ICT4Water cluster, which represent all ICT for water related EU funded projects under FP7 and H2020 research programs. Regarding the conferences, journals, books and other reports, sources from 2010 until today are being considered.

This release will provide first results regarding this task. This work will be completed in coming deliverables "D1.4 Reports containing Literature reviews 2nd release" and "D1.5 Reports containing Literature reviews 3rd release" in months 16 and 22 of the project. The ambition is to analyse the more sources possible before the end of the project.

In addition, all this information will be collected in the WIDEST IWO, and uploaded into existing similar tools on the network, thus assuring further exploitation of WIDEST efforts after the project ends.

Number	Title	Description
		This report focuses on the definition and implementation of the ICT
		for Water Observatory (IWO). The IWO defines a methodology to
		collect, analyse and publish in a knowledge base resources from
	Report with IWO definition	relevant sources of information related to ICT for Water
וט	and implementation	technologies. This report includes the objectives, methodologies,
		functionalities and structure the IWO is going to offer and support,
		conforming the inputs of the literature reviews and commercial
		developments and technology trends analysis.
D4.1	Methodology for Portfolio	The present document contains the proposed methodology to
	Development	develop, execute and update the ICT for Water Management
		Technologies Portfolio including the contact strategy, the portfolio
		structure and the information interchange protocol. The portfolio will
		be developed as a knowledge management system using principles
		and methodologies inspired in collective intelligence in order to
		achieve the vision of a global ICT for Water Management Portfolio.

To understand this document the following deliverables have to be read.





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1. Introduction

This deliverable provides a comprehensive review of the literature and technological trends within the ICT (Information and Communication Technologies) for Water community. It covers the main development and research ICT areas that are being studied to provide benefits in the Water Management all over the world. ICTs are considered one of the most promising fields to deal with the current problems that humanity is facing related to water availability. On the one hand, developed countries are facing the ageing of its water distribution networks (Awwa, 2012) while try to improve security (Perelman & Ostfeld, 2010), energy minimization (United States Environmental Protection Agency, 2013) and sustainable usage (UNESCO-International Hydrological Programme, 2015). On the other hand, developing countries must improve the access to freshwater and sanitation facilities as the world has fallen short on the sanitation target (2015 Millennium Development Goal 7), leaving 2.4 billion without access to improved sanitation facilities (UNICEF, 2015).

ICT ranges a wide spectrum of fields, going from most essential communication techniques to high complex computational models, passing through satellite remote sensing, semantic sensor web, and Geographical Information Systems (GIS) among others. The aim of these technologies is to obtain information about water use, improve water management, to forecast the level of rivers and to identify new sources of fresh water that can be used wisely by water authorities. Moreover, due to the impact of climate change, historical data becomes less informative and less useful for forecasting. For that reason, a fast access to the current situation and conditions would become a crucial tool for decision-making. As stated in (ITU, 2010), ICT provides a unique opportunity for water stakeholders to obtain information in near real time about a number of physical and environmental variables such as temperature, soil moisture levels, rainfall, and others through web enabled sensors and communication net- works. These allow having accurate information about the situation at hand (without physically being there) for their forecasts and decisions.

As stated in (ITU, 2010), ICT is recognised as a strategic enabler in the process of developing innovative solutions to address the problems of water scarcities. The same role is played when facilitating the analysis of environmental data to enable researchers and climatologists to build more accurate weather forecasting models, as reliance on past data is no longer sufficient in the looming era of climate change. The main areas where ICT could play a pivotal role in water management are shown in Figure 1.





Mapping of Water Resources And Weather Forecasting Remote sensing from satellites In-situ terrestrial sensing systems Geographical Information Systems Sensor networks and Internet	Asset Management For The Water Distribution Network Buried asset identification and electronic tagging Smart pipes Just in time repairs / Real time risk assess- ment
Setting up Early Warning Systems and Meeting Water Demand In Cities Of The Future Rain/Storm water harvesting Flood management Managed aquifer recharge Smart metering Process Knowledge Systems	Just In Time Irrigation In Agriculture And Landscaping Geographical Information Systems Sensor networks and Internet

Figure 1: Major Areas for ICT in Water Management (from (ITU, 2010))

Additionally, the industry driven initiative ACQUEAU (which is part of the EUREKA¹ cluster) has identified the technological areas from nine water components of the water cycle. This identification has been done in its Blue Book (Hervé-Bazin, 2010), and its goal is to set out the major challenges and potential technological breakthroughs that could be expected from ACQUEAU within the short term (2015) and the long term (2030). These key water components are:

- 1. Water resources
- 2. Water treatment
- 3. Water distribution
- 4. Customer requirements
- 5. Agriculture
- 6. Industry
- 7. Urban drainage and wastewater collection
- 8. Wastewater treatment
- 9. Biosolids

The aim of this Deliverable is to provide a review of the literature and technological trends within the ICT for Water community. To this end, a set of Tags and Topics have been identified to ease the classification of each document or review included in this Deliverable. On the one hand, Tags try to classify the different technologies within the ICT for Water. In a certain sense, Tags will identify "by means of which technology" the improvements are driven. On the other hand, Topics will set in "which

¹ URL: <u>http://www.eurekanetwork.org/</u>





water field" those improvements will contribute. Taking in consideration the last, and using as basis previous WIDEST efforts (Haro, 2015)(Anzaldi, 2015), tags and topics have been selected. Tags will be based on the keywords available on the documents, and/or the fields described in (ITU, 2010). Topics will be based on the Thematic Areas defined in "D4.1: Methodology for Portfolio Development"; Section "3.1.4 Final Portfolio Structure"; Table "6 WIDEST thematic areas and correspondences". This table, can be checked in Annex I: WIDEST Thematic Areas.

- 1. Drinking water production
- 2. Quality of water
- 3. Wastewater treatment (including recovery of resources)
- 4. Water reuse and recycling
- 5. Water-energy nexus
- 6. Water supply and distribution
- 7. Wastewater and storm water collection (including Flood risk management)
- 8. Water Scarcity and droughts
- 9. Sustainable development, Circular Economy & Ecosystem services
- 10. River Basin Management
- 11. Sea Water
- 12. Data management and Smart City services
- 13. Customer Relationship
- 14. Management of the water cycle in industry

Finally, the information collected will be stored in the IWO and later uploaded into existing water observatory tools and portals, thus assuring exploitation of results after the end of WIDEST project.

This report is structured as follows:

- Section 1: Introduction makes an introduction to this report and presents the rest of the chapters.
- Section 2: ICT4Water cluster European Funded Projects makes a short review of the projects funded by the European Commission that are part of the ICT4Water cluster.
- Section 3: compiles the most relevant books and book chapters regarding the ICT technologies for Water community while providing a classification and a short review.
- Section 4: Scientific Journals compiles the most relevant scientific journals available and provides access to the papers published in each journal.
- Section 5: International Conferences compiles the most relevant international conferences and tries to identify the areas where the papers published within have a greater impact.





- Section 6: Reports and White Papers compiles the reports and white papers published by private and publics initiatives that are not indexed, and contribute to the development of the ICT in Water community.
- Section 7: Conclusions and Future Work summarizes the state of the literature of the ICT in the Water community and state the future tasks to be done.
- Section 8: References provide the bibliography used to write this Deliverable.





2. ICT4Water cluster European Funded Projects

2.1 BlueSCities



Figure 2 BlueSCities logo

BlueSCities is a H2020 project that aims to develop the methodology for a coordinated approach to the integration of the water and waste sectors within the 'Smart Cities and Communities' EIP. It will identify synergies in accordance with the Smart City context and complement other priority areas such as energy, transport and ICT.

It will seek to contribute to the achievements of the 20-20-20 objectives. Placing emphasis on local solutions for global issues, the proposal seeks improved public engagement and enhanced decision-making processes at all political levels based on scientific knowledge and adequate social and economic awareness. BlueSCities will build on the hitherto successful implementation of the EIP Water Action Group, CITY BLUEPRINTS, which will provide the data required for a practicable planning cycle.

The necessary socio-technological tools will be produced. It will aim to improve exchange synergies between researchers and users, decision-makers and consumers, industry, SMEs and national and international authorities. In order to achieve this, the project will further review the current situation in 50 European cities employing its unique methods of analysis. It will produce detailed case studies of four specifically chosen municipalities/cities, and demonstrate a self-assessment baseline tool for water and waste in cities, which will enhance the implementation of European Smart City activities, to be published in the Blue City Atlas. It will, in a carefully planned step-by step process, collate data and formulate sufficient recommendations in order to produce an administrative methodology capable of eliminating cross sector barriers between water, waste and Smart City sectors to be described in a practical guidance document for the use of all relevant stakeholders. This will be supported by a programme of dissemination ensuring a wider public understanding of the nature of water and waste systems within the structures of European municipalities, regions and countries.





Table 1 BlueSCities publications

Title	Туре	Tags	Topics	Year	Open Access
Application of the Renewed City Blueprint Assessment to 45 Cities and Regions	Deliverable	Water resources management	Data management and Smart City services	2015	Yes
D6.2 Six-Monthly Report and Document for the EAB and EIP Smart Cities and Communities	Deliverable	Water resources management	Data management and Smart City services	2015	YES

2.2 DAIAD



Figure 3 DAIAD logo

DAIAD is a research project funded by European Commission's 7th Framework Programme, and it is based on the principle that user awareness and self-induced behavioural change are the foundations for delivering sustainable changes in water consumption for society as whole. All research and technological activities in the project do not simply promote user awareness, but rather empower citizens to act as the catalyst for change.

In the DAIAD project, technologies that provide the missing data concerning water consumption are developed. The project delivers new, low cost/maintenance sensors for real-time and highly granular water consumption monitoring, decoupled from water metering. This enables users to proactively and voluntarily adopt water-monitoring sensors at low cost, and form a critical mass of consumers demanding similar services from water providers.

DAIAD provides simple and intuitive multimodal interfaces and knowledge delivery mediums to efficiently communicate knowledge concerning water consumption and actively promote sustainable consumption changes. These provide consumers with actionable knowledge and incentives to promote a sustainable lifestyle, interlinking their physical behaviour with timely information and stimuli. Such instruments do not only modify consumer change, but also maintain it over time. Further, in DAIAD is developed automatic knowledge management and analysis services for consumers and consumer groups that continuously analyse water consumption, identify patterns, provide recommendations, and offer incentives to strengthen sustainable consumption changes, both through self-motivation and social interaction.





DAIAD provides the required software tools with an open knowledge license, enabling users to selfadopt the produced technologies at a low cost. This creates and sustains a network effect with consumers becoming self-aware and introducing others in modified consumption behaviours. Further, this change in consumer behaviour also drives innovation in water metering and produces a demand for new products, value added services and business opportunities.

Finally, the DAIAD project produces educational and training material that can be applied by citizen associations, NGOs and water stakeholders, to inform the general population regarding water consumption, benefits from adopting a sustainable lifestyle, practical measures everyone can apply, and the technical means ICT can offer on a personal, community, and enterprise level.

Title	Туре	Tags	Topics	Year	Open Access
A Map Reduce based k-NN Joins Probabilistic Classifier	Conference Paper	Map Reduce, Classifier, KNN	Data management and Smart City services	2015	No
DAIAD: from droplets of participation to streams of knowledge	Conference Paper	Big Data, Open Data, Open Source, Water management	Data management and Smart City services	2014	No
DAIAD: Open Water Monitoring	Conference Paper	Water management	Data management and Smart City services	2014	No
D1.1 State of the art Report	Deliverable	Real-time water monitoring, sensors, interfaces, data management, knowledge extraction	Data management and Smart City services	2014	Yes
D1.2 Requirements and Architecture	Deliverable	Synthetic Data Generator, stakeholder surveys, big water consumption data	Data management and Smart City services	2014	Yes
D3.1.1 Design Studies	Deliverable	User interface development, usability testing, development	Data management and Smart City services	2014	Yes
D8.2 Dissemination and Training Plan	Deliverable	Dissemination plan, Training plan	Data management and Smart City services	2014	Yes
D8.4 Exploitation and Business Plan	Deliverable	Exploitation plan, business plan	Data management and Smart City services	2015	Yes

Table 2 DAIAD publications





2.3 EFFINET



Figure 4 EFFINET logo

EFFINET is a project funded under the EU 7th Framework Program. EFFINET started in October 2012 and finished in 2015.

EFFINET project addresses three main management challenges in urban water system:

- Optimal operational control
- Real-time monitoring
- Demand forecasting and management

Real-time monitoring of water quantity and quality refers to the continuous detection and location of leakage and or water quality problems. It uses fault detection and diagnosis techniques. Demand forecasting and management is based on smart metering techniques. It includes detailed modelling of consumption patterns as well as a service of communication to consumers. Real-time optimal control deals with operating the main flow and pressure actuators to meet demands using the most sustainable sources and minimizing electricity costs and is tackled using stochastic model predictive control techniques.

The EFFINET project proposes the integration in a cloud platform, of selected innovative ICT technologies of operational control, network monitoring, and demand forecasting and management for improving the efficiency in water and energy use of drinking water networks, developing:

- Model predictive control (MPC) techniques to operate water networks and tailored to meet demand, to comply with environmental resource usage constraints and water service dependability, and to make the least possible use of energy and cost.
- Real-time monitoring methodology to detect and locate leaks and water quality-breach events, based on the use of real-time sensor information and mathematical models.
- Demand forecasting and management methodology, based on the use of AMR and on consumer information technologies.

The project provides an integrated software platform and two real-life pilot demonstrations in Barcelona (Spain) and Limassol (Cyprus), respectively.

The partnership assembled to deliver the EFFINET project is a combination of key players in the field, leading ICT companies, business leaders, technology developers, water companies and top scientists in the field of water management, information and systems analysis and the social sciences.





Table 3 EFFINET publications

Title	Туре	Tags	Topics	Year	Open Access
Accuracy assessment of leak localisation method depending on available measurements	Conference Paper	leak localisation, measurements, water distribution	Water supply and distribution	2013	Yes
Optimal Sensor Placement for Leak Location in Water Distribution Networks Using Genetic Algorithms	Conference Paper	leak location, water distribution, genetic algorithms	Water supply and distribution	2013	Yes
Multi-layer Model Predictive Control of Regional Water Networks: Application to the Catalunya Case Study	Conference Paper	Predictive control, reservoirs, water supply	Water supply and distribution	2013	Yes
Receding Horizon Control of Hybrid Linear Delayed Systems: Application to Sewer Networks	Conference Paper	sewer networks, hybrid linear delayed systems, water transport	Water supply and distribution	2013	Yes
Sensor placement for leak detection and location in water distribution networks	Conference Paper	leak detection, water distribution, sensor	Water supply and distribution	2013	Yes
Extended-Horizon Analysis of Pressure Sensitivities for Leak Detection in Water Distribution Networks: Application to the Barcelona Network	Conference Paper	leak detection, water distribution, sensor	Water supply and distribution	2013	Yes
Model-based leakage localization in drinking water distribution networks using structured residuals	Conference Paper	leak detection, water distribution	Water supply and distribution	2013	Yes
A multiobjective-based switching topology for hierarchical model predictive control applied to a hydro-power valley	Conference Paper	hierarchical model predictive control, switching topologies, supervisory control, multiobjective optimization, hydro-power valley	Water supply and distribution	2014	Yes
Combining CSP and MPC		-			
of Water Networks Application to the Richmond Case Study	Conference Paper	MPC, CSP, Epanet, PLIO	Water supply and distribution	2014	Yes
Drinking Water Networks: Challenges and opportunities	Conference Paper	water demand, pumping energy	Water supply and distribution	2014	Yes





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On the assessment of tree based and chance constrained predictive control approaches applied to drinking water network	Conference Paper	control of water systems, model predictive control, stochastic programming	Water supply and distribution	2014	Yes
On the comparison of predictive control and command governor approaches for operational management of drinking water networks: A case study	Conference Paper	drinking water networks, command governor strategy, model predictive control	Water supply and distribution	2014	Yes
Water demand forecasting for the optimal operation of large-scale drinking water networks: The Barcelona Case Study	Conference Paper	water demand, drinking water networks	Water supply and distribution	2014	Yes
Water demand forecasting for the optimal operation of large-scale water networks	Conference Paper	water demand forecasting, water networks	Water supply and distribution	2014	Yes
Short-term demand forecasting for real-time operational control of the Barcelona water transport network	Conference Paper	Demand forecasting, water transport network	Water supply and distribution	2014	Yes
Contamination Event Detection In Drinking Water Systems Using A Real-time Learning Approach	Conference Paper	Contamination Event Detection, Drinking Water Systems	Quality of water	2014	Yes
Contamination event detection in drinking water systems using a real-time learning approach	Conference Paper	Contamination Event Detection, Drinking Water Systems	Quality of water	2014	Yes
Hybrid control-oriented modelling of combined sewer networks: Barcelona case study	Conference Paper	sewer networks, hybrid control- oriented modelling	Water supply and distribution	2014	Yes
Hybrid modelling and receding horizon control of combined sewer networks: Barcelona case study	Conference Paper	sewer networks, hybrid control- oriented modelling	Water supply and distribution	2014	Yes
On Real-time Monitoring and Control for Efficient Management of Drinking Water Networks: Barcelona Case Study	Conference Paper	monitoring, control, drinking water networks	Water supply and distribution	2014	Yes
Contamination Event Detection In Water Distribution Systems Using A Model-based Approach	Conference Paper	Contamination Event Detection, Drinking Water Systems	Quality of water	2014	Yes
Robustness Analysis of Sensor Placement for Leak Detection and Location under Uncertain Operating	Conference Paper	Leak detection, sensor placement, water	Water supply and distribution	2014	Yes





Conditions		distribution			
Model-driven software tool	Conference	Leak detection,	Water supply and	2014	Ves
localization	Paper	distribution	distribution	2014	103
Proyecto Effinet. Integración de la monitorización y control eficiente en tiempo real de redes de agua potable	Journal Paper	monitoring, control, drinking water networks	Water supply and distribution	2014	Yes
Leak localization in water networks: a model-based methodology using pressure sensors applied to a real network in Barcelona (applications of control)	Journal Paper	Leak detection, sensor, water distribution	Water supply and distribution	2014	Yes
Learning-based tuning of supervisory model predictive control for drinking water networks	Journal Paper	drinking water networks, learning based tuning, supervisory model predictive control	Water supply and distribution	2013	Yes
A Low-cost Sensor Network For Real Time Monitoring And Contamination Detection In Drinking Water Distribution Systems	Journal Paper	Monitoring, sensor, contamination detection, drinking water distribution systems	Quality of water	2014	Yes
Leak Localization In Drinking Water Distribution Networks Using Structured Residuals	Journal Paper	Leak localization, Drinking Water Distribution Networks	Water supply and distribution	2014	Yes
Model-based Leak Detection And Location In Water	Journal Paper	Leak detection	Water supply and distribution	2014	Yes
Temporal Multi level Coordination Techniques Oriented to Regional Water Networks. Application to the Catalunya Case Study	Journal Paper	predictive control	Data management and Smart City services	2014	Yes
Chance-constrained Model Predictive Control for Drinking Water Networks	Journal Paper	Drinking Water Networks, Predictive Control, Chance- constrained model	Water supply and distribution	2014	Yes
Optimal Sensor Placement for Leak Location in Water Distribution Networks Using Genetic Algorithms	Journal Paper	water distribution networks, leak isolation, sensor placement, sensitivity	Water supply and distribution	2013	Yes





		analysis			
Flowmeter data validation and reconstruction methodology to provide the annual efficiency of a water transport network: the ATLL case study in Catalonia	Journal Paper	data validation, water transport network	Data management and Smart City services	2013	Yes
D1.2 Project Methodology	Deliverable	project methodology	Water supply and distribution	2013	Yes
D2.1 - Control-oriented Modelling For Operational Management Of Urban Water Networks	Deliverable	urban water networks	Data management and Smart City services	2013	Yes
D2.2 - Real-time Control Algorithms For Optimal Operational Management	Deliverable	operational management, real-tiem control algorithms	Data management and Smart City services	2014	Yes
D2.3 - Economic And Technical Evaluation Of Operational Management Algorithms	Deliverable	operational management algorithms	Data management and Smart City services	2014	Yes
D3.1 - Statement Of The Real-time Network Monitoring Problem	Deliverable	Real-time network monitoring	Data management and Smart City services	2014	Yes
D3.2 - Network Monitoring Sensor Placement Mass Balance And Water Quality	Deliverable	Sensor placement, water quality, network monitoring	Quality of water	2014	Yes
D3.3 - Sensor Validation And Reconstruction	Deliverable	Sensor validation	Quality of water	2013	Yes
D4.2 - Optimal Placement Of Meters, Pattern Demand Estimation And Short-term Forecasting	Deliverable	Sensor placement, short-term forecasting	Quality of water	2014	Yes
D6.1 - General Guidelines For Sensor Placement, Optimal Control And Demand Mgmt. Strategies	Deliverable	Sensor placement, demand management	Data management and Smart City services	2014	Yes
D7.1 Dissemination And Exploitation Strategies	Deliverable	Dissemination plan, Exploitation plan	Data management and Smart City services	2014	Yes





2.4 FREEWAT



Figure 5 FREEWAT logo

FREEWAT is a HORIZON 2020 project financed by the EU Commission under the call WATER INNOVATION: BOOSTING ITS VALUE FOR EUROPE. FREEWAT main result will be an open source and public domain GIS integrated modelling environment for the simulation of water quantity and quality in surface water and groundwater with an integrated water management and planning module.

FREEWAT aims at promoting water resource management by simplifying the application of the Water Framework Directive and other EU water related Directives.

Specific objectives of the FREEWAT project are:

- to coordinate previous EU and national funded research to integrate existing software modules for water management in a single environment into the GIS based FREEWAT;
- to support the FREEWAT application in an innovative participatory approach gathering technical staff and relevant stakeholders (in primis policy and decision makers) in designing scenarios for the proper application of water policies.

The open source characteristics of the platform allow considering this an initiative "*ad includendum*", as further research institutions, private developers etc. may contribute to the platform development.

The core of the FREEWAT platform will be the SID&GRID framework (GIS integrated physically based distributed numerical hydrological model based on a modified version of MODFLOW) in its version ported to the QGIS desktop. Capabilities to be integrated in FREEWAT are:

- a dedicated module for water management and planning;
- a whole module for calibration, uncertainty and sensitivity analysis;
- a module for solute transport in the unsaturated zone;
- a module for crop growth and yield and water requirements in agriculture;
- tools for dealing with groundwater quality issues;
- tools for the analysis, interpretation and visualization of hydrogeological data.

Through creating a common environment among water research/professionals, policy makers and implementers, FREEWAT main impact will be on enhancing science- and participatory approach and evidence-based decision making in water resource management, hence producing relevant and appropriate outcomes for policy implementation. The Consortium is constituted by partners from various water sectors from 10 EU countries, plus Turkey and Ukraine. Synergies with the UNESCO HOPE





initiative on free and open source software in water management greatly boost the value of the project. Large stakeholders' involvement is thought to guarantee results dissemination and exploitation.

Table 4 FREEWAT publications

Title	Туре	Tags	Topics	Year	Open Access
FREEWAT: FREE and open source software tools for WATer resource management	Journal Paper	Water resource management, open source	Data management and Smart City services	2015	Yes

2.5 ICeWater



Figure 6 ICeWater logo

ICeWater project is a European Union's 7th Framework Programme project aimed at increase the stability of freshwater supply to citizens in urban areas by adjusting the water supply to the actual consumption, while minimizing energy consumption through smart-grid integration and water spillage through leak detection.

ICeWater uses wireless sensor networks for water flow monitoring and it provides a decision support system for the water utilities so that supply and demand patterns can be matched in real-time. As an additional benefit, leakage can be predicted with statistical methods so that water network damages can be mended even before they occur (fix-before-break).

ICeWater uses wireless sensors of various types to provide real-time monitoring of water supply and demand. Based on the sensor data, decision support systems facilitate optimization of the water grid network operation (pumping schedules, pressure etc.). The demand management and consumption information is accessible online to the relevant actors in the water supply chain (including consumers) and allows dynamic pricing schemes with nudge pricing to motivate behavioural change in customers causing critical consumption patterns. Services for asset management, such as predicting deterioration, leakage detection and leakage localization functionalities, reduces water waste. New networking concepts (protocols, management of virtualized network resources) are required for better information flow, network resources management and sharing in a service oriented architecture (SOA).

The information gathered with these services allows a better understanding of the consumers. It also allows improving the effectiveness of the water resource management, together with new metering and pricing schemes.





Table 5 ICeWater publications

Title	Туре	Tags	Topics	Year	Open Access
D2.1 State of the Art Analysis	Deliverable	Clear fresh water, urban areas, water consumption, decision support system, real- time monitoring, smart metering	Data management and Smart City services	2013	Yes
D5.1 Multiple spatial and temporal models for consumption patterns identification	Deliverable	consumption patterns, urban areas	Data management and Smart City services	2014	Yes
D5.2 Deterministic and probabilistic approaches for predictive models of components deterioration	Deliverable	predictive models, components deterioration	Water supply and distribution	2014	Yes

2.6 ISS-EWATUS



Figure 7 ISS-EWATUS logo

The ISS-EWATUS project has received funding from the European Union's 7th Framework Programme for research, technological development and demonstration. The general approach used by ISS-EWATUS is to recognise and then exploit the untapped water-saving potential in the EU. Its goal is to increase the awareness of all water stakeholders and problems at all levels, ISS-EWATUS is intended to focus on household and urban water-saving potentials respectively.

The ISS-EWATUS project is an interdisciplinary effort of specialists from water management and ICT research respectively to develop an intelligent Integrated Support System for Efficient WATer USage and resources management (ISS-EWATUS). The project develops several innovative ICT methods aiming to exploit the untapped water-saving potential in EU. The overall goal is achieved by developing an innovative, multi-factor system capable to optimize water management and reduce water usage.

At household level:

a) an information system for gathering data about water usage is planned to increase the awareness of water consumption; the data is interpreted and presented to household consumers in an understandable way using mobile devices (smartphones, tablets),





b) a household Decision Support System (DSS) is developed for mobile devices to reduce water consumption. Recommendations regarding water-saving devices and behaviour is produced,

c) a social-media platform is developed to reinforce water-saving behaviour of consumers via the social interactions among users (and between consumers and experts of water-saving techniques).

At urban level:

a) an innovative decision support system for reducing leaks in the water delivery system is built based on the dynamic modifications of pumping schedules to reduce leakages at municipal level,

b) an adaptive pricing policy is developed as the economic instrument to induce water-saving behaviour and reduce peaks in water and energy distribution loads.

Being validated at two differently characterized locations, the ISS-EWATUS is sufficiently flexible to be exploited in any EU location. Appropriate training, manuals and dissemination gives people across EU an efficient tool for water conservation. The solutions of ISS-EWATUS for households are available on the mobile applications portals. The rest of solutions are offered to water management companies in EU.

Title	Туре	Tags	Topics	Year	Open Access
Forecasting Daily Water Demand Using Fuzzy Cognitive Maps	Conference Paper	Water demand, Fuzzy cognitive maps, Forecasting	Water supply and distribution	2015	No
Enterprise Architecture Stakeholders Management for Smart City Development	Conference Paper	Stakeholders management, smart city development	Data management and Smart City services	2015	No
Imperialist Competitive Learning Algorithm for Fuzzy Cognitive Map – Application to water demand forecasting	Conference Paper	learning algorithm, fuzzy cognitive map, water demand forecasting	Data management and Smart City services	2014	No
Integrated Support System for Efficient Water Usage and Resources Management	Conference Paper	Efficient water usage, resource management, support system	Data management and Smart City services	2014	No
Urban Water Demand Forecasting for the Island of Skiathos	Conference Paper	urban water, demand forecasting	Data management and Smart City services	2014	No
ICT and stakeholder participation for improved urban water management in the cities of the future	Journal Paper	urban water, water management	Data management and Smart City services	2014	No

Table 6 ISS-EWATUS publications





2.7 iWIDGET



Figure 8 iWIDGET logo

iWIDGET is a European Commission project aimed at improved water efficiencies through the use of novel ICT technologies for integrated supply-demand side management. It is a project funded under the EU 7th Framework Programme, which started in November 2012 and finished in 2015.

iWIDGET's focus is a more integrated approach to water resources management and the project contributes to delivering a sustainable, low-carbon society, helping progress towards the Europe 2020 targets on Climate and Energy. This approach is developed by researching, developing, demonstrating and evaluating a fully integrated ICT-based system of techniques and technologies, which encourages and enables householders and water suppliers to understand and manage down their demand and minimize wastage in the supply chain.

The Project is being led by Prof. Dragan Savić, Founder and Co-director of the Centre for Water Systems at the University of Exeter.

The partnership assembled to deliver the iWIDGET project is a combination of all the key players in the field, leading ICT companies, business leaders, technology developers, standardization organizations, water companies and top scientists in the field of water management, information and systems analysis and the social sciences. See Project Partners page and Partner Responsibilities page for more details.

Together the iWIDGET consortium brings to the table a clear understanding of the market, the technological state-of-the-art with respect to hardware and software, new research and development in data mining, analytics, decision support, scenario modelling, data management, standards interfaces, visualization, water conservation modelling and social simulation. The project also obtains input from householders through two case studies and input from the broader water industry through its Advisory Panel.

Tahle	7 iW/IDGET	nublications
iubie	<i>TIVVIDGET</i>	publications

Title	Туре	Tags	Topics	Year	Open Access
An eLearning Approach for Improving Household Water Efficiency	Conference Paper	household, water efficiency	Data management and Smart City services	2014	Yes
A new approach to improve water loss control using smart metering data	Journal Paper	water loss control, smart metering	Water supply and distribution	2014	No





A Web-Based Platform for Water Efficient Households	Conference Paper	water efficiency, households	Data management and Smart City services	2014	Yes
Considering the Mutual Dependence of Pulse Duration and Intensity in Models for Generating Residential Water Demand	Journal Paper	pulse duration, pulse intensity, residential water demand	Data management and Smart City services	2015	No
Correlation or not correlation? This is the question in modelling residential water demand pulses	Conference Paper	Water demand, demand pulses, intensity, duration, correlation	Data management and Smart City services	2015	Yes
Definição De Aplicações Tecnológicas Baseadas Em Dados De Telemedição Para Promover A Eficiência No Consumo De Água- Energia Em Sistemas De Abastecimento	Conference Paper	Smart metering, consumption efficiency, water distribution	Data management and Smart City services	2014	Yes
Forecasting domestic water consumption from smart meter reading using statistical methods and artificial neural networks	Conference Paper	Smart metering, consumption efficiency, water distribution	Data management and Smart City services	2015	Yes
Framework for technical evaluation of decision support systems based on water smart metering: the iWIDGET case	Conference Paper	decision support systems, smart metering	Water supply and distribution	2015	Yes
From Smart Meters to Smart Decisions: Web- based Support for the Water Efficient Household	Conference Paper	smart meters, water efficient household	Data management and Smart City services	2014	Yes
Innovative smart metering based applications for water utilities	Journal Paper	smart metering	Water supply and distribution	2014	No
Linking water consumption smart metering with census data to improve demand management	Conference Paper	water consumption, smart metering, demand management	Data management and Smart City services	2014	Yes
Preserving duration- intensity correlation on synthetically generated water demand pulses	Conference Paper	water demand	Data management and Smart City services	2015	Yes
Prioritising Use Cases for Water Smart Technology Development: Similarities and differences from Portugal and UK case studies	Conference Paper	water smart technologies	Data management and Smart City services	2014	Yes
Scenario generation for network optimization with uncertain demands	Conference Paper	demand forecasting, water network	Data management and Smart City services	2015	No





		optimization			
Smart metering use cases to increase water and energy efficiency in water supply systems	Journal Paper	smart metering, water efficiency, energy efficiency, water supply	Water-energy nexus	2014	No
Using Smart Meters for Household Water Consumption Feedback: Knowns and Unknowns	Conference Paper	smart meters, water consumption	Data management and Smart City services	2014	Yes
Using Smart Water Meters in (near) real-time on the iWidget System	Conference Paper	Smart meters, (near) real-time	Data management and Smart City services	2014	Yes
Web Services for Water Systems - the iWIDGET REST API	Conference Paper	Smart meters, web services	Data management and Smart City services	2014	Yes
iWIDGET: helping water efficiencies	Journal Paper	water efficiency, energy efficiency	Data management and Smart City services	2013	Yes
New ways to improve network performance management	Journal Paper	water network, performance management	Data management and Smart City services	2014	Yes
Smart water metering: reality or pipe dream?	Journal Paper	smart meters, smart water, water metering	Data management and Smart City services	2015	Yes

2.8 KINDRA



Figure 9 KINDRA logo

The KINDRA project (Knowledge Inventory for hydrogeology research) is funded by the European Commission's HORIZON2020 Framework Programme. The overall objective of the project is to take stock of Europe's contemporary practical and scientific knowledge of hydrogeology research and innovation with the help of an inventory of research results, activities, projects and programmes, and then use the inventory to identify critical research challenges and gaps, with a view to avoiding overlaps. This approach takes into account the implementation of the Water Framework Directive and latest innovation areas within integrated water resources management, allowing at EU scale the future correct management and policy development of groundwater. The project started on 1 January 2015 and lasts for 36 months; work is divided into five work packages.





Table 8 KINDRA publications

Title	Туре	Tags	Topics	Year	Open Access
D1.2 Harmonized terminology and methodology for groundwater research classification	Deliverable	smart meters, residential water demand, demand management	Data management and Smart City services	2015	Yes

2.9 SmartH2O



Figure 10 SmartH20 logo

The SmartH2O is a project funded under the EU 7th Framework Programme and develops an ICT platform for improving the management of urban and peri-urban water demand thanks to the integrated use of smart meters, social computation, and dynamic water pricing, based on advanced models of consumer behaviour.

Water consumers are people whose behaviour depends on a variety of motivations and social and individual drivers and triggers. For this reason, it is necessary to develop a framework able to consider both the technical and the social sides of the problem, and able to promote the active engagement of the consumers with the shared objective of saving water and energy. The SmartH2O project aims to provide water utilities, municipalities and citizens, with an ICT-enabled platform to design, develop and implement better water management practices and policies, leading to a reduction in water consumption, without compromising the quality of life, and to an increase in resource security.

The project is led by SUPSI (University of Applied Sciences of Southern Switzerland) which is supported by seven partners, from academia and industry.

The mission of the SmartH2O project is to develop an ICT platform to:

- Understand and model the consumers' current behaviour, based on historical and real-time water usage data
- Predict how the consumer behaviour can be influenced by various water demand management policies: water savings campaigns, social awareness campaigns, to dynamic water pricing schemes
- Raise the awareness of water consumers on their current water usage habits and their lifestyle implications and to stimulate them to reduce water use





The SmartH2O ICT infrastructure enables water managers to close the loop between actual water consumption levels and desired targets, using information about how the consumers adapt their behaviour to new situations: new regulations, new water prices, and appeals to water savings. This feedback allows to aptly revising the water demand management policies, enabling to maximize the water and energy saving goals

Table 9 SmartH20 publications

Title	Туре	Tags	Topics	Year	Open Access
Benefits and challenges of using smart meters for advancing residential water demand modelling and management: A review	Journal Paper	Water management, smart meters, consumer modelling	Data management and Smart City services	2015	No
The SmartH2O platform: advancing residential water management by smart metering and data intensive modelling of consumers' behaviours	Conference Paper	residential water management, water efficiency	Data management and Smart City services	2015	No
The SmartH2O project: a platform supporting residential water management through smart meters and data intensive modelling	Conference Paper	water pricing, social media, residential water efficiency, smart meter	Data management and Smart City services	2014	No
Smart metering, water pricing and social media to stimulate residential water efficiency: opportunities for the SmartH2O project	Conference Paper	social computing, water efficiency	Data management and Smart City services	2014	Yes
The SmartH2O project and the role of social computing in promoting efficient residential water use: a first analysis	Conference Paper	social media, residential water efficiency, smart meter	Data management and Smart City services	2014	Yes
D1.1 : MANAGEMENT PROCESSES – Defining rules and standards for joint work	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2014	Yes
D2.1: USE CASES AND EARLY REQUIREMENTS	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2014	Yes
D2.2: FINAL REQUIREMENTS	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2015	Yes
D3.2: FIRST USER BEHAVIOUR MODELS – SmartH2O algorithms for water end-use disaggregation and user	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2015	Yes





modelling					
D4.1: FIRST SOCIAL GAME AND IMPLICIT USER INFORMATION TECHNIQUES – Persuasive games for water efficiency	Deliverable	water pricing, social media, residential water efficiency, smart meter	Data management and Smart City services	2015	Yes
D5.1: REVIEW OF PRICING INSTRUMENTS	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2014	Yes
D6.1: DELIVERY MANAGEMENT PLAN AND TESTING SPECIFICATION – Developing, testing and releasing the SmartH2O software platform	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2015	Yes
D6.2: PLATFORM ARCHITECTURE AND DESIGN	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2015	Yes
D6.3: PLATFORM IMPLEMENTATION AND INTEGRATION – INITIAL PROTOTYPE	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2015	Yes
D7.1: VALIDATION METHODOLOGY – The design of SmartH2O case studies	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2015	Yes
D8.2: TECHNOLOGY WATCH REPORT – Exploring the market dimensions	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2014	Yes
D9.1: DISSEMINATION TOOLS AND MATERIALS	Deliverable	social media, residential water efficiency, smart meter	Data management and Smart City services	2015	Yes
D9.2: FIRST DISSEMINATION REPORT	Deliverable	Water management, smart meters, consumer modelling	Data management and Smart City services		Yes





2.10 UrbanWater



Figure 11 UrbanWater logo

The UrbanWater is an EU 7th Framework Programme project that incorporates weather prediction and surface water reserves (e.g. reservoirs) data, household consumption data, and includes water distribution data, including on pressure and leakages, and additional information and statistics coming from other sources. The platform incorporates advanced metering solutions, real-time consumption data and new data management technologies with real-time demand forecasting capability, consumption analysis, decision support systems, adaptive pricing and user empowerment solutions. The platform remains open to ensure interoperability with energy and water management schemes and further enhance collaboration between key partners from outside of the consortium.

In brief, the project integrates high quality and already proven solutions for data management and billing systems, with innovative models for forecasting water supply availability, predicting customers' demand and detecting leakages. It develops spatial tools based on strong knowledge from previous developments in the field of supporting distributors and authorities in decision-making. Furthermore, the project develops innovative solutions to empower customers and efficiently integrate them in the UrbanWater platform.

- The scientific and technologic challenges identified in the project as key enablers to develop new technological solutions to efficiently manage water are:
- To estimate water demand in urban areas in order to efficiently manage water supply chains.
- To reduce waste of water and economic losses associated to leakages in the urban water distribution network.
- To smoothen daily water demand daily peaks in order to allow distributors to save costs related to the urban water distribution networks' management.
- To guarantee efficient and secure computational data management on the base of smart grids' recent and upcoming deployments in Europe.
- To reduce operating and maintenance costs associated with water metering and billing in urban areas.
- To incentivise urban households to reduce current consumption and soften the current European water demand peaks, side-by-side with decreasing their own water expenditures.
- To build effective partnerships and develop innovation synergies between equipment providers, ICT companies and water distributors.





Table 10 UrbanWater publications

Title	Туре	Tags	Topics	Year	Open Access
D1.1 The European water market analysis	Deliverable	water market analysis	Sustainable development, Circular Economy, & Ecosystem services	N/A	Yes
D1.2 User requirements in the water market	Deliverable	water market, stakeholders requirements	Data management and Smart City services	N/A	Yes
D2.1 Analysis of proven technologies in AMR, WDN and WR	Deliverable	Automatic Meter Reading, Water Distribution Network, Water Reservoirs	Water supply and distribution	N/A	Yes
D4.3 Identification procedures for water demand prediction	Deliverable	Water demand, demand prediction	Data management and Smart City services	N/A	Yes
D5.1 Customer's empowerment tools system requirement	Deliverable	customer requirements, sensor requirements, platform requirements	Data management and Smart City services	N/A	Yes
D6.2 UrbanWater platform architecture design	Deliverable	architecture, SOA, web services ICT	Data management and Smart City services	N/A	Yes
D8.6 Project Webpage	Deliverable	dissemination, water demand, sensor, water distribution networks	Data management and Smart City services	N/A	Yes

2.11 WaterInnEU



Figure 12 WaterInnEU logo

The WaterInnEU project is an European Union's Horizon 2020 research and innovation programme, which primary vision is to create a marketplace to enhance the exploitation of EU funded ICT models, tools, protocols and policy briefs related to water and to establish suitable conditions for new market opportunities based on these offerings.

This project is addressing the lack of use and applicability of the research outcomes in the water management market from a different point of view and is offering an innovative and commercially driven





solution. The new perspective comes from the assumption that the lack of application is not only due to the lack of knowledge and awareness about the outcomes and the results of the research projects about water, but also to the lack of an appropriate and credible vehicle for accessing these solutions in a form that best fits the needs of the stakeholders and the associated supply chain.

This means a framework where the outputs of the research can reach the potential users (mainly managers and water administrations) in an applied and useful way, providing a practical and deployable solution that meets their needs and addresses their priority problems - what they need are solutions, not tools. The potential participants and beneficiaries of this project include both end users and practitioners, and other key stakeholders with an active role to play in the regulation and management of water systems and services.

The real marketplace is composed of the market actors (mainly project responsible persons, water companies and river basin managers) and the market activities (demonstrations, workshops, networking, negotiations) and the support of a virtual web based marketplace.

The proposed framework is a marketplace in which SMEs and companies are the ones who transform offerings into a service, and goods will be offered as well as required services.

The users (river basin district managers) want a service that allows them to find the solution to their needs (mainly, follow the EU directives and act as public servants to the benefit of the citizens). The solution is called the "marketplace as a service" (MaaS). The marketplace adds the missing link to the situation: the companies that are able to provide services to the users based in EU funded project results.

Title	Туре	Tags	Topics	Year	Open Access
D1.1 Project management structure and communication channels	Deliverable	project management, river basin management, innovation, ICT for water	River Basin Management	2015	Yes
D1.2 Draft Data Management Plan	Deliverable	Data management plan, river basin management, innovation, ICT for water	River Basin Management	2015	Yes
D2.1 Data availability report	Deliverable	Data availability, river basin management, innovation, ICT for water	River Basin Management	2015	Yes
D2.2 Water companies and solutions report	Deliverable	Water companies, river basin management, innovation, ICT for water	River Basin Management	2015	Yes

Table 11 WaterInnEU publications





D4.1 Plan for disseminating and exploiting the project's results	Deliverable	Dissemination plan, exploitation plan, river basin management, innovation, ICT for water	River Basin Management	2015	Yes
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2.12 Wat€rnomics



Figure 13 Waternomics logo

WATERNOMICS is a project funded under the EU 7th Framework Programme and its main goal is to provide personalized and actionable information about water consumption and water availability to individual households, companies and cities in an intuitive and effective manner at a time-scale relevant for decision making. Access to this information increases end-user awareness and improve the quality of the decisions from decision makers regarding water management and water government. WATERNOMICS accomplishes this by:

- Combining water usage related information from various sources and domains to offer water information services to end-users (see Fig. 1)
- Making water usage related information accessible across devices and locations
- Supporting personalised interaction with water information services (see Fig. 1)
- Conducting knowledge transfer from energy management systems to water management systems
- Enabling sharing of water information services across communities of users
- Showing that generic water information services can be used in a variety of environments, geological, environmental and social
- Enabling open (collaborative) business models and flexible pricing mechanisms that are responsive to both demand and climate/environmental conditions (e.g. drought periods)

WATERNOMICS uses both new and state of the art sensors and water meters to provide new services (applications) and add new features like leakage detection, fault detection and water awareness games. These services are bundled into the WATERNOMICS Water Information Services Platform, or short name, WATERNOMICS Platform. This software platform is able to integrate (convergence layer) on top of existing water infrastructures or be employed using dedicated sensors fielded using the project methodology for water management system design.





Table 12 Wat€rnomics publications

Title	Туре	Tags	Topics	Year	Open Access
Interactive Water Services: The Waternomics Approach	Conference Paper	Interactive water services; decision support; gamification; linked data; fault detection	Data management and Smart City services	2014	Yes
Linked Water Data For Water Information Management	Conference Paper	Water Resource Management, Water Information Management, Real- Time Processing, Dynamic Data, Linked Data, Water Management	Data management and Smart City services	2014	No

2.13 WatERP



Figure 14 WatERP logo

WatERP is a project funded under the EU 7th Framework Programme and its main goal is to develop a web-based "Open Management Platform" (OMP) supported by real-time knowledge on water supply and demand, enabling the entire water distribution system to be viewed in an integrated and customized way. The OMP provides to the user-inferred information regarding water supplies, flows, water consumption patterns, water losses, distribution efficiency, and water supply and demand forecasts, within a web-based unified framework. This information is stored in a Water Data Warehouse making use of semantics and common language and open standards (such as WaterML 2.0) which is defined in the ontology developed to ensure interoperability and maximize usability. In addition, external linkages to costs, energy factors, control systems, data acquisition systems, external models, forecasting systems and new data sources are made possible for easy integration into the system.

The main purpose of this information interaction and processing is to improve the matching between supply and demand. To achieve this final goal, a Decision Support System (DSS) tool supports coordination of actions throughout the entire water supply distribution chain, prioritization of water uses, distribution efficiency improvements, and water, energy and cost savings. A Demand Management System (DMS) analyses socioeconomical drivers and policies to improve demand management. The project outcomes have been tested and validated in two pilots representative of different European water problems (water scarcity - water abundance) with clearly distinct objectives (optimize water resources management - improve water energy efficiency).





Water can be saved through infrastructure investment; improved coordination; or behavioural changemeasures with different costs & time scales.

While 40% water savings could be achieved from technological improvements, this value is the sum of a series of different actions. Based on water resources management experience, it can be roughly estimated that improving coordination among actors could lead to water savings between 5 and 8%, with smart metering providing an additional 8 to 10%.

WatERP technological solution gives response to the coordination among actors building a smart water solution.

Title	Туре	Tags	Topics	Year	Open Access
Research on Optimal Operation Method of Large Scale Urban Water Distribution System	Conferenc e Paper	Water distribution system; optimal operation; genetic algorithm; decision support system	Data management and Smart City services	2013	Yes
Data Reduction Methods for Wireless Smart Sensors in Monitoring Water Distribution Systems	Conferenc e Paper	Data Reduction; Continuous Monitoring of Water Distribution Systems; Smart Sensors; Wireless Sensor Networks; Prediction	Water supply and distribution	2013	Yes
Towards an enhanced knowledge based Decision Support System (DSS) for Integrated Water Resource Management (IWRM)	Conferenc e Paper	Knowledge Base; Decision Support System; Rule-Based Reasoning; Case-Based reasoning; Water Management Ontology; Intelligent System	Data management and Smart City services	2014	Yes
A water demand forecasting method ology for supporting day-to-day management of water distribution systems	Conferenc e Paper	Water Demand Management, Forecasting Model, Similar Days, Water Demand Drivers	Data management and Smart City services	2014	Yes
A Sensor and Semantic Data Warehouse for Integrated Water Resource Management	Conferenc e Paper	WatERP architecture, OGC standards, Water Data warehouse, Integrated Water Resource Management	Data management and Smart City services	2014	Yes
A two-layer energy efficient framework using SAW sensor network for leakage detection in monitoring water distribution system.	Conferenc e Paper	SAW, control leakage, detection, signal processing, water distribution system, wireless sensor network	Data management and Smart City services	2014	No
Behaviour interventions for water	Conferenc e Paper	leakage, detection, signal processing, water	Data management	2014	No

Table 13 WatERP publications




end use: an integrated model		distribution system, wireless sensor network"	and Smart City services		
Standards and Semantics to Support Interoperable Software Solutions in the Water Distribution Chain	Conferenc e Paper	behaviour intervention, modelling, water end use, water saving	Data management and Smart City services	2014	No
A System-Based Approach for the Assessment of Water Demand Management Instruments	Conferenc e Paper	Demand management, Regulatory instruments, Economic Instruments	Data management and Smart City services	2014	Yes
Leakage separation by LAB and DMA experiment in water distribution network	Conferenc e Paper	Water Supply Network(WSN); Leakage Experiment; Blind Source Separation(BSS); Fast Independent Component Analysis(FastICA); District Meter Area (DMA)	Data management and Smart City services	2014	Yes
Results of current research on water consumption behaviour in German households	Conferenc e Paper	water distribution chain, water-supply chain"	Data management and Smart City services	2014	Yes
A Holistic ICT Solution to Improve Matching between Supply and Demand over the Water Supply Distribution Chain	Journal Paper	Demand management, Regulatory instruments, Economic Instruments	Data management and Smart City services	2015	Yes
D1.1 Generic taxonomy for water supply distribution chain	Deliverable	Water Supply Network(WSN); Leakage Experiment; Blind Source Separation(BSS); Fast Independent Component Analysis(FastICA); District Meter Area (DMA)	Data management and Smart City services	2013	Yes
D1.2 Generic Functional model for water supply and usage data	Deliverable	Water Demand, Water Demand Management, User behaviour, Water consumption behaviour	Data management and Smart City services	2013	Yes
D1.3 Generic Ontology for water supply distribution chain	Deliverable	SOA-MAS, Water management, Ontology, Agents, WaterML2.0, IWRM, Logical models	Data management and Smart City services	2013	Yes
D7.1.1 Holistic Auditing	Deliverable	Taxonomy, Ontology, Knowledge base	Data management and Smart City services	2013	Yes
D7.2.1 Implementation of MAS	Deliverable	Water management decision processes, Ontology Enhancement, WaterML2, Functional models	Data management and Smart City services	2013	Yes





2.14 WISDOM



Figure 15 WISDOM logo

The WISDOM project is supported by the European Commission under the 7th Framework Programme. WISDOM (Water analytics and Intelligent Sensing for Demand Optimised Management) project aims at developing and testing an intelligent ICT system that enables "just in time" actuation and monitoring of the water value chain from water abstraction to discharge, in order to optimise the management of water resources.

The WISDOM project's unique selling point is the combined use of three key elements: the adoption of a semantic approach that captures and conceptualizes holistic water management processes, including the associated socio-technical dimensions (social networks interactions with physical systems).

The adoption of semantic modelling enables to promote:

- the (semi)automated control of the water system operation,
- the computer-aided decision making for human intervention,
- the data sharing among numerous components and tools, and
- the integration of the water infrastructure functionalities,
- the interfacing with other smart energy infrastructures and building systems.

The WISDOM project considers a holistic view of water management systems and processes across the entire water value chain, from abstraction to discharge

The WISDOM project aims at achieving a step change in water and energy savings via the integration of innovative Information and Communication Technologies (ICT) frameworks to optimize water distribution networks and to enable change in consumer behaviour through innovative demand management and adaptive pricing schemes.

More specifically the project aims to develop a sophisticated ICT system that is able to understand, monitor, and control the water network.

We aim that the WISDOM solution is able to:

- To collect real-time data about water consumption at domestic, corporate and city level.
- To deliver an ICT framework for real-time and predictive water management at domestic, corporate and city level.
- To provide a Water Decision Support Environment to enable professionals within the water industry to visualise, manage and optimise the water system.





At a global level, the objectives of the WISDOM project are to:

- increase user awareness and modify behaviours concerning the use of water,
- achieve quantifiable and significant reduction of water consumption,
- achieve peak-period reduction of water and energy distribution loads,
- improved resource efficiency and business operations of water utilities due to ICT,
- contribute to the improvement of the environmental performance of buildings.

Table 14 WISDOM publications

Title	Туре	Tags	Topics	Year	Open Access
The WISDOM project for smart water monitoring using advanced ICT equipment, data and tools	Conference Paper	water awareness, monitoring and management, user-centred predictive platform	Data management and Smart City services	2014	Yes
Optimised Water Demand Management Through Intelligent Sensing and Analytics: The WISDOM Approach	Conference Paper	Water Awareness, monitoring and management, User-Center Predictive Platform, ICT	Data management and Smart City services	2014	Yes
Water analytics and intelligent sensing for demand optimised management: the WISDOM vision and approach	Conference Paper	Water Awareness, monitoring and management, User-Center Predictive Platform, ICT	Data management and Smart City services	2014	Yes
D1.1 Stakeholder Oriented Socio-technical and Business Requirement Capture	Deliverable	Water Value Chain, Behaviour & Feedback, Resource Management	Data management and Smart City services	2014	Yes
D1.3 Software Requirement Specification	Deliverable	User requirements, Governance Requirements, ICT architecture, Efficient Water Use, Demand Management, Adaptive Pricing	Data management and Smart City services	2015	Yes
D2.1 Wisdom software and hardware detailed system design	Deliverable	ICT architecture, Efficient Water Use, Demand Management, Adaptive Pricing	Data management and Smart City services	2015	Yes
D.4.1 Shared district water	Deliverable	Water Value	Customer	2015	Yes





stakeholders' vision document		Chain, Operational Water System,	Relationship		
D6.3 Special Interest Group	Deliverable	SIG, Water Consumer, Water Network operators	Customer Relationship	2014	Yes

2.15 WIDEST



Figure 16 WIDEST logo

WIDEST is a European Commission (H2020 Coordination and Support Action) project. The vision of WIDEST is to establish and support a thriving and interconnected Information and Communication Technology (ICT) for the Water Community with the main objective of promoting the dissemination and exploitation of the results of European Union (EU) funded activities in this area.

Once the project ends, the vision is twofold: in one hand, contribute to advance the consolidation of ICT for the Water Community that is better informed, defined and integrated than today; on the other hand, WIDEST will help the results and outcomes from current research projects improving their exploitation plans and increasing their dissemination potential by delivering co-produced knowledge to a wide range of stakeholders and actors within the water community.

The project is backed by a strong consortium composed by institutions with proven record of accomplishment and expertise across different facets of ICT for water research, including established connections with key stakeholders.

The WIDEST project is aligned with the 15 EU-funded projects clustered around the ICT4Water Cluster.







Figure 17 ICT for Water cluster projects

Table	15	WIDEST	publications
10010			pasneations

Title	Туре	Tags	Topics	Year	Open Access
D1.1 - Report with IWO definition and implementation v1.5	Deliverable	ICT for water	Data management and Smart City services	2015	YES
D4.1 Methodology for Portfolio Development	Deliverable	ICT for water	Data management and Smart City services	2015	YES
D5.1 Project website	Deliverable	ICT for water	Data management and Smart City services	2015	YES
D5.2 Communication and Dissemination Plan	Deliverable	ICT for water	Data management and Smart City services	2015	YES
D6.1 Project Management Handbook	Deliverable	ICT for water	Data management and Smart City services	2015	YES





3. Books and Book Chapters

3.1 Urban Hydroinformatics. Data, Models and Decision Support for Integrated Urban

Water Management

Title: Urban Hydroinformatics. Data, Models and Decision Support for Integrated Urban Water Management	Date: 2011
Authors: Roland Price, Zoran Vojinovic	Publisher: Elsevier

URL:

http://www.researchgate.net/publication/251670832_Urban_Hydroinformatics._Data_Models_and_Deci sion_Support_for_Integrated_Urban_Water_Management

Open Access: No

Tags: Urban Water Management, Hydroinformatics, Data Management, Modelling Paradigms, Decision Support Systems, Asset Management, Water Distribution systems, Collection Systems, Wastewater Treatment Management, Water Quality, Integrated Drainage Systems, Urban Flood Risk Management

Topic: Data management and Smart City services

Abstract:

Urban Hydroinformatics: Data, Models and Decision Support for Integrated Urban Water Management is an introduction to hydroinformatics applied to urban water management. It shows how to make the best use of information and communication technologies for manipulating information to manage water in the urban environment. The book covers the acquisition and analysis of data from urban water systems to instantiate mathematical models or calculations, which describe identified physical processes. The models are operated within prescribed management procedures to inform decision makers, who are responsible to recognized stakeholders. The application is to the major components of the urban water environment, namely water supply, treatment and distribution, wastewater and storm water collection, treatment and impact on receiving waters and groundwater, and urban flooding. Urban Hydroinformatics pays particular attention to modelling, decision support through procedures, economics and management, and implementation in developing countries. The book is written with Post-graduate students, researchers and practicing engineers in all aspects of urban water management in mind.

3.2 Water Demand Management

Title: Water Demand Management	Date:2005		
Authors: David Butler, Fayyaz Memon	Publisher: IWA		
URL: http://www.iwapublishing.com/books/9781843390787/water-demand-management			
Open Access: No			
Tags: Water Consumption, Demand Forecasting Techniques, Rainwater Catchment Systems, Greywater Treatment, Water Conservation, Life Cycle Assessment, Water Demand Management, Decision Support Tools			
Topic: Water supply and distribution			
Abstract:			





A common characteristic of water demand in urban areas worldwide is its inexorable rise over many years; continued growth is projected over coming decades. The chief influencing factors are population growth and migration, together with changes in lifestyle, demographic structure and the possible effects of climate change (the detailed implications of climate change are not yet clear, and anyway will depend on global location, but must at least increase the uncertainty in security of supply). This is compounded by rapid development, creeping urbanization and, in some places, rising standards of living.

Meeting this increasing demand from existing resources is self-evidently an uphill struggle, particularly in water stressed/scarce regions in the developed and developing world alike. There are typically two potential responses: either "supply-side" (meeting demand with new resources) or "demand-side" (managing consumptive demand itself to postpone or avoid the need to develop new resources). There is considerable pressure from the general public, regulatory agencies, and some governments to minimise the impacts of new supply projects (e.g. building new reservoirs or inter-regional transfer schemes), implying the emphasis should be shifted towards managing water demand by best utilising the water that is already available.

Water Demand Management has been prepared by the academic, government and industry network WATERSAVE. The concept of the book is to assemble a comprehensive picture of demand management topics ranging from technical to social and legal aspects, through expert critical literature reviews. The depth and breadth of coverage is a unique contribution to the field and the book will be an invaluable information source for practitioners and researchers, including water utility engineers/planners, environmental regulators, equipment and service providers, and postgraduates.

Contents

- Water consumption trends and demand forecasting techniques
- The technology, design and utility of rainwater catchment systems
- Understanding greywater treatment
- Water conservation products
- Water conservation and sewerage systems
- An introduction to life cycle and rebound effects in water systems
- Developing a strategy for managing losses in water distribution networks
- Demand management in developing countries
- Drivers and barriers for water conservation and reuse in the UK
- The economics of water demand management
- Legislation and regulation mandating and influencing the efficient use of water in England and Wales
- Consumer reactions to water conservation policy instruments
- Decision support tools for water demand management

3.3 Smart Water Utilities: Complexity Made Simple

Title: Smart Water Utilities: Complexity Made Simple	Date: 2015			
Authors: Pernille Ingildsen, Gustaf Olsson	Publisher: IWA			
URL: <u>http://www.iwapublishing.com/books/9781780407579/smart-water-utilities-complexity-made-</u> simple				
Open Access: No				
Tags: Industry & Water, Urban Water Utility/Network Management, Water Supply & Treatment				
Topic: Water supply and distribution				
Abstract:				





Today there is increasing pressure on the water infrastructure and although unsustainable water extraction and wastewater handling can continue for a while, at some point water needs to be managed in a way that is sustainable in the long-term. We need to handle water utilities "smarter".

New and effective tools and technologies are becoming available at an affordable cost and these technologies are steadily changing water infrastructure options. The quality and robustness of sensors are increasing rapidly and their reliability makes the automatic handling of critical processes viable. Online and real-time control means safer and more effective operation.

The combination of better sensors and new water treatment technologies is a strong enabler for decentralised and diversified water treatment. Plants can be run with a minimum of personnel attendance. In the future, thousands of sensors in the water utility cycle will handle all the complexity in an effective way.

Smart Water Utilities: Complexity Made Simple provides a framework for Smart Water Utilities based on an M-A-D (Measurement-Analysis-Decision). This enables the organisation and implementation of "Smart" in a water utility by providing an overview of supporting technologies and methods.

The book presents an introduction to methods and tools, providing a perspective of what can and could be achieved. It provides a toolbox for all water challenges and is essential reading for the Water Utility Manager, Engineer and Director and for Consultants, Designers and Researchers.

3.4 Practical Application of Online Monitoring

Title: Practical Application of Online Monitoring	Date: 2005		
Authors: M Frey, L Sullivan	Publisher: IWA		
URL: http://www.iwapublishing.com/books/9781843399124/practical-application-online-monitoring			
Open Access: No			
Tags: Urban water, Utility / network management, Water supply & treatment			
Topic: Water supply and distribution			

Abstract:

Utilities across the USA rely on online monitors to help them track important parameters such as disinfectant residual and particle removal. However, there are no guidelines on how to operate these monitors so that they are consistent and measure as accurately as possible. This study investigated the current uses of all online monitors in plants and their calibration and maintenance procedures in order to gain an understanding of the current industry standards.

The purpose of this project was to evaluate how utilities are using and maintaining their online equipment and to provide guidelines for utilities to consider in their online monitoring program.

The status of online instrument use in U.S. water utilities was surveyed. The survey was completed by 264 utilities representing 392 treatment plants. Case studies of six utilities were performed to supplement the survey results by recording, in-depth, the instrument uses, maintenance practices, instrument support structure, and supervisory structure as related to online instrument use. In addition, case studies provided online and bench data from their online instruments for analysis. The utilities selected included conventional filtration, direct filtration, lime softening, and unfiltered systems with widely varying source water quality. A sample Standard Operating Procedure (SOP) was developed to provide utilities with guidance in creating SOPs.

The findings concerning using volatility as a way of evaluating the performance of online instruments could affect the water industry by providing new techniques to measure online monitor performance and as an early warning system of monitor problems...





3.5 Visual Tool for Supporting Asset Management Performance, Risk, and Cost Analysis

Title: Visual Tool for Supporting Asset Management Performance, Risk, and Cost Analysis	Date: 2015	
Authors: Sergio T. Coelho, Diogo Vitorino, Bradley Jurkovac, Helena Alegre, David Kerr, Rita S. Brito	Publisher: IWA	
URL: <u>http://www.iwapublishing.com/books/9781780407777/visual-tool-supporting-asset-management-performance-risk-and-cost-analysis</u>		

Open Access: No

Tags: Policy & governance, Utility / network management

Topic: Water supply and distribution

Abstract:

Managing urban water infrastructures faces the challenge of jointly dealing with assets of diverse types, useful life, cost, ages and condition. Service quality and sustainability require sound long-term planning, well aligned with tactical and operational planning and management. In summary, the objective of an integrated approach to infrastructure asset management is to assist utilities in answering the following questions:

Who are we at present, and what service do we deliver? What do we own? Where do we want to be in the long-term? How do we get there?

The AWARE-P approach (www.aware-p.org) offers a coherent methodological framework and a valuable portfolio of software tools. It is designed to assist water supply and wastewater utility decision-makers in their analyses and planning processes. It is based on a Plan-Do-Check-Act process and is in accordance with the key principles of the International Standards Organization (ISO) 55000 standards on asset management. It is compatible with, and complementary to WERF's SIMPLE framework. The software assists in strategic, tactical, and operational planning, through a non-intrusive, web-based, collaborative environment where objectives and metrics drive IAM planning. It is aimed at industry professionals and managers, as well as at the consultants and technical experts that support them. It is easy to use and maximizes the value of information from multiple existing data sources, both in data-rich and data-stressed environments.

This project aimed at testing, validating and tailoring the AWARE-P approach and software in the U.S. wastewater services context; developing new open-source software tools. The project produced:

- A portfolio of tools for the Advanced Water Management and Rehabilitation-Portugal (AWARE-P) software validated at Gwinnett County Department of Water Resources (GCDWR), the main pilot case, and at two other U.S. cases, where a large amount of GIS and inspection data from a major utility, and GIS and operational data from a small utility were extensively explored;
- A new, enhanced version of the tool to assess infrastructure value and support long-term reinvestment policies; and
- A new set of tools directed at data mining and condition-based inspection analysis and prediction.





3.6 Compendium of Sensors and Monitors and Their Use in the Global Water Industry

Title: Compendium of Sensors and Monitors and Their Use in the Global Water Industry	Date: 2015			
Authors: Joep van den Broeke	Publisher: IWA			
URL: <u>http://www.iwapublishing.com/books/9781780406695/compendium-sensors-and-monitors-and-their-use-global-water-industry</u>				
Open Access: No				
Tags: Water supply & treatment, Water resources / environment, Utility / network management				
Topic: Water supply and distribution				

Abstract:

Online monitoring of water quality is a powerful enabler in the water industry. It is a crucial component in the pro-active management of processes and assets, and helps improve performance and cost efficiency. Instrumentation for the monitoring of most water quality parameters is commercially available. Implementation of such equipment, however, remains largely limited to a small number of basic parameters and is still confined to key nodes in collection, treatment and distribution systems. A primary hurdle to further realization of the potential of online monitoring is the lack of publicly available information on system performance, key drivers and barriers (technical, economic and social) to successful implementation. A study was performed to identify and document information on commercially available instrument types, associated costs (capital and operating), and real-world experiences with the use of sensors in the global water / wastewater industry. This information was compiled in an online compendium, to facilitate sharing of information and learning from experience.

The study has shown that the current generation of technology is suitable for routine operation. However, there is no one-size-fits-all solution to monitoring questions. Furthermore, successful application of on-line water quality monitoring requires commitment of considerable resources, which need to be accompanied by a solid QA/QC plan. Furthermore, the understanding and appreciation of monitoring and the efforts required to make it a success need to be embedded and supported at all levels within an organization.

Deciding whether on-line monitoring is the best solution to a need for information has to be done in careful process. Defining needs and requirements, building a business case around this and then carefully working out the specifications and all organizational aspects of the monitoring program are prerequisites for effective implementation and to prevent surprises and disappointment.

3.7 Mathematical Optimization of Water Networks

Title: Mathematical Optimization of Water Networks	Date: 2012			
Authors: Martin, A., Klamroth, K., Lang, J., Leugering, G., Morsi, A., Oberlack, M., Ostrowski, M., Rosen, R.	Publisher: Springer			
URL: http://www.springer.com/us/book/9783034804356				
Open Access: No				
Tags: Optimization, Water Industry/Water Technologies, Computational Mathematics and Numerical Analysis, Calculus of Variations and Optimal Control, Optimization, Mathematics (general)				
Topic: Water supply and distribution				
Abstract:				





Water supply- and drainage systems and mixed water channel systems are networks whose high dynamic is determined and/or affected by consumer habits on drinking water on the one hand and by climate conditions, in particular rainfall, on the other hand. According to their size, water networks consist of hundreds or thousands of system elements. Moreover, different types of decisions (continuous and discrete) have to be taken in the water management. The networks have to be optimized in terms of topology and operation by targeting a variety of criteria. Criteria may for example be economic, social or ecological ones and may compete with each other.

The development of complex model systems and their use for deriving optimal decisions in water management is taking place at a rapid pace. Simulation and optimization methods originating in Operations Research have been used for several decades, usually with very limited direct cooperation with applied mathematics.

The research presented here aims at bridging this gap, thereby opening up space for synergies and innovation. It is directly applicable for relevant practical problems and has been carried out in cooperation with utility and dumping companies, infrastructure providers and planning offices. A close and direct connection to the practice of water management has been established by involving application-oriented knowledge from the field of civil engineering. On the mathematical side, all necessary disciplines were involved, including mixed-integer optimization, multi-objective and facility location optimization, and numeric for cross-linked dynamic transportation systems and optimization as well as control of hybrid systems.

Most of the presented research has been supported by the joint project "Discreet-continuous optimization of dynamic water systems" of the federal ministry of education and research (BMBF).

3.8 Practical Hydroinformatics: Computational Intelligence and Technological

Developments in Water Applications

Title: Practical Hydroinformatics: Computational	Date: 2008	
Intelligence and Technological Developments in		
Water Applications		
Authors: Robert J. Abrahart, Linda M. See,	Publisher: Springer	
Dimitri P. Solomatine		
URL: http://link.springer.com/book/10.1007%2F978-3-540-79881-1		

Open Access: No

Tags: Hydroinformatics: Integrating, Data and Models, Models Based on Neural Networks, Models Based on Fuzzy Logic, Global and Evolutionary, Optimization, Emerging Technologies, Model Integration

Topic: Water supply and distribution

Abstract:

Hydroinformatics has emerged over the last decade to become a recognised and established field of independent research activities within the hydrological and environmental science communities. Hydroinformatics is not just an application of Information and Communications Technologies (ICT) to water resources, hydraulics, hydrology or environment. It strives to provide an amalgamation of water





science with modern technologies for the purposes of satisfying social requirements. The European Geosciences Union (EGU) held its first dedicated session on Hydroinformatics in 2005 at the Vienna Meeting; that same meeting voted to establish the Hydroinformatics Sub-Division and Technical Committee (part of the Hydrological Sciences Division).

The aim of that original session was to provide an active forum in which to demonstrate and discuss the integration and appropriate application of emergent computational technologies in a water-modelling context. The initial proposal for this book arose at that meeting out of a desire to collect together a range of different contributions from academics and practitioners working in various sectors across the field; there were no other published compendiums at that point which attempted to span the latest set of methods or topics of hydrological interest that were presented at our meeting. The starting point for the selection of authors was the session itself. Further contributors were invited to submit papers in order to bolster particular sections and provide a representative selection of research across the main thematic areas: neural networks, fuzzy logic, global and evolutionary optimisation, emerging technologies and model integration.

This book is aimed at hydrologists, scientists, students and practitioners interested in a set of techniques derived largely from artificial and computational intelligence to solve a range of problems in hydrology. We hope that this book will promote the field of Hydroinformatics and bridge the gap between theory and practice.

3.9 Data-Driven Modelling: Using MATLAB[®] in Water Resources and Environmental Engineering

Title: Data-Driven Modelling: Using MATLAB [®] in Water Resources and Environmental Engineering	Date: 2014	
Authors: Shahab Araghinejad	Publisher: Springer	
URL: http://link.springer.com/book/10.1007/978-94-007-7506-0		

Open Access: No

Tags: MATLAB, Environmental engineering, Water-supply engineering, Earth Sciences, Environmental Management, Environmental Monitoring/Analysis, Hydrogeology, Hydrology/Water Resources, Math. Appl. in Environmental Science, Waste Water Technology, Water Pollution Control, Water Management, Aquatic Pollution

Topic: Sustainable development, Circular Economy, & Ecosystem services

Abstract:

The purpose of writing this book has been to give a systematic account of major concepts and methodologies of data-driven models and to present a unified framework that makes the subject more accessible and applicable to researchers and practitioners. The book is structured to integrate important theories and applications on data-driven models and to use them in a wide range of problems in the field of water resources and environmental engineering. The presented models are useful for various applications, namely, hydrological forecasting, flood analysis, water quality monitoring, quantitative and qualitative modelling of water resources, regionalizing climatic data, and general function approximation. This book addresses the issue of data-driven modelling in two





contexts. Theoretical background of the models and techniques is presented and discussed in a comparative manner, briefly. In addition, the source files of relative programs demonstrating how to use the explained models are presented with practical advice on how to advance them. The programs have been developed within the unified platform of MATLAB. The proposed models are applied in various illustrative examples as well as several workshops. The focus of the book remains a straightforward presentation of explained models by discussing in detail the necessary components and briefly touching on the more advanced components.

The book is served as a practical guide to the main audience of graduate students and researchers in water resources engineering, environmental engineering, agricultural engineering, and natural resources engineering. This book may also be adapted for use as a senior undergraduate and graduate textbook by selective choice of topics. Alternatively, it may also be used as a resource for practicing engineers, consulting engineers, and others involved in water resources and environmental engineering. The book contains eight chapters; except first and last, each was developed in two parts of theory and practice to achieve the aim of the book.

3.10 Distributed Hydrologic Modelling Using GIS

Title: Distributed Hydrologic Modelling Using GIS	Date: 2004	
Authors: Baxter E. Vieux	Publisher: Springer	
URL: http://link.springer.com/book/10.1007/1-4020-2460-6		

Open Access: No

Tags: Hydrogeology, Environmental Management, Atmospheric Sciences, Waste Management, Waste Technology

Topic: Sustainable development, Circular Economy, & Ecosystem services

Abstract:

'Distributed Hydrologic Modelling Using GIS' celebrates the beginning of a new era in hydrologic modelling. The debate surrounding the choice of either lumped or distributed parameter models in hydrology has been a long one. The increased availability of sufficiently detailed spatial data and faster, more powerful computers has levelled the playing field between these two basic approaches. The distributed parameter approach allows the hydrologist to develop models that make full use of such new datasets as radar rainfall and high-resolution digital elevation models (DEMs). The combination of this approach with Geographic Information Systems (GIS) software, has allowed for reduced computation times, increased data handling and analysis capability, and improved results and data display. 21st century hydrologists must be familiar with the distributed parameter approach as the spatial and temporal resolution of digital hydrologic data continues to improve. Additionally, a thorough understanding is required of how this data is handled, analysed, and displayed at each step of hydrologic model development.

It is in this manner that this book is unique. First, it addresses all of the latest technology in the area of hydrologic modelling, including Doppler radar, DEMs, GIS, and distributed hydrologic modelling. Second, it is written with the intention of arming the modeller with the knowledge required to apply these new technologies properly. In a clear and concise manner, it combines topics from different scientific disciplines into a unified approach aiming to guide the reader through the requirements, strengths, and pitfalls of distributed modelling. Chapters include excellent discussion of theory, data analysis, and application, along with several cross references for further review and useful conclusions.

This book tackles some of the most pressing concerns of distributed hydrologic modelling such as: What are the hydrologic consequences of different interpolation methods? How does one choose the data resolution necessary to capture the spatial variability of your study area while maintaining feasibility and minimizing computation time? What is the effect of DEM grid resampling on the hydrologic response of the model? When is a parameter variation significant? What are the key aspects of the distributed model calibration process? In 'Distributed Hydrologic Modelling Using GIS',





Dr. Vieux has distilled years of academic and professional experience in radar rainfall applications, GIS, numerical methods and hydrologic modelling into one single, comprehensive text. The reader will not only gain an appreciation for the changes brought about by recent technological advances in the hydrologic modelling arena, but will fully understand how to successfully apply these changes toward better hydrologic model generation. 'Distributed Hydrologic Modelling Using GIS' not only sets guiding principles to distributed hydrologic modelling, but also asks the reader to respond to new developments and calls for additional research in specific areas. All of the above make this a unique, invaluable book for the student, professor, or hydrologist seeking to acquire a thorough understanding of this area of hydrology.

3.11 Artificial Neural Networks in Hydrology

Title: Artificial Neural Networks in Hydrology	Date: 2000	
Authors: R. S. Govindaraju, A. Ramachandra Rao	Publisher: Springer	
UDL + http://liple.opringer.com/hook/40.4007/070.04.045.0244.0		

URL: http://link.springer.com/book/10.1007/978-94-015-9341-0

Open Access: No

Tags: Hydrogeology, Statistical Physics, Dynamical Systems and Complexity, Theory of Computation

Topic: Sustainable development, Circular Economy, & Ecosystem services

Abstract:

In this book, the writers investigate the role of artificial neural networks (ANNs) in hydrology. ANNs are gaining popularity, as is evidenced by the increasing number of papers on this topic appearing in hydrology journals, especially over the last decade. In terms of hydrologic applications, this modelling tool is still in its nascent stages. The practicing hydrologic community is just becoming aware of the potential of ANNs as an alternative modelling tool. This paper is intended to serve as an introduction to ANNs for hydrologists. Apart from descriptions of various aspects of ANNs and some guidelines on their usage, this paper offers a brief comparison of the nature of ANNs and other modelling philosophies in hydrology. A discussion on the strengths and limitations of ANNs brings out the similarities they have with other modelling approaches, such as the physical model.

3.12 Knowledge-Based Decision Support for Integrated Water Resources Management

with an application for Wadi Shueib, Jordan

Title: Knowledge-Based Decision Support for Integrated Water Resources Management with an application for Wadi Shueib, Jordan	Date: 2013	
Authors: Riepl, David	Publisher: KIT Scientific Publishing, Karlsruhe	
URL: http://digbib.ubka.uni-karlsruhe.de/volltexte/documents/2558456		
Open Access: Yes		
Tags:IntegratedWaterResourcesManagementResource Management	nt, Knowledge-Based Decision Support, Water	
Topic: Water supply and distribution		
Abstract:		





This book takes a two-staged approach to contribute to the contemporary Integrated Water Resources Management (IWRM) research. First, it investigates sub-basin-scale IWRM modelling and scenario planning. The Jordanian Wadi Shueib is used as exemplary case study. Then, it develops a framework to collaboratively manage planning and decision-making knowledge based on semantic web technologies. Future IWRM initiatives can benefit from the valuable insights achieved in the presented study.

3.13 Smart Sensors for Real-Time Water Quality Monitoring

Title: Smart Sensors for Real-Time Water Quality Monitoring	Date: 2013
Authors: Subhas C Mukhopadhyay, Alex Mason	Publisher: Springer
URL: http://link.springer.com/book/10.1007/978-3-642-37006-9	

Open Access: No

Tags: Hydrogeology, Electronics and Microelectronics Instrumentation, Waste Water Technology, Water Pollution Control, Water Management, Aquatic Pollution

Topic: Wastewater treatment (including recovery of resources)

Abstract:

This book focuses on three main themes; literature review, examples of technology and practice and supporting technologies/future trends. Thus, the book begins in Chapter 1 by providing a very general overview of the current contaminants of concern for the wastewater industry and the available sensor technologies with which these contaminants have been detected to varying extents. Popular systems in use by industry (such as ultraviolet and mass spectroscopy) are discussed in addition to some technologies, which are still within the research domain. This is continued in Chapter 2, which discusses the detection of phosphates in seawater, comparing the available spectrophotometric technologies for this purpose. The chapter then continues by discussing the potential of electrochemical techniques, and this is supplemented by Chapter 3, which describes fluorescence and phosphorescence chemical sensors applied to water samples. Chapter 4, written by group in Spain well known for the work in the area of voltammetric electronic tongues, discusses the principle and application of this technology in the case of water contamination analysis. Finally, for the literature review section, Chapter 5 discusses the automation of water analysis systems with a focus particularly on Sequential Injection Analysis.

3.14 Book Chapters

Book: Environmental Monitoring	Date: 2011	
Chapter: ICT for Water Efficiency		
Authors: Philippe Gourbesville	Publisher: Intech	
URL: http://www.intechopen.com/books/environmental-monitoring/ict-for-water-efficiency		
Open Access: Yes		
Tags: Real-time Monitoring tools, Cities of Tomorrow, Assessment Management, Energy Efficiency, Water Efficiency		
Topic: Data management and Smart City services		
Abstract:		





The water sector represents a major challenge for the 21st century. The climate evolution combined with the growing of pressure of populations will generate new stresses on a limited resource, which has to be carefully managed and protected. The fast development of ICT solutions allows today to enter a new area, which may be characterized by the idea to move from a scarcity of data to a continuous flow of data - "data rich world" - about natural and built environment. This new situation will become a reality in the coming two decades and will allow potentially improving, globally, the water management. However, if this perspective represents a clear benefit both for natural and manmade environments, it request the development of a coherent vision based on a process allowing to integrate the fragmented activities developed until now in the water sector.

Book: Scientific and Engineering Applications Using MATLAB	Date: 2011	
Chapter: Data Reduction for Water Quality Modellin	ng, Vaal Basin	
Authors: Bloodless Dzwairo, George M. Ochieng', Maupi E. Letsoalo and Fredrick A.O. Otieno	Publisher: Intech	
URL: http://www.intechopen.com/books/environmental-monitoring/ict-for-water-efficiency		
Open Access: Yes		
Tags: Water Quality Modelling, Multivariate Linear regression		
Topic: Quality of water		
Abstract:		
The water sector represents a major challenge for the 21st century. The climate evolution combined with the growing of pressure of populations will generate new stresses on a limited resource, which has to be carefully managed and protected. The fast development of ICT solutions allows today to enter a new area, which may be characterized by the idea to move from a scarcity of data to a continuous flow of data - "data rich world" - about natural and built environment. This new situation will become a reality in the coming two decades and will allow potentially improving, globally, the water management. However, if this perspective represents a clear benefit both for natural and manmade environments, it		

Book: Scientific and Engineering Applications Using MATLAB	Date: 2011	
Chapter: Modelling Reliability Based Optimization	Design for Water Distribution Networks	
Authors: Mohamed Abdel Moneim	Publisher: Intech	
URL: http://www.intechopen.com/books/scientific-and-engineering-applications-using-matlab/modelling-		
reliability based entirelization design for water distrib	hution notworks	
reliability-based-optimization-design-for-water-distribution-networks		
Onen Accesso Vac		
Open Access: res		
Tage: Water Distribution Networks Average Cro	diant Madal, hydraulia aalyar, antimization madal	
Tays. Water Distribution Networks, Average Gra	alent wodel, nydraulic solver, optimization model,	
Linear Adaptive Genetic Algorithm		
1 5		
Topic: Water supply and distribution		
Abstract:		

request the development of a coherent vision based on a process allowing to integrate the fragmented

activities developed until now in the water sector.





There is a growing concern on the capacity of water utilities via governmental regulatory agencies regarding potential optimization and reliability for water distribution network. Generally, water distribution networks comprise about 60% of the total budget for a complete framework of a water supply system. According to this fact, achieving an optimum solution for water distribution networks as models' outcome of reliability-based optimization design has become the great concern to save considerable amount of allocated budget. During the last decade, many authors were interested in studying optimization and reliability for water distribution networks that include solving non-linear hard problem of the network hydraulic equations. The optimization and reliability models of water distribution networks have number of varieties in studying aspects that include efficiency, accuracy, different sizes/scales of networks, and the consumed run time to define the optimum solution. During the current decade, considerable amount of attention has been given to reliability of water distribution networks in conjunction with the optimization to achieve maximum benefits with the minimum cost. This concern has been extended to cover the risk management for water distribution networks as a way to embark on facing the shortage of water resources all over the world or improving asset management programs. The main objective of this chapter is to develop standalone model divided into four submodels using MATLAB environment programming language. The developed model and its corresponding sub-models would acquaint an optimum solution for a given water distribution network that achieve both least cost design and reliability based optimization design in the meantime. The main model is called RELOPT and can be used as a tool to implement modelling reliability-based optimization design, deterioration analysis of water pipe networks, risk analysis and assessment, and decision support system. RELOPT is integrated with four sub-models those are: optimization search engine model that is based on a new technique driven from Genetic Algorithms approach is called Linear Adaptive Genetic Algorithm (LAGA); pre-estimation optimization model that is based on Average Gradient Method (AGM) to accelerate the process of the optimization search engine; reliability model that is based on load resistance concept for calculating system reliability. Through this chapter the number of subjects will be discussed those are: background of water distribution systems, definition of problem in statement, main objectives, history of optimization and techniques, history of reliability and techniques, proposed optimization technique, the advantage of the new optimization technique, proposed reliability evaluation technique, proposed risk assessment technique, resultant decision support system, applications of the proposed model using existing cases studies, and conclusion including outcomes and recommendations. Developing the main model and it's sub-models in using MATLAB power with some snapshots will be discussed.

Book: Scientific and Engineering Applications Using MATLAB	Date: 2011		
Chapter: Integrated Cyber-Physical Simulation of Intelligent Water Distribution Networks			
Authors: By Jing Lin and Sahra Sedigh and Ann Miller	Publisher: Intech		
URL:http://www.intechopen.com/books/scientific-and-engineering-applications-using- matlab/integrated-cyber-physical-simulation-of-intelligent-water-distribution-networks			
Open Access: Yes			
Tags: Water Distribution Networks, cyber-physical systems			
Topic: Water supply and distribution			
Abstract:			

In cyber-physical systems (CPSs), embedded computing systems and communication capability are used to streamline and fortify the operation of a physical system. Intelligent critical infrastructure systems are among the most important CPSs and also prime examples of pervasive computing systems, as they exploit computing to provide "anytime, anywhere" transparent services. While the added intelligence offers the promise of increased utilization, its impact must be assessed, as unrestricted cyber control can actually lower the reliability of existing infrastructure systems. As a





practical example, water distribution networks (WDNs) are an emerging CPS domain. Physical components, e.g., valves, pipes, and reservoirs, are coupled with the hardware and software that support intelligent water allocation. Information such as demand patterns, water quantity (flow and pressure head), and water quality (contaminants and minerals) is critical in achieving this goal, and beneficial in guiding maintenance efforts and identifying vulnerable areas requiring fortification and/or monitoring. Sensors dispersed in the physical infrastructure collect this information, which is fed to algorithms (often distributed) running on the cyber infrastructure. These algorithms provide decision support to hardware controllers that are used to manage the allocation (quantity) and chemical composition (quality) of the water. As WDNs become larger and more complex, their reliability comes into question.

Book: Modelling Simulation and Optimization - **Date:** 2010 Tolerance and Optimal Control

Chapter: Fuzzy Model Based Fault Detection in Waste-Water Treatment Plant

Authors: Skrjanc I.

Publisher: Intech

URL: <u>http://www.intechopen.com/books/modeling-simulation-and-optimization-tolerance-and-optimal-control/fuzzy-model-based-fault-detection-in-waste-water-treatment-plant</u>

Open Access: Yes

Tags: fuzzy clustering, fuzzy modelling, waste-water treatment plant, process monitoring, fault detection

Topic: Water supply and distribution

Abstract:

In this paper, monitoring and sensor fault detection of wastewater treatment benchmark is discussed. The monitoring is based on the fuzzy model of the plant, which is obtained by the use of Gustafson-Kessel fuzzy clustering algorithm. The main idea in the case of process monitoring by the use of fuzzy modelling is to cope with the non-linearity, which is inherent for the plants of this type. We are comparing the fuzzy model response of the normal operation regime with the current behaviour. The data, which are treated here, are obtained by the simulation model of the wastewater treatment plant and the sensor faults are simulated.

The signals, which have to be measured in the case of the monitoring, are the following: influent ammonia concentration, dissolved oxygen concentration in the first aerobic reactor tank, temperature, dissolved oxygen concentration and the ammonia concentration in the second aerobic reactor. The results of the plant monitoring and fault detection based on fuzzy model are shown and discussed.





4. Scientific Journals

4.1 Journal of Hydroinformatics

Journal of Hydroinformatics is a peer-reviewed journal devoted to the application of information technology in the widest sense to problems of the aquatic environment. It promotes Hydroinformatics as a cross-disciplinary field of study, combining technological, human-sociological and more general environmental interests, including an ethical perspective.

The following articles conform the last issue².

Title	Topics	Keywords
Twenty-five years of ASM1: past, present and future of wastewater treatment modelling	Wastewater treatment (including recovery of resources)	Activated Sludge, Application, Kinetic, Modelling, Stoichiometry, Wastewater Treatment
A simple clustering technique to extract subsets of data for function approximation	Data management and Smart City services	Clustering, Data Sub Sets, Function Approximation, Fuzzy Models, Phase Space, Time Series
A novel hybrid neural network based on continuity equation and fuzzy pattern-recognition for downstream daily river discharge forecasting	River Basin Management	Artificial Neural Network, Continuity Equation, Daily River Discharge Forecasting, Fuzzy Pattern-Recognition, Particle Swarm Optimization, Storage Reservoir
Modelling settling tanks for water treatment using computational fluid dynamics	Water supply and distribution	Baffles, Computational Fluid Dynamics (CFD), Flow Through Curves (FTCS), Settling Tanks, Wind Effect
Improving the efficiency of Monte Carlo Bayesian calibration of hydrologic models via model pre-emption	Water supply and distribution	AR, Calibration, Dream, Pre- Emption, SMC, Uncertainty Analysis
ATES: a geo-informatics decision aid tool for the integration of groundwater into land planning	Water supply and distribution	Groundwater Protection, Land Planning, Risk Evaluation, Web- Based GIS Tool
Evaluating the role of deterioration models for condition assessment of sewers	Wastewater treatment (including recovery of resources)	CCTV Inspection, Decision Support, Infrastructure Asset Management, Sensitivity Analysis, Sewer Condition

Table 16 Journal of Hydroinformatics - Volume 17, Issue 5 (2015)

² URL: <u>http://www.iwaponline.com/jh/017/5/default.htm</u>





		Assessment, Sewer
	Diver Desig Management	Deterioration
A comparative evaluation of shear stress modelling based on machine learning methods in small streams	River Basin Management	Ann, C&R-T, Genlin, Machine Learning, Shear Stress Distribution, Small Streams
Data-driven recursive input output multivariate statistical forecasting model: case of DO concentration prediction in Advancetown Lake, Australia	Water supply and distribution	Data Processing, Dissolved Oxygen, Input Algorithm, Time- Series Forecasting, Water Resources Management
Using SWAT to simulate streamflow in Huifa River basin with ground and Fengyun precipitation data	River Basin Management	Fengyun (Fy) Precipitation Product, Precipitation Input, Rainfall, Remote Sensing, Streamflow, Swat
Modelling aerated flows with smoothed particle hydrodynamics	Water supply and distribution	Aerated Flows, CFD In Wastewater Treatment, Lagrangian Particle Methods, Physically Based Simulation Modelling, Smoothed Particle Hydrodynamics Model, Two- Dimensional Numerical Simulation
General metrics for segmenting infrastructure networks	Water supply and distribution	Infrastructure Networks, Modularity Index, Network Segmentation, Resolution Limit
A high-performance integrated hydrodynamic modelling system for urban flood simulations	Water supply and distribution	Finite-Volume Godunov-Type Scheme, Graphics Processing Unit, Hi-Pims, Hydrodynamic Model, Shallow Water Equations, Urban Flood Inundation
An object-oriented development environment to optimally design cyclic storage systems	Sustainable development, Circular Economy, & Ecosystem services	Conjunctive Use, Cyclic Storage Systems, Multi-Objective Optimization, Sustainable Development
A two-stage interval-stochastic water trading model for allocating water resources of Kaidu-Kongque River in north western China	Water supply and distribution	Interval Analysis, Market Approach, Reallocating Water, Stochastic Programing, Uncertainty, Water Trading
A novel nested dynamic programming (nDP) algorithm for multipurpose reservoir optimization	Water supply and distribution	Algorithm, Dynamic Programming, Optimal Reservoir Operation
Efficient joint probability analysis of flood risk	Wastewater and storm water collection (including Flood risk management)	Design Variable Method, Extremal Dependence, Flood Risk, Joint Probability Analysis, R





		Package
Assimilation of weather radar and binary ubiquitous sensor measurements for quantitative precipitation estimation	Water reuse and recycling	Bayesian Methods, Data Assimilation, Data Fusion, Markov Random Fields, Quantitative Rainfall Estimation, Ubiquitous Sensing
Artificial neural network ensemble modelling with exploratory factor analysis for streamflow forecasting	River Basin Management	Artificial Neural Network, Ensemble Modelling, Exploratory Factor Analysis (EFA), Nakdong River, Streamflow Forecasting
Data quality assessment in hydrological information systems	Data management and Smart City services	Data Quality, Data Supply Chain, Hydrological Information System, Quality Assessment, Quality Dimension, Task
Numerical analysis of hydraulic jumps using OpenFOAM	Water supply and distribution	Hydraulic Jump, Open Channel, OpenFOAM, Rans, K-Epsilon, K- Omega
Eutrophication forecasting and management by artificial neural network: a case study at Yuqiao Reservoir in North China	Water supply and distribution	Artificial Neural Network, Data- Driven Technique, Orthogonal Experimental Design, Prediction And Forecast, Reservoir Eutrophication, Sensitivity Analysis
Appropriate resolution timescale to evaluate water saving and retention potential of rainwater harvesting for toilet flushing in single houses	Wastewater and storm water collection (including Flood risk management)	Behavioural Models, Rainwater Tanks, Resolution Timescale, Storm Water Retention, Water Saving
Pump as turbine implementation in a dynamic numerical model: cost analysis for energy recovery in water distribution network	Water supply and distribution	Dynamic Network Model, Energy Recovery, Pump As Turbine, Renewable Energy, Water Distribution Network
Dual-use value of network partitioning for water system management and protection from malicious contamination	Quality of water	District Sectorization, Malicious Attack, Network Partitioning, Water Contamination, Water Network Protection
Anomaly pre-localization in distribution-transmission mains by pump trip: preliminary field tests in the Milan pipe system	Water supply and distribution	Genetic Algorithm, Lagrangian Model, Pipe Diagnosis, Transient Tests, Transmission-Distribution Pipe System, Wavelet Transform
A dynamic urban development model designed for purposes in the field of urban water management	Water supply and distribution	Hydrodynamic Simulation, Multi-Scenario Analysis, Simulation Variation
Power use methods for optimal design of WDS: history and their	Water supply and distribution	Hot Start, Metaheuristics, Power Use Surface, Water





use as post-optimization warm starts		Distribution System (WDS) Optimal Design
Comparison of different radar- raingauge rainfall merging techniques	Water supply and distribution	Geostatistical, Kriging, Merging, Precipitation Estimation, Raingauges, Weather Radar
Artificial neural network modelling of scale-dependent dynamic capillary pressure effects in two-phase flow in porous media	Water supply and distribution	Ann, Dynamic Capillary Pressure Effects, Multi-Scale, Porous Media, Two-Phase Flow, Viscosity Ratio
Quadratic approximations for pipe friction	Water supply and distribution	Modelling, Pipe Friction, Water Networks
Analysis of extreme flooding events through a calibrated 1D/2D coupled model: the case of Barcelona (Spain)	Wastewater and storm water collection (including Flood risk management)	1D/2D Coupled Modelling, Dual Drainage, Sewer And Overland Flows Calibration
An enquiry into the place of systems analysis in the politics of water and the environment	Sustainable development, Circular Economy, & Ecosystem services	Anti-System, Legislature, Power- Sharing, Social Justice, Stakeholder, Water Resources
Water and the city: exploring links between urban growth and water demand management	Data management and Smart City services	Cellular Automata, Decentralised Technologies, Urban Growth, Urban Water Management
Resilience-based failure mode effects and criticality analysis for regional water supply system	Water supply and distribution	Decentralized Wastewater Treatment, Failure Mode Effects And Criticality Analysis (FMECA), Regional Water Supply System (RWSS), Resilience, Risk Management, Risk Priority Number (RPN)
Development of priority setting process for the small stream restoration projects using multi criteria decision analysis	Wastewater and storm water collection (including Flood risk management)	Flood Risk Assessment, Multi Criteria Decision-Making Method, Priority Ranking, Small Stream Watershed Restoration Project
Estimation of scour depth around circular piers: applications of model tree	Sea Water	Bridge Pier, Data Mining Approaches, M5' Model Tree, Scour, Soft Computing, Unidirectional Flow
Reorganization of water demand under changing conditions with possibilistic programming	Water supply and distribution	Changing Conditions In Water Resources, Fuzzy Sets, Multicriteria Methods, Possibilistic Programming, Water Availability Constraints, Water Resources Management
Towards standard metadata to support models and interfaces in a hydro-meteorological	Sustainable development, Circular Economy, & Ecosystem services	Controlled Vocabulary, Environmental Numerical Modelling, ISO19115, Metadata





model chain		Standard, Model Interface
Fish tracking in vertical slot fishways using computer vision techniques	River Basin Management	Computer Vision, Fish Behaviour, Tracking, Vertical Slot Fishway
Spatial diversity of chlorine residual in a drinking water distribution system: application of an integrated fuzzy logic technique	Drinking water production	Calibration, Clustering, Fuzzy Logic, Networks, Reactions, Water Quality
Improving the rapidity of responses to pipe burst in water distribution systems: a comparison of statistical process control methods	Water supply and distribution	Burst Detection, Detectability, Resilience, Statistical Process Control (SPC), Water Distribution System (WDS)
Numerical simulation of water free-surface flows through a front-tracking lattice Boltzmann approach	Water supply and distribution	Dam Break, Free-Surface Flows, Hydraulic Modelling, Lattice Boltzmann Model
Water quality monitoring with online change-point detection methods	Quality of water	Change-Point Detection, Prediction, Roc, Time Series, Water Quality
Using real options for an eco- friendly design of water distribution systems	Water supply and distribution	Carbon Emissions, Optimisation, Real Options, Simulated Annealing, Uncertainty, Water Distribution Networks
Efficient multi-objective optimization methods for computationally intensive urban water resources models	Water supply and distribution	Computationally Intensive Models, Efficient Methods, Multi-Objective, Optimization, Urban Water Management
Modelling of daily runoff from a small agricultural watershed using artificial neural network with resampling techniques	Sustainable development, Circular Economy, & Ecosystem services	10-Fold Cross-Validation, Ann, Bann, Daily Runoff, Small Agricultural Watershed
Custom functionality and integrative approaches for hydrological modelling tools for water resources planning and management	Water supply and distribution	Custom Functionality, eWater Source, Hydrological Modelling, Plug-Ins, River Modelling, Water Resources Management
Pressure transfer modelling for an urban water supply system based on Pearson correlation analysis	Water supply and distribution	Network Division, Pearson Correlation Coefficient, Pressure Transfer Model, Sensor Network, Water Supply System
Neural network river forecasting with multi-objective fully informed particle swarm optimization	River Basin Management	FIPS, Multi-Objective, Neural Network River Forecasting, NNRF, Particle Swarm Optimization, PSO
Input selection for long-lead precipitation prediction using	Sustainable development, Circular Economy, & Ecosystem	Climatic Prediction, Entropy Theory, Gamma Test,





large-scale climate variables: a	services	Precipitation Prediction,
case study		Support Vector Machine
The open real-time control	Water supply and distribution	Feedback Control, Model
(RTC)-Tools software framework		Predictive Control, Real-Time
for modelling RTC in water		Control, Short-Term Reservoir
resources systems		Management
Modelling impacts of water	Quality of water	Chlorophyll A, Lake Taihu,
transfers on alleviation of		Simulation, Water Transfers,
phytoplankton aggregation in		Yangtze River
Lake Taihu		

4.2 Journal of Water Resources Planning and Management

The Journal of Water Resources Planning and Management reports on all phases of planning and management of water resources. The papers examine social, economic, environmental, and administrative concerns relating to the use and conservation of water. Social and environmental objectives in areas such as fish and wildlife management, water-based recreation, and wild and scenic river use are assessed. Developments in computer applications are discussed, as are ecological, cultural, and historical values.

The following articles conform the last published issue³:

Title	Topics	Keywords
Innovative Systems-Based Decision Support: Tales for the Real World	Water supply and distribution	Resource Management, Complex decision-making, systems-based decision support tools
Real-World Considerations in Water Distribution System Design	Water supply and distribution	water distribution
Inversion Model of Water Distribution Systems for Nodal Demand Calibration	Water Scarcity and droughts	Water distribution system, Inversion model, Nodal demand, Calibration
Adjoint-Based Probabilistic Source Characterization in Water-Distribution Systems with Transient Flows and Imperfect Sensors	Quality of water	Water distribution systems, Water quality, Mathematical models, Probability, Adjoint state
Strategic Planning for Drought Mitigation under Climate Change	Wastewater and storm water collection (including Flood risk management)	Drought preparedness, Climate change, Infrastructure development, Risk management
Water Quantity and Quality	Sustainable development,	Dams and floodgates, Water

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³ URL: <u>http://ascelibrary.org/toc/jwrmd5/141/9</u>





Joint-Operation Modelling of Dams and Floodgates in Huai River Basin, China	Circular Economy, & Ecosystem services	quantity and quality, Water pollution, Operation rules, Huai River basin
Stormwater Control Measures: Optimization Methods for Sizing and Selection	Water supply and distribution	Stormwater, Water quality, Optimization, Water balance, Water pollutants
Downscaling Global Circulation Model Projections of Climate Change for the United Arab Emirates	Sustainable development, Circular Economy, & Ecosystem services	Climate change, Downscaling, Temperature, Precipitation, United Arab Emirates (UAE)
Multi-Objective Operations of Multi-Wetland Ecosystem: iModel Applied to the Everglades Restoration	Water supply and distribution	Flood Control, Water Supply, Environmental demands, Artificial Neural Network
Successful Collaborative Negotiation over Water Policy: Substance versus Process	Water supply and distribution	Dispute resolution, Water allocation policy, Public participation, Water management, Water rights, Cooperation
Use of Pressure Management to Reduce the Probability of Pipe Breaks: A Bayesian Approach	Water supply and distribution	Pressure management, Pipe breaks, Statistical analysis, Bayes theorem
Real-Time Multiobjective Optimization of Operation of Water Supply Systems	Water supply and distribution	Pumps, Scheduling, Optimization model, Reliability, Water supply, Pump scheduling, Optimization, Real-time operation, Reliability, Water supply
Water Resources Management Models Based on Two-Level Linear Fractional Programming Method under Uncertainty	Water supply and distribution	Water resources management, Two-level linear fractional programming, Multi-objective, Sustainability, Uncertainty
Ethiopia's Grand Renaissance Dam: Implications for Downstream Riparian Countries	Water supply and distribution	Reservoir Management, Weather data, water policies





5. International Conferences

5.1 Computing and Control for the Water Industry (CCWI)

CCWI international conferences are a series of biennial conferences hosted and organized by the universities of Exeter, Sheffield and De Montfort. The first CCWI conference took place at Leicester Polytechnic, predecessor of De Montfort University, and was organized by Prof. Coulbeck and Dr Chun-How Orr in 1987. In 2015, the 13th edition was celebrated and its aim is to share the best practice among researchers and water engineers.

The papers in this last volume⁴ address many crucial topics of the currently mentioned problems with the focus on improving water management. The papers are grouped into 13 themes and one additional section related to the European projects cluster called ICT4Water.

Table 18 Computing and Control for the Water Industry (CCWI2015) Sharing the best practice in water

management

Title	Topics	Keywords
Estimation of Area Leakage in Water Distribution Networks: A Real Case Study	Water supply and distribution	water loss, leakage detection, hydraulic model, fire flow test, estimation error
Real-time Burst Detection in Water Distribution Systems Using a Bayesian Demand Forecasting Methodology	Water supply and distribution	Pipe Burst, Detection, Demand Forecast, Bayesian Statistics, Anomaly Detection, Probability
Water Supply Network Monitoring Based on Demand Reverse Deduction (DRD) Technology	Water supply and distribution	Water supply network, Demand Reverse Deduction (DRD), Wireless Sensor Network (WSN), pressure monitoring
A Particle Filter Based Leak Detection Technique for Water Distribution Systems	Water supply and distribution	Particle filter, leak detection, water distribution systems
Traditional Leakage Models for Leakage Modelling: Effective or Not?	Water supply and distribution	Leakage management, modelling, viscoelasticity
Cloud Based Machine Learning Approaches for Leakage Assessment and Management in Smart Water Networks	Water supply and distribution	Leakage, Smart Networks, AMR, Neural Networks, Cloud computing
Non-hydraulic Factors Analysis of Pipe Burst in Water Distribution Systems	Water supply and distribution	Water distribution system, data mining, pipe burst, improved three-scale AHP
Locating Leaks in Water Distribution Networks with Simulated Annealing	Water supply and distribution	Leak location, water distribution network, simulated annealing, graph theory

⁴ URL: <u>http://www.sciencedirect.com/science/journal/18777058/119/supp/C</u>





and Graph Theory		
Leakage Management: Planning Remote Real Time Controlled Pressure Reduction in Oppegard Municipality	Water supply and distribution	Water distribution networks, WDN models, leakages, pressure reduction valves
Leakage Management: WDNetXL Pressure Control Module	Water supply and distribution	Water Distribution Systems, Models, Leakages, Real Time Control, Pressure Reduction Valves
Laboratory Investigation of the Leakage Characteristics of Unburied HDPE Pipes	Water supply and distribution	Viscoelasticity, High Density Polyethylene (HDPE), Fixed and Variable Area Discharges (FAVAD)
Locating Pipe Bursts in a District Metered Area Via Online Hydraulic Modelling	Water supply and distribution	Burst Detection, Burst Localisation, Online Hydraulic Modelling, Water Distribution System
Experimental Investigation of Internal Fluidisation Due to a Vertical Water Leak Jet in a Uniform Medium	Water supply and distribution	Leak-soil interaction, Internal fluidisation, Pitot tubes
Development of a Leakage Target Setting Approach for South Korea Based on Economic Level of Leakage	Water supply and distribution	Non-Revenue Water, Economic Level of Leakage, Leakage Target
Identifying Factors that Influence the Factor of Safety and Probability of Failure of Large-diameter, Cast Iron Water Mains with a Mechanistic, Stochastic Model: A Case Study in the City of Hamilton	Water supply and distribution	water mains, cast iron, failure, factor of safety, Monte Carlo simulations
Pipe-level Energy Metrics for Energy Assessment in Water Distribution Networks	Water supply and distribution	Energy efficiency, energy metrics, energy losses, pipe rehabilitation, water distribution networks
Non-Destructive In-Situ Condition Assessment of Plastic Pipe Using Ultrasound	Water supply and distribution	Plastic pipe, Non-destructive testing, Voids detection, Health monitoring
Multi-aspect Performance Analysis of Water Distribution Systems Under Pipe Failure	Water supply and distribution	Water distribution system, multi-aspect performance analysis, Octant/quadrant analysis, pipe failure
Water Supply Infrastructure Cost Modelling	Water supply and distribution	Cost function, Asset management, Linear regression, Water supply
Exploring the Sensitivity of Fatigue Analysis with Regard to Design Parameters in PVC Pipes Subjected to Cyclic Transient Pressures	Water supply and distribution	Fatigue, PVC pipes, cyclic pressures, transient analysis, operation
Defining the Rehabilitation Needs of Water Networks	Water supply and distribution	Economic level of leakage, Leakage Management, Intermittent supply, Rehabilitation
Economic Performance of DMAs in Water Distribution Systems	Water supply and distribution	DMAs, alternative solutions, benefit analysis, multiple criteria, ranking
Water Distribution System	Water supply	Water network partitioning, clustering,





Clustering and Partitioning Based on Social Network Algorithms	and distribution	social network, graph theory
A Study on the Probability of Failure Model Based on the Safety Factor for Risk Assessment in a Water Supply Network	Water supply and distribution	Probability of Failure, Priority of pipe renewal, Safety factor
Pressure Changes Evaluation for Valve Replacement Condition Based on a Micro-Scope Hydraulic Model	Water supply and distribution	water distribution system, valve replacement, isolated segments, micro hydraulic model, pressure analysis
Study on the Frequency Response Function of Viscoelastic Pipelines Using a Multi-Element Kevin-Voigt Model	Water supply and distribution	frequency domain, numerical simulation, plastic, transient, transfer matrix, water hammer
Investigation of Transient Vaporous Cavitation: Experimental and Numerical Analyses	Water supply and distribution	Cavitating flow, Fluid transients, Pipe-rig, Experimental data, Column separation
Leak-Induced Pressure Decay During Transients in Viscoelastic Pipes. Preliminary Results	Water supply and distribution	leak, pipe systems, transients, viscoelasticity
Pipe Failure Analysis and Impact of Dynamic Hydraulic Conditions in Water Supply Networks	Water supply and distribution	Pressure Transient, Pressure Fluctuations, Pipe Failure, Failure Mechanism, Deterioration Models
Hydraulic Characterization of PVC-O Pipes by Means of Transient Tests	Water supply and distribution	PVC-O, pipe flexibility, pipe failure
Measurements and Analysis of Cavitation in a Pressure Reducing Valve During Operation - a Case Study	Water supply and distribution	pressure reducing valve (PRV), cavitation, hydraulic measurements, acoustic measurements
Temperature Influences Discolouration risk	Quality of water	Drinking water distribution, discolouration, temperature
Particle Accumulation Rate of Drinking Water Distribution Systems Determined by Incoming Turbidity	Quality of water	Drinking water distribution, discolouration, temperature, fouling rate
Interpreting and Estimating the Risk of Iron Failures	Quality of water	Decision Trees, District metering areas, Geographical Information Systems, Iron, Self-organising maps, Water quality
Improving Root Cause Analysis of Bacteriological Water Quality Failures at Water Treatment Works	Quality of water	Bacteriological water quality, data analysis, monitoring data, proactive failure prevention
A System Architecture for the Detection and Mitigation of CBRN Related Contamination Events of Drinking Water	Quality of water	CBRN, Drinking Water, Decision Support, Software Architecture
Modelling Heavy Metal Contamination Events in Water Distribution Systems	Quality of water	Heavy metals, water quality simulation, detailed chemical model, water distribution system, EPANET-MSX
Evaluation of the Ability of Sensor Networks to Detect E.coli Events	Quality of water	E. coli, contamination event, sampling programme, sensor network, detection





Compared to Sampling Programmes		likelihood, optimization
A Multi-Objective Approach for Minimizing Water Network Disinfection Time and Disinfectant Quantity	Quality of water	Water distribution system, disinfection, contamination
SAFEWATER - Innovative Tools for the Detection and Mitigation of CBRN Related Contamination Events of Drinking Water	Quality of water	Drinking water networks, CWRN sensors, real-time detection, event management, online simulation
A Pre-screening Procedure for Pollution Source Identification in Sewer Systems	Quality of water	Source identification, Sewer systems, Pre- screening, Optimization problems
Modelling Chlorine Decay in a Pilot Scale Water Distribution System Subjected to Transient	Quality of water	Chlorine concentration, Water Distribution system, Transient
Using Fuzzy Inference System to Predict Iron and Manganese Accumulation Potential in Water Distribution Networks	Quality of water	Sorption, biological oxidation, corrosion, chemical oxidation, Fe and Mn accumulation potential
Drinking Water Vulnerability Assessment after Disinfection through Chlorine	Quality of water	Vulnerability assessment, chlorine, trihalomethanes, drinking water quality, exposure index parameters
Identifying Material Accumulation Processes in Drinking Water Distribution Systems with Extended Period EPANET MSX Turbidity Simulations	Quality of water	Discolouration, shear stress, conditioning, Epanet MSX
Investigating the Impact of Sectorised Networks on Discoloration	Quality of water	Water distribution systems, District metered areas, Water quality, Discoloration risk management, Discoloration customer contact
Influence of Temperature, Network Diagnostics, and Demographic Factors on Discoloration-Related Customer Reports	Quality of water	Discoloration, Drinking water, temperature, pipe size
Contaminant Intrusion through Leaks in Water Distribution System: Experimental Analysis	Quality of water	Health risks, intermittent distribution, pollutant intrusion, transient analysis, water distribution system
Current Perspectives on Disinfectant Modelling	Quality of water	Disinfectant residual, water quality modelling, water distribution system modelling
Decision Support for the Design and Operation of Water Supply Systems	Data management and Smart City services	Water supply management, decision support, multicriteria optimization, scheduling, branch-and-bound
Showcasing a Smart Water Network Based on an Experimental Water Distribution System	Data management and Smart City services	Experimental water distribution system, EWDS-TUG, demand pattern, control, OpenSDM, data processing, data





		validation
Waternomics: A Cross-site Data Collection to Support the Development of a Water Information Platform	Data management and Smart City services	water, ICT, information systems, decision support, data analytics, data integration
A Cloud-based Distributed Data Collection System for Decentralised Wastewater Treatment Plants	Data management and Smart City services	water, ICT, information systems, decision support, data analytics, data integration
Software Prototype for Optimization of Monitoring and Data Logging in Water Distribution Systems	Data management and Smart City services	Monitoring, field data collection, flushing, model calibration
Applications of Deep Learning for Smart Water Networks	Data management and Smart City services	smart water networks, modelling, big data, data analytics, data-driven model, deep learning
A Tool for Practical Simplification of Water Networks Models	Data management and Smart City services	simplification, tool, water distribution systems
Network Analysis of Water Distribution System in Rural Areas using EPANET	Data management and Smart City services	Distribution network, EPANET, Nodal demand, Effective design ;Mathematical models
The Identification of Loops in Water Distribution Networks	Data management and Smart City services	network topology, loops, reliability
A Linearization Approach for Improving the Computational Efficiency of Water Distribution System Ranking-based Optimization Algorithms	Data management and Smart City services	linearization, optimization, pipe network, global gradient method
Different Approaches for Calibration of an Operational Water Distribution System Containing Old Pipes	Data management and Smart City services	Operational WDS, calibration, roughness, pipe diameter
Sensitivity of Regional Water Supply Systems Models to the Level of Skeletonization - A Case Study from Apulia, Italy	Data management and Smart City services	Regional water supply systems, simulation models, skeletonization level
Parameterization of Offline and Online Hydraulic Simulation Models	Data management and Smart City services	Hydraulic online simulation, parameterization, calibration, SCADA- System, GIS, data acquisition, model update
Modelling and Simulation of Water Distribution Systems with Quantised State System Methods	Data management and Smart City services	modelling, quantised state systems, QSS, simulation, water distribution systems
Installing Fixed Sensors for Double Calibration and Early-warning	Data management and Smart City	Sensor placement, Computer-aided designs, Models, Early-warning detection





Detection Purposes	services	system, Calibration, Multi-objective optimization
Water Distribution Network Model Building, Case Study: Milano, Italy	Data management and Smart City services	Water Distribution Networks, ICeWater project, Milano, Setup, Calibration
Parameter Uncertainty Modelling in Water Distribution Network Models	Data management and Smart City services	Uncertainty, water networks, demands, pressure measurements
Advances in Water Mains Network Modelling for Improved Operations	Data management and Smart City services	Innovation, water mains network models, optimisation, leakage, unknown status valves, pipe roughness
Model Calibration and Leakage Assessment Applied to a Real Water Distribution Network	Data management and Smart City services	Model, Water Networks, Calibration, Leaks
The Backtracking Uncertainty Bounding Algorithm for Chlorine Sensor Fault Detection	Data management and Smart City services	Water Distribution Networks, Water Quality Monitoring, Chlorine Sensor Faults
Efficient Preconditioned Iterative Methods for Hydraulic Simulation of Large Scale Water Distribution Networks	Data management and Smart City services	Water distribution networks, hydraulic analysis, inexact Newton method, preconditioned conjugate gradient, null space algorithm
Hydraulic System Modelling: Background Leakage Model Calibration in Oppegard Municipality	Data management and Smart City services	Water distribution networks, WDN models, background leakages, calibration
Experimental Investigation of Resilience and Pressure Management in Water Distribution Networks	Data management and Smart City services	Dynamic topology, Water Distribution Networks, Resilience, Optimization
Automating Workflow in Online Water Network Analysis	Data management and Smart City services	Water Network Analysis, Online Hydraulic Simulation, Petri nets, Concurrent Processes
Numerical Model of A Medium-Sized Municipal Water Distribution System Located in Romania	Data management and Smart City services	Variable speed driven pumps, water distribution system, pumping station scheduling, EPANET, affinity laws
WDNetXL: Hydraulic and Topology Analysis Integration and Features	Data management and Smart City services	Advanced hydraulic analysis, Topological analysis, WDNetXL, planning and management of hydraulic systems
Water distribution network analysis accounting for different background leakage models	Data management and Smart City services	Background leakage modelling, Hydraulic analysis, Water distribution network
A new approach to model development of water distribution networks with high leakage and burst rates	Data management and Smart City services	District metered area (DMA), Water distribution network (WDN), Minimum Night Flow (MNF), Average Zone Point (AZP)





Convergence issues in the EPANET solver	Data management and Smart City services	EPANET, demand-driven, hydraulic solver, pressure-driven, WaterNetGen
OOPNET: An object-oriented EPANET in Python	Data management and Smart City services	Water Distribution, Parallel Computing, Open Source Project, Simulation Software, Genetic Algorithms, Optimization
Water Distribution System Modelling and Optimization: A Case Study	Data management and Smart City services	Modelling, WDS, Optimization, MOGA, Pumping
Water distribution system calibration: Manual versus optimization-based approach	Data management and Smart City services	Water Distribution Systems, design, optimization, multi-objective optimization, Pareto-Optimal Dynamically Dimensioned Search
Modelling water supply system control system algorithms	Data management and Smart City services	parallel pumping, control system, modelling, SCADA, PID, EPANET
Real Time Water Supply System Hydraulic and Quality Modelling - A Case Study	Data management and Smart City services	quality modelling, real-time, EPANET, SCADA
A system dynamics computer model to assess the effects of developing an alternate water source on the water supply systems management	Data management and Smart City services	alternate water source, computer model, simulation, system dynamics, water supply
Simulation and conservation of the end use water based on behaviour intervention modelling	Data management and Smart City services	Water end use, Behaviour change, Behaviour intervention modelling, TPB, ANN
Comparison of demand calibration in water distribution networks using pressure and flow sensors	Data management and Smart City services	Water Distribution Networks, Demands, Calibration, Sensors
Dynamic Nature of Explanatory Variables in Water Demand Forecasting	Data management and Smart City services	water demand forecasting, explanatory variables, dynamic nature, chaotic data
Engaging users in tracking their water usage behaviour	Data management and Smart City services	Innovation, technology, water measurement, raising awareness, user experience, habit formation
Log logistic distribution to model water demand data	Data management and Smart City services	Water demand, stochastic nature, probability distribution function, log logistic distribution, Minitab, Anderson Darling
Procedure to Derive Parameters for Stochastic Modelling of Outdoor Water use in Residential Estates	Data management and Smart City services	water use, end-use, model, outdoor, indoor, GIS
Novel Performance Assessment	Data	Performance assessment, performance





Indices for Domestic Water Use	management and Smart City services	indices, water use devices, domestic water use efficiency
Assessment of Water use Efficiency in the Household Using Cluster Analysis	Data management and Smart City services	Water use efficiency, household, domestic consumption, cluster analysis, socio- demographic variables
A Control Simulation Tool for Online Demand Calibration	Data management and Smart City services	Water distribution networks, Network security, Real-time demand calibration, PID controllers, Least-squares method
Data driven analysis of customer flow meter data	Data management and Smart City services	customer side leakage, data analysis, numerical methods
Short-term forecasting of hourly water consumption by using automatic metering readers data	Data management and Smart City services	Short-term demand forecasting, Time- series mining, Time-series clustering, Support Vector Machines regression
Privacy and incongruence-focused disaggregation of water consumption data in real time	Data management and Smart City services	Water privacy, disaggregation, anomaly detection, privacy preserving data mining, complex event processor
Correlating Sound and Flow Rate at a Tap	Data management and Smart City services	Water use, flow rate, sound
Comparison of Info-gap and Robust Optimisation Methods for Integrated Water Resource Management under Severe Uncertainty	Data management and Smart City services	Water resources planning, decision making methods, climate change uncertainty, robust optimisation, info-gap decision theory
Research on Air Valve of Water Supply Pipelines	Data management and Smart City services	Air valve, one stage closing air valve, two stages closing air valve, water supply pipelines
Water Pressure Sensing based on Wireless Passive SAW Technology	Data management and Smart City services	Water pressure, SAW sensor, reader, interrogation, response
Cloud-based Event Detection Platform for Water Distribution Networks Using Machine-learning Algorithms	Data management and Smart City services	machine-learning, time series analysis, event-detection, cloud-based service
Water distribution Network Management in Emergency Conditions	Data management and Smart City services	\{WDS\} Management, Water Network Analysis, PDA Analysis, Sampling Design
Applying Numerical Models and Optimized Sensor Networks for Drinking Water Quality Control	Data management and Smart City services	Sensor, optimal sensor deployment, aqueduct, sensor location, GIS, InfoWater, Epanet
Optimal Sensors Placement for Flood Forecasting Modelling	Data management and Smart Citv	Sampling design, model calibration, hydro-rain gauges, hydrological





	services	modelling, flooding forecasting
Mathematical Programming Methods for Pressure Management in Water Distribution Systems	Data management and Smart City services	Water distribution systems, valve placement, mathematical optimization, mixed integer nonlinear programming, pressure management
An Incremental Sensor Placement Optimization in a Large Real-World Water System	Data management and Smart City services	Early Warning Detection System (EWDS), Sensor Placement Optimization Problem (SPOP), Greedy algorithm, Water Distribution Network (WDN), Water Quality, Syndicat des Eaux d'Ile de France (SEDIF)
Optimal Pressure Sensor Placement in Water Distribution Networks Minimizing Leak Location Uncertainty	Data management and Smart City services	Sensor placement, leak location, clustering
Combining Model Predictive Control with Constraint-satisfaction Formulation for the Operative Pumping Control in Water Networks	Data management and Smart City services	linear MPC, CSP, DWNs, NAM, Epanet
Determination of Optimal Location and Settings of Pressure Reducing Valves in Water Distribution Networks for Minimizing Water Losses	Data management and Smart City services	Leakages, NSGA-II, Pressure Management, Pressure Reduction Valves, Water Losses
Pressure control for WDS management. A case study	Data management and Smart City services	water distribution system, pressure reducing valve, pump as turbine, energy recovery
Pressure control for WDS management. A case study Using Predictive Model for Strategic Control of Multi-reservoir System Storage Capacity	Data management and Smart City services Data management and Smart City services	water distribution system, pressure reducing valve, pump as turbine, energy recovery Multi-reservoir System, Active Storage Capacity, Strategy Control, Prediction Model, Adaptability, Optimization, Artificial Neural Network
Pressure control for WDS management. A case study Using Predictive Model for Strategic Control of Multi-reservoir System Storage Capacity Optimized Control of Pressure Reducing Valves in Water Distribution Networks with Dynamic Topology	Data management and Smart City services Data management and Smart City services Data management and Smart City services	water distribution system, pressure reducing valve, pump as turbine, energy recovery Multi-reservoir System, Active Storage Capacity, Strategy Control, Prediction Model, Adaptability, Optimization, Artificial Neural Network Dynamic Topology, Water Distribution Networks, Resilience, Optimization
Pressure control for WDS management. A case study Using Predictive Model for Strategic Control of Multi-reservoir System Storage Capacity Optimized Control of Pressure Reducing Valves in Water Distribution Networks with Dynamic Topology \{EPANET\} Simulation of Control Methods for Centrifugal Pumps Operating under Variable System Demand	Data management and Smart City servicesData management and Smart City servicesData management and Smart City servicesData management and Smart City servicesData management and Smart City services	 water distribution system, pressure reducing valve, pump as turbine, energy recovery Multi-reservoir System, Active Storage Capacity, Strategy Control, Prediction Model, Adaptability, Optimization, Artificial Neural Network Dynamic Topology, Water Distribution Networks, Resilience, Optimization Variable demand, booster station, variable speed driven pumps, duty operation point, EPANET
Pressure control for WDS management. A case study Using Predictive Model for Strategic Control of Multi-reservoir System Storage Capacity Optimized Control of Pressure Reducing Valves in Water Distribution Networks with Dynamic Topology \{EPANET\} Simulation of Control Methods for Centrifugal Pumps Operating under Variable System Demand Does Pressure Reduction Test have Significant Effect on Evaluating Pressure Management to Reduce Physical Leakage Amount?	Data management and Smart City servicesData management and Smart City services	 water distribution system, pressure reducing valve, pump as turbine, energy recovery Multi-reservoir System, Active Storage Capacity, Strategy Control, Prediction Model, Adaptability, Optimization, Artificial Neural Network Dynamic Topology, Water Distribution Networks, Resilience, Optimization Variable demand, booster station, variable speed driven pumps, duty operation point, EPANET Index model, Physical leakage flow, Pressure management, Pressure reduction test, Water head
Pressure control for WDS management. A case studyUsing Predictive Model for Strategic Control of Multi-reservoir System Storage CapacityOptimized Control of Pressure Reducing Valves in Water Distribution Networks with Dynamic Topology\{EPANET\} Simulation of Control Methods for Centrifugal Pumps Operating under Variable System DemandDoes Pressure Reduction Test have Significant Effect on Evaluating Pressure Management to Reduce Physical Leakage Amount?Transient Effects of Self-adjustment of Pressure Reducing Valves	Data management and Smart City servicesData management and Smart City services	 water distribution system, pressure reducing valve, pump as turbine, energy recovery Multi-reservoir System, Active Storage Capacity, Strategy Control, Prediction Model, Adaptability, Optimization, Artificial Neural Network Dynamic Topology, Water Distribution Networks, Resilience, Optimization Variable demand, booster station, variable speed driven pumps, duty operation point, EPANET Index model, Physical leakage flow, Pressure management, Pressure reduction test, Water head pressure reducing valve, pressurized pipes, transients





to Evaluate Energy Dynamics in Canadian Water Distribution Systems	management and Smart City services	indicators
Impact of Urban form on Energy Use in Water Distribution Systems at the Neighbourhood Level	Data management and Smart City services	Water distribution systems, urban form, energy use
Approximation of System Components for Pump Scheduling Optimisation	Data management and Smart City services	Pump Control, Optimisation, Branch and Bound
Pumping Pattern Optimization in Order to Reduce WDS Operation Costs	Data management and Smart City services	Optimal Pumping Patter, Genetic Algorithm, EPANET, Variable Speed Pumps, Energy Tariffs, Leakages
Expeditious Pump Rescheduling in Multisource Water Distribution Networks	Data management and Smart City services	Water distribution, Pump scheduling, Optimization, Multi-sources, Graph theory, Elementary districts
Direct and Indirect Water Supply: An Energy Assessment	Data management and Smart City services	Water and energy, energy savings, network layout, energy assessment
Energy Auditing as a Tool for Outlining Major Inefficiencies: Results from a Real Water Supply System	Data management and Smart City services	energy auditing, water-energy nexus, water losses, water supply systems, energy efficiency
A Decision Support Tool for Water and Energy Saving in the Integrated Water System	Data management and Smart City services	Energy saving, water losses, water supply system, decision support tool
Reliability of Harvested Rainfall as an Auxiliary Source of Non-potable Water	Water reuse and recycling	Rainwater harvesting, urban water supply, reliability, simulation
Heavy Rainfall Temporal Characterization in the Peri-Urban Solofrana River Basin, Southern Italy	Water reuse and recycling	heavy rainfall, intensity-duration- frequency, trend analysis, change point, Southern Italy
Analysis of Rainfall Events Driving MDHEs Occurred in the Solofrana River Basin, Southern Italy	Water reuse and recycling	
Simulation of the Partial Load Operation of an Urban Groundwater Well Field	Water reuse and recycling	Groundwater well field, partial load, variable speed driven pumps, orifice plates, EPANET
Three Dimensional Simulation of Seawater Intrusion in a Regional Coastal Aquifer in UAE	Sea Water	Numerical modelling, artificial recharge, seawater intrusion, treated wastewater
Trends in Water Quality in Laborec River, Slovakia	Quality of water	pollutants, sources of pollution, Mann- Kendall test
Climate Change in Urban Versus Rural Areas	Sustainable development, Circular Economy, &	Precipitation, temperature, trends





	Ecosystem services	
Sustainable Development of Storm- water Systems in African Cities Considering Climate Change	Sustainable development, Circular Economy, & Ecosystem services	Climate change impacts, adaptive planning, sustainable urban drainage systems, storm-water management, African cities
Resiliency Assessment Model	Quality of water	overall resiliency, pressure, flow, water quality, analytical hierarchy process, fuzzy set approach
Flexibility Ranking of Water Distribution System Designs Under Future Mechanical and Hydraulic Uncertainty	Water supply and distribution	Water distribution system, flexibility, uncertainty, reliability
Gondwana: A Generic Optimization Tool for Drinking Water Distribution Systems Design and Operation	Drinking water production	Optimization, DWDS, design, software
Different Design Criteria for District Metered Areas in Water Distribution Networks	Water supply and distribution	District Metered Areas design, Floyd- Warshall algorithm, Simulated Annealing
A Multicriteria Approach for a Phased Design of Water Distribution Networks	Water supply and distribution	Water distribution networks, multicriteria analysis, phased design, optimization
Graph-theoretic Surrogate Measures for Analysing the Resilience of Water Distribution Networks	Water supply and distribution	Water distribution systems, network resilience, graph theory, complex networks
Hydraulic Resilience Index for the Critical Link Analysis of Multi-feed Water Distribution Networks	Water supply and distribution	Resilience, Water Distribution Networks, Reserve Capacity, Dynamic Topology
Resilience and Vulnerability in Urban Water Distribution Networks through Network Theory and Hydraulic Simulation	Water supply and distribution	Network analysis, resilience, vulnerability, water distribution network
Sequence Analysis-based Hyper- heuristics for Water Distribution Network Optimisation	Water supply and distribution	Hyper-heuristic, Water Distribution Network, Hidden Markov Model
The Optimal Balance Point between NRW Reduction Measures, Full Water Costing and Water Pricing in Water Distribution Systems. Alternative Scenarios Forecasting the Kozani's WDS Optimal Balance Point	Water supply and distribution	Residential water demand, panel data, water price, elasticity of demand, full water cost
Predictive risk modelling of real- world wastewater network incidents	Water supply and distribution	Data mining, Wastewater, Networks, Blockages, Asset failure, Real-world
Probabilistic Analysis of the Retention Time in Stormwater Detention Facilities	Wastewater and storm water collection (including Flood	Probabilistic analysis, retention time, stormwater detention, pre-filling




	risk management)	
Optimal Placement of Water Quality Monitoring Stations in Sewer Systems: An Information Theory Approach	Quality of water	Information theory, Sewer systems, Monitoring stations, Entropy, Optimization, NSGA-II
ASM1-based Activated Sludge Model with Biopolymer Kinetics for Integrated Simulation of Membrane Bioreactors for Wastewater Treatment	Wastewater and storm water collection (including Flood risk management)	activated sludge model, MBR, identification, SMP, EPS
A Behavioural Membrane Fouling Model for Integrated Simulation of Membrane Bioreactors for Wastewater Treatment	Wastewater and storm water collection (including Flood risk management)	mathematical model, MBR, identification, irreversible fouling, reversible fouling
Interface Model between the Bioreactor and the Membrane in a Membrane Bioreactor for Wastewater Treatment	Wastewater and storm water collection (including Flood risk management)	activated sludge model, MBR, SMP, EPS
Framework for Technical Evaluation of Decision Support Systems Based on Water Smart Metering: The iWIDGET Case	Data management and Smart City services	behaviour change, consumers, smart metering, technical evaluation, water utilities
Adaptive Sampling for Wireless Household Water Consumption Monitoring	Data management and Smart City services	wireless sensing system, adaptive sampling, time series forecast
Implementation of OGC Compliant Framework for Data Integration in Water Distribution System	Water supply and distribution	Web Services, Data Integration, Ontology, Service Oriented Architecture, Hydraulic Information System
Application of HADOOP to Store and Process Big Data Gathered from an Urban Water Distribution System	Data management and Smart City services	Big data, Hadoop, Map Reduce, SQL, water distribution system
Water Use Disaggregation Based on Classification of Feature Vectors Extracted from Smart Meter Data	Data management and Smart City services	Water end-use disaggregation, extraction of features from time-series data, multicategory robust linear programming
A Benchmarking Model for Household Water Consumption Based on Adaptive Logic Networks	Data management and Smart City services	Household water consumption, Benchmarking, Socio-demographical factors, Adaptive Logic Networks
Model-based Monitoring Techniques for Leakage Localization in Distribution Water Networks	Water supply and distribution	Water Networks, Hydraulic Models, Leakage Localization, Optimal Sensor Placement, Pressure Sensor, Genetic Algorithm
Household Water Consumption: Insight from a Survey in Greece and	Data management and Smart City	Household water consumption, Consumer behaviour, Survey





Poland	services	
Forecasting Domestic Water Consumption from Smart Meter Readings Using Statistical Methods and Artificial Neural Networks	Data management and Smart City services	Smart water meters, domestic water consumption, prediction, artificial neural networks
Contamination Event Detection Using Multi-level Thresholds	Quality of water	Water Contamination Detection, Multi- Level Threshold, Fault Diagnosis
Exploring Patterns in Water Consumption by Clustering	Data management and Smart City services	Kohonen Self-Organized Maps (SOM), urban water demand, clustering algorithms, data mining, water consumption analysis
Psychosocial and Behavioural Factors Associated with Intention to Save Water Around the Home: A Greek Case Study	Data management and Smart City services	Household water saving, Theory of planned behaviour, Web survey, Linear regression
Correlation or not Correlation? This is the Question in Modelling Residential Water Demand Pulses	Data management and Smart City services	Water demand, demand pulses, intensity, duration, correlation

5.2 Water Distribution System Analysis Conference, Urban Water Hydroinformatics and Strategic Planning (WSDA)

The first WDSA conference was held in the USA in the 1999 (Tempe – Arizona) as a symposium within the ASCE Water Resources Planning and Management conference, aimed at presenting and publishing research in this field. Thereafter, the first independent WDSA conference was held in 2006 in Cincinnati (Ohio) and, since then, it was organized as a stand-alone conference each even year and as a symposium within the ASCE Environmental and Water Resources Institute (EWRI) conference each odd year. Previous editions of the WDSA conference were held at Kruger National Park (South Africa) in 2008, in Tucson (Arizona) in 2010 and in Adelaide (Australia) in 2012. Then WDSA2014 is the first time in Europe following the urgent need of the *old Continent* to effectively allocate investments for managing existing water distribution infrastructures.

The WDSA 2014 conference, whose main theme was "Urban Hydroinformatics and Strategic Planning", joined the best expertise on water distribution sector from all over the world to share new paradigms and solutions in such a challenging framework. It was attended by about 250 people and 220 papers were presented by authors coming from 42 countries, thus demonstrating the worldwide increasing interest to the urban hydraulic infrastructure management. The presentations were divided in 19 sections:

- Sustainable Resilient Water Infrastructures
- Intelligent Use of Energy in Water Distribution Systems
- Phasing the Development of Water Distribution Networks
- Water Distribution Network Modelling





- Urban Hydraulics and System Integration
- Water Quality
- Network Segmentation and Smart Management
- Modelling "Flows" in Water Infrastructure Asset Management
- Smart Water and ICT
- Pressure and Leakage
- Real-time Management of Smart Water Systems Using Big Data
- Water Demand Modelling and Forecasting
- Water Distribution Systems Modelling for Security Enhancements
- Aquifers as Subsurface Reservoirs for Drought Management
- Rainwater Harvesting and Water Reuse
- Transients in Pipe Systems
- Water Distribution Network Model Calibration
- Leakage Analysis and Management
- Water Resources Management

Table 19 16th Water Distribution System Analysis Conference, WDSA2014 Urban Water Hydroinformatics and

Strategic Planning

Title	Topics	Keywords
Battle of Background Leakage Assessment for Water Networks (BBLAWN) at WDSA Conference 2014	Water supply and distribution	Water Distribution Networks, Background Leakages, Asset Management, Pump Scheduling, Pressure Reduction Valves
A Comparison of Population-based Optimization Techniques for Water Distribution System Expansion and Operation	Water supply and distribution	Multiple Objective Optimization, Evolution Algorithms, Bblawn, Water Distribution Systems, Leakage
WDS Leakage Management through Pressure Control and Pipes Rehabilitation Using an Optimization Approach	Water supply and distribution	Water Distribution Systems, Leakage Control, Pressure Management, Rehabilitation Planning, Optimization
BBLAWN: A Combined Use of Best Management Practices and an Optimization Model Based on a Pseudo-Genetic Algorithm	Water supply and distribution	Background Leakage, Pressure Reducing Valves, Optimization, Genetic Algorithms
A Multi-step Approach for Optimal Design and Management of the C-Town Pipe Network Model	Water supply and distribution	Optimal Design, Leakage, Multi- Objective
Battle of Background Leakage Assessment for Water Networks Using Successive Linear Programing	Water supply and distribution	Water System, Optimal Operation, Pump Scheduling, Headloss, Pipe Diameter
Hierarchical Decomposition of Water Distribution Systems for Background Leakage	Water supply and distribution	Leackage Control, Clustering, Optimal pressure Control





Assessment		
A Simulation-Optimization Approach for Reducing Background Leakage in Water Systems	Water supply and distribution	Water Networks, Background Leakage, Optimization
Battle of Background Leakage Assessment for Water Networks (BBLAWN): An Incremental Savings Approach	Water supply and distribution	Water Distribution Systems, Design, Multi-Objective Optimization, Incremental Savings, Engineering Judgement
An Energy Based Methodology Applied to C- Town	Water supply and distribution	WDS, Leakages, Unit Headloss, Flow-Pressure, Valves, Genetic Algorithms
Guided Evolutionary Approaches for Redesigning Water Distribution Networks	Water supply and distribution	Evolutionary Algorithms, Leakage Assessment, Optimization, Water Supply, Water Losses
Sequential Multi-objective Evolutionary Algorithm for a Real-world Water Distribution System Design	Water supply and distribution	Water Distribution System, Sequential Multi-Objective, Leakage, Cost
WaterNetGen Helps C-Town	Water supply and distribution	WaterNetGen, Water Distribution Network Design, Water Losses, Pressure Management
Background Leakage Assessment for BBLAWN	Water supply and distribution	Water Distribution System, Leakages, Optimization
Evolutionary Computation-based Decision- making Framework for Designing Water Networks to Minimize Background Leakage	Water supply and distribution	Genetic Algorithm, Water Distribution System Design, Rehabilitation, Infrastructure Management
Online Model for Hydraulic and Water Quality Analysis in Hangzone Sonnenberg, Zurich	Quality of water	Online Modelling, Automation, Model Update, Maintenance Tool, Model Calibration, Water Quality, Water Age
Controlled, Realistic-scale, Experimental Study of How the Quantity and Erodibility of Discolouration Material Varies with Shear Strength	Quality of water	Discolouration, Turbidity, Biofilms, Biofouling, Modelling
Drinking Water Temperature Modelling in Domestic Systems	Quality of water	Drinking Water Quality, Temperature, Domestic Systems, Point-Of-Use, Simdeum
QMRA in the Drinking Water Distribution System	Drinking water production	QMRA, Drinking Water Distribution
The Relationship between Water Biostability and Initial Bacterial Growth Variations to Different Organic Carbon Concentrations	Quality of water	Water Biostability, ATP (Adenosine Triphosphate), Bacteria, AOC (Assimilable Organic Carbon), Toc (Total Organic Carbon)
Optimal Disinfection of Water Distribution	Drinking water	water Distribution Systems.





Networks Following a Contamination Event	production	Optimization, Water Quality, Disinfection
Multivariate Data Mining for Estimating the Rate of Discoloration Material Accumulation in Drinking Water Systems	Drinking water production	Material Accumulation, Discolouration, Turbidity, Operation And Maintenance Strategies, Evolutionary Polynomial Regression, Self- Organising Maps
Sensor Placement Methods for Contamination Detection in Water Distribution Networks: A Review	Quality of water	Critical Review ;Sensor Location, Sensor Placement, Water Security, Water Distribution Networks
Water Quality Supervision of Distribution Networks Based on Machine Learning Algorithms and Operator Feedback	Quality of water	Machine Learning, Time Series Analysis, Condition Monitoring
Optimal Operation of a Multi-quality Water Distribution System with Changing Turbidity and Salinity Levels in Source Reservoirs	Quality of water	Water Distribution Systems, Multi-Objective Optimisation, System Operation, Water Quality, Pumping Costs
Autonomous VPS-based Manganese Prediction System for Sub-tropical Water Reservoirs	Quality of water	Manganese, Water Quality Monitoring, Vertical Profiler System, Water Treatment, Water Reservoirs, Expert System, Forecasting
Using the Set Point Concept to Allow Water Distribution System Skeletonization Preserving Water Quality Constraints	Quality of water	Water Quality Model, Skeletonization, Optimization
Impacts of Large-demand Customer on Water Distribution System	Customer Relationship	Large-Demand Customer, Water Distribution System, Water Demand, Pressure, Turbidity
Rehabilitation Actions in Water Supply Systems: Effects on Biofilm Susceptibility	Quality of water	Biofilm, Drinking Water Distribution System, Data Mining, Multi-Agent Systems, Rehabilitation
Safeguarding Drinking Water: Use and Quality of Water, Case Study of Taranto Province	Drinking water production	Drinking Water, Quality, Monitoring Drinking Water
Enhanced Adaptive Control of Water Quality in Water Distribution Networks by Incorporating Abrupt Hydraulic Changes	Quality of water	Quality Control, Chlorine Regulation, Adaptive Control, Feedback Control
Multi Sources Water Supply System Optimal Control: A Case Study	Quality of water	Optimization, Water Quality, Desalination, Multi Source Supply
Modelling the Fate of Disinfection By- products in Water Distribution Systems	Drinking water production	Disinfection By-Products, Drinking Water, Water Distribution Network, Chlorate
WQNetXL: A MS-excel Water Quality System Tool for WDNs	Quality of water	Water Network Segmentation, Districtualization, Sectorization, Modularity Index, Infrastructure





		Segmentation
Theoretical Modelling of Pressure and Leakage in Water Distribution Systems	Water supply and distribution	Pressure, Leakage, Leakage Exponent, Leakage Number, Water Distribution Systems, Theory, Models, FAVAD
Estimating Area Leakage in Water Networks Based on Hydraulic Model and Asset Information	Water supply and distribution	Water Loss, Leakage Detection, Hydraulic Model, Risk Model, Optimisation
Dynamic Leakage: Physical Study of the Leak Behaviour of Longitudinal Slits in MDPE Pipe	Water supply and distribution	Leakage Management, Pressure Management, Viscoelasticity
Use of Torricelli's Equation for Describing Leakages in Pipes of Different Elastic Materials, Diameters and Orifice Shape and Dimensions	Water supply and distribution	Leakages, Cracks And Holes, Laboratory Experiments, Leakage-Pressure Relationship, Elastic Pipes
Experimental Investigation on a Buried Leaking Pipe	Water supply and distribution	Water Losses, Pipe Bursts, Leakage Law, Pressure Management, Soil Saturation
Water Leakage Evolution Based on GPR Interpretations	Water supply and distribution	Water Leakage Evolution, Ground Penetrating Radar, Water Supply Systems, Leak Visualization, GPR Interpretations
Experimental Setup to Examine Leakage Outflow in a Scaled Water Distribution Network	Water supply and distribution	Lab Model, Measurement Accuracies, Power Law, Orifice Equation, Leakage Exponent
Applying Pressure Management to Reduce Water Losses in Two Greek Cities' WDSs: Expectations, Problems, Results and Revisions	Water supply and distribution	Water Loss, Pressure Management, DMAS, PRVS
Simultaneous Multi-pipe Failure Impact on Reliability of Water Distribution Systems	Water supply and distribution	Water Distribution System, Multi-Criteria Decision Analysis, Reliability
A Surrogate Measure for Multi-Component Failure Based Reliability Analysis of Water Distribution Systems	Water supply and distribution	Water Distribution System, Surrogate Measure, Reliability
Robustness of the Drinking Water Distribution Network under Changing Future Demand	Drinking water production	Network Modelling, Scenario Approach, Drinking Water Distribution Systems, Future Water Demand, Simdeum
A New Approach to Urban Water Management: Safe and Sure	Water supply and distribution	Adaptation, Coping, Mitigation, Reliability, Resilience, Safety, Sustainability, Water Management
Water Distribution System Risk Assessment Method	Water supply and distribution	Risk Assessment, Sectorization, Urban Water Service Provision, Distribution Systems
Water Distribution System Performance Metrics	Water supply and distribution	Water Network Analysis, Energy Efficiency, Performance Index, Redundancy, Resilience





Upgrading Reliability of Water Distribution Networks Recognizing Valve Locations	Water supply and distribution	Design, Redundancy, Reliability, Segment Analysis, Water Distribution System
Why PRVs Tends to Oscillate at Low Flows	Water supply and distribution	Pressure Control, Pressure Reducing Valves, Stability, Nonlinear Systems
Fire Flow Capacity Analysis Based on Hydraulic Network Model	Water supply and distribution	Water Distribution System, Fire Flow, Hydraulic Model, Optimization, Reliability
Principal Component Analysis of Water Pipe Flow Data	Water supply and distribution	Flow Data, Outliers, Principal Component Analysis, Water Distribution System
A Random Forest Algorithm Applied to Condition-based Wastewater Deterioration Modelling and Forecasting	Wastewater and storm water collection (including Flood risk management)	Asset Management, Wastewater Systems, Condition Assessment, Deterioration, Decision Tree, Random Forest
A New Indicator for Real-time Leak Detection in Water Distribution Networks: Design and Simulation Validation	Water supply and distribution	Water Loss, Leakage Detection, Pressure Measurements, Data Analysis
Online Burst Detection in a Water Distribution System Using the Kalman Filter and Hydraulic Modelling	Water supply and distribution	Burst Detection Metric, District Metred Area, Kalman Filter, Water Distribution System, Water Demand Forecasting Model
Automated Water Balance Calculation for Water Distribution Systems	Water supply and distribution	Water Balance, Water Audit, Water Loss Management, Water Distribution
Making Water Systems Smarter Using M2M Technology	Data management and Smart City services	Big Data, Smart Grid, Data Management, Data Analytics, Machine-To-Machine Technology (M2M)
Water Distribution Operation Systems Based on Smart Meter and Sensor Network	Quality of water	Smart Meter, Water Quality Sensors, Water Distribution, Operation And Management
Use of Metamodels in Real-Time Operation of Water Distribution Systems	Water supply and distribution	Optimization, Real-Time Operation, Metamodelling, Water Distribution Systems
Real-Time Model of a Large-scale Water Distribution System	Water supply and distribution	Water Distribution Network, State Estimation, Real-Time, Nodal Demand
Leveraging Big Data to Improve Water System Operations	Data management and Smart City services	Big Data, Smart Grid, Data Management, Data Analytics, Machine-To-Machine Technology
Decentralized Real Time Control in Combined Sewer System by Using Smart Objects	Wastewater treatment (including recovery of resources)	Real-time Control, Combined Sewer Systems, Smart Gates, rainfall-runoff events detection





Contaminant Detection Using Multiple Conventional Water Quality Sensors in an Early Warning System	Quality of water	Multivariate Parameters, Conventional Water Quality Sensor, Contaminant Detection, Glyphosate
Cloud-based Decision Making in Water Distribution Systems	Data management and Smart City services	Cloud Computing, Water Distribution System Analysis, Decision Making, Multi- Objective Optimization
Real Time Control of Water Distribution Systems Using a Multi-criteria Decision- support Tool for Optimal Water Network Management - A Case Study	Water-energy nexus	Network Management, Miser Ps, Pump Scheduling, Energy Savings
Optimal Water System Operation Using Graph Theory Algorithms	Water supply and distribution	Graph Theory, Water System, Optimal Operation, Pump Scheduling, Headloss
Genetic Algorithm Optimization of Operational Costs and Greenhouse Gas Emissions for Water Distribution Systems	Water supply and distribution	Genetic Algorithm, Optimization, Pump Operation, Greenhouse Gas Emissions, Water Distribution Systems
Pumps Energy Consumption Based on New EU Legislation	Water-energy nexus	Pumps, Energy Consumption, Energy Efficiency, EU Legislation
Simple Visual Tool to Analyse Pump Battery Efficiencies for Various Pump Combinations	Water supply and distribution	Parallel Pumping, Variable Speed Drive, Optimization, Case Study
Design and Optimization of Small Hydropower Systems in Water Distribution Networks Based on 10-Years Simulation with Epanet2	Water supply and distribution	Long Time Simulation, Water Surplus, Optimization, Benefit- Cost Analysis
Experimental Study of Cross-flow Micro- turbines for Aqueduct Energy Recovery	Water-energy nexus	Cross-Flow, Banki-Michel, Turbines, Hydraulic Turbine Design, Hydraulic Testing, Hydraulic Lab
Tools for Energy Footprint Assessment in Urban Water Systems	Water-energy nexus	Energy Footprint, Energy Recovery, Intervention Assessment, Renewable Energy Generation, Urban Water Systems, Water Supply, Water- Energy Nexus
Energy Auditing as a Tool for Improving Service Efficiency of Water Supply Systems	Water-energy nexus	Energy Auditing, Energy Assessment, System Efficiency, Energy Efficiency Indices
Scenario Analysis for Optimization of Pumping Schedules in Complex Water Supply Systems Considering a Cost-risk Balancing Problem	Water Scarcity and droughts	Scenario Analysis Optimization, Pumping Schedules, Cost-Risk Balance
Optimal Water Supply System Management by Leakage Reduction and Energy Recovery	Water-energy nexus	Water Distribution Systems, Energy Production, Pump As Turbine (PAT), Pressure Reducing Valve (PRV)
Evaluation of PAT Performances by Modified	Water supply and	Pump As Turbine (PAT), Variable





Affinity Law	distribution	Operating Strategy (VOS), Turbomachinery Affinity Law, Sutter Parameters
A Control Valve for Energy Harvesting	Water-energy nexus	Energy Harvesting, Control Valve, Turbine, Water Supply, Energy Dissipation Recovery, Off-Grid Power
Extending the Control Volume Method to Unsteady Network Hydraulic Simulations	Water supply and distribution	Control-Volume Method, Global Gradient Algorithm, Transient
Analysis of Demand and Leakage Distributing Uniformly Along Pipes	Water supply and distribution	Demand, Leakage, Pressure- Dependent, Uniform Pipe Flow
Incorporating the FAVAD Leakage Equation into Water Distribution System Analysis	Water supply and distribution	Extended Period Simulation, Energy Minimisation, Leakage, FAVAD Model, Water Distribution System Analysis
Implementing ΔQ Method to Accelerate the Optimization of Pressurized Pipe Networks	Water supply and distribution	Acceleration, Genetic Algorithms, ΔQ Method, Efficiency, Looped Networks
Modelling Pressure Deficient Water Distribution Networks in EPANET	Water supply and distribution	Algorithms, Epanet, Modelling, Pressure-Deficient Network Analysis, Water Distribution, Water Pipelines
Pressure-dependent Demand and Leakage Modelling with an EPANET Extension - WaterNetGen	Water supply and distribution	Epanet, WaterNetGen, Demand- Driven Analysis, Pressure-Driven Analysis, Leakage
Demand Constructs for Risk Analysis	Water supply and distribution	Risk Analysis, Water Distribution, Catastrophic Failure, Epanet, Simulation, Demand Analysis
Artificial Neural Networks and Entropy-based Methods to Determine Pressure Distribution in Water Distribution Systems	Water supply and distribution	Water Distribution System, Water Demands, Scaling Laws, Artificial Neural Network, Entropy
Experimental Investigation for Local Tank Inflow Model	Water supply and distribution	Laboratory Tests, Float Valve, Local Tank Modelling
Leakage Calibration of Water Distribution Networks	Water supply and distribution	Water Distribution Systems. Leakage, Calibration
Model Calibration as a Tool for Leakage Identification in WDS: A Real Case Study	Water supply and distribution	Model Calibration, Network Analysis, Water Pipe Networks, Leakage
Determination of Water Distribution Network Resistance Coefficient and Hydraulic Capacity	Water supply and distribution	Water Distribution Network, Hydraulic Power, Hydraulic Efficiency, Surplus Power Factor
Calibration of Numerical Model of WDS in a Real Case	Water supply and distribution	Water Distribution System, Model Calibration, Optimization, Measured Data
Identification of Measurement Points for Calibration of Water Distribution Network	Water supply and distribution	Model Calibration, Network Analysis, Water Pipe Networks,





Models		Leakage
Real Water Network Comparative Calibration Studies Considering the Whole Process from Engineer's Perspective	Water supply and distribution	Hydraulic Network Model, Calibration, Genetic Algorithm, Levenberg-Marquardt, Optimization
Optimization of Drinking Water and Sewer Hydraulic Management: Coupling of a Genetic Algorithm and Two Network Hydraulic Tools	Drinking water production	Optimization, Hydraulic Modelling, Genetic Algorithms, Drinking Water System, Sewer System
Resilience-based Performance Assessment of Water-recycling Schemes in Urban Water Systems	Wastewater and storm water collection (including Flood risk management)	Resilience Index, Reliability, Urban Water System, Water Reuse Schemes, Rainwater Harvesting, Grey Water Recycling
Stability of Traditional Urban Water Systems - Integrated Assessment of Transitions Scenarios	Data management and Smart City services	Integrated Water System, Coupled Sewer And Water Supply Modelling, Virtual Infrastructure Benchmarking - Vibe
Cost Efficiency of Low Impact Development (LID) Stormwater Management Practices	Wastewater and storm water collection (including Flood risk management)	Low Impact Development, Land Development, Cost Efficiency
Selection of the Optimal Design Rainfall Return Period of Urban Drainage Systems	Wastewater and storm water collection (including Flood risk management)	Drainage System, Design Rainfall, Return Period, Construction Costs, Flooding, Expected Damages
SWMM5 Toolkit Development for Pollution Source Identification in Sewer Systems	Quality of water	Toolkit, Sewer System, Swmm5, Optimization Problems, Pollution Source
Porous Pavement Quality Modelling	Quality of water	Suds, Modelling, Porous Pavements, Tss, Swmm, K-C* Model, Efficiency
SITES - A Novel Approach for Controlling Combined Sewer Overflows	Wastewater treatment (including recovery of resources)	Innovation, Stormwater, Urban Areas, Combined Sewer Overflows, Resilient Infrastructure
Sustaining Irrigated Agriculture in Mediterranean Countries with Treated Municipal Wastewater: A Case Study	Sustainable development, Circular Economy, & Ecosystem services	Wastewater Reuse, Water Demand Management, Non- Potable Water, Disinfection, Filtration, Membrane Bioreactor
Climate Change and Stormwater Management Strategies in Tehran	Wastewater and storm water collection (including Flood risk management)	Climate Change, Stormwater Management, LARS-WG Model, Decision Making, Best Practices Management
Assessment of Modelling Structure and Data Availability Influence on Urban Flood Damage	Wastewater and storm water	Bayesian Model-Averaging, Flooding Damage Evaluation.





Modelling Uncertainty	collection (including Flood risk management)	Uncertainty Analysis
The Effect of Future Water Demand Reduction on WDS Rehabilitation Planning	Water supply and distribution	Water Distribution Systems, Water Conservation, Water Main Asset Rehabilitation Planning, Optimization, Demand Reduction
Sensitivity of Energy Use to Factors in Pipe Replacement Planning for a Large Water Distribution System	Water-energy nexus	Water Distribution Systems, Water Main Replacement, Energy Use, Pipe Breaks, Leakage, Sensitivity Analysis
Prioritization of Rehabilitation Areas for Urban Water Infrastructure. A Case Study	Water supply and distribution	Asset Management, Decision Making, Water Distribution
Development of Renovation Techniques for Medium and Large Diameter Water Transmission Pipes	Water supply and distribution	Rehabilitation, Water Pipes, Renovation Techniques, Lining
Network Design through the Phasing of Construction Approach	Water supply and distribution	Water Distribution Networks, Design, Multi-Objective Optimization, Phasing Of Construction
A Strategy for Real Options from Multi- objective Optimal Design	Water supply and distribution	Water Network Segmentation, Districtualization, Sectorization, Modularity Index, Infrastructure Segmentation
Optimal Design of Water Distribution Systems with Pressure Driven Demands	Water supply and distribution	Pressure-Driven Model, Optimal Design, Integer Linear Programming
Comparison of Flow-distribution Models for Design of Water Distribution Networks with Redundancy	Water supply and distribution	Design, Optimization, Redundancy, Reliability, Water Distribution Networks
Dealing with Uncertainty through Real Options for the Multi-objective Design of Water Distribution Networks	Water supply and distribution	Water Distribution Network, Uncertainty, Real Options, Simulated Annealing, Multi- Objective Optimization, Carbon Emissions
Robust Staged Development of Water Supply Systems	Sustainable development, Circular Economy, & Ecosystem services	Staged Development, Water Resource Management, Optimization, Robustness, Uncertainty, Sustainability, Climate Change
A Study on Economic Evaluation for Pipeline Renewal Using Contingent Valuation Method and Forecasting Pipeline Burst	Sustainable development, Circular Economy, & Ecosystem services	Pipeline Renewal, Economic Evaluation, Benefit-Cost Analysis, Contingent Valuation Method, Willingness To Pay
Optimization of Distribution Systems: Water Distribution System of Smolensk City Pilot District	Water supply and distribution	Innovation, Technology, Simulation, Inverter, Consumption, Device, Leakage,





		Reduction, Loss
Fractal-based Planning of Urban Water Distribution System in China	Water supply and distribution	Water Supply Network, District Planning, K-Means Algorithm, Level Analysis, Fractal Theory, Prim Algorithm
Assessment of the Predictive Uncertainty within the Framework of Water Demand Forecasting by Using the Model Conditional Processor	Water supply and distribution	Water Demand, Forecasting, Predictive Uncertainty
Multivariate Statistical Analysis for Water Demand Modelling	Water supply and distribution	Multivariate Analysis, Vine Copula, Water Demand Modelling
Studying a Hospital Distribution Network with a Stochastic End-uses Demand Model	Management of the water cycle in industry	Legionella, Hospital Water Demand, Stochastic Models
The Effect of Temporal Resolution on the Accuracy of Forecasting Models for Total System Demand	Water supply and distribution	Water Demand, Forecasting, Water Production, Time Series Models, Real-Time Estimation, Temporal Resolution
24-Hours Demand Forecasting Based on SARIMA and Support Vector Machines	Water supply and distribution	SARIMA, Support Vector Machine, Water Distribution Network, Water Demand, Prediction, Forecasting, Calibration
Study on Leakage Rate in Water Distribution Network Using Fast Independent Component Analysis	Water supply and distribution	Water Distribution Network, Water Consumption, Water Leakage, Leakage Simulation, Blind Source Separation, Fastica
The Overall Pulse Model to Predict the End User Water Demand	Water supply and distribution	Residential Water Demand, Time Series, Overall Pulse Model, Stochastic Process
Water Demand Projection in Distribution Systems Using a Novel Scenario Planning Approach	Water supply and distribution	Water Demand Projection, Water Distribution Systems, Scenario Planning, Regression Analysis
Forecasting the Residential Water Demand, Balancing Full Water Cost Pricing and Non- revenue Water Reduction Policies	Sustainable development, Circular Economy, & Ecosystem services	Residential Water Demand, Panel Data, Water Price, Elasticity Of Demand, Full Water Cost
Model for Estimating Domestic Outdoor Water Demand of Properties in Residential Estates	Water supply and distribution	Water Demand, End-Use, Model, Outdoor, Indoor
The Mixed Model for the Residential Flow Demand of a Small Number of Users	Water supply and distribution	Water Demand, Probabilistic Approach, Probability Of Null Water Request
In Defence of the Demand Pattern, a Software Approach	Water supply and distribution	Demand Pattern, Software, DMA, Flow Metering
Using Smart Meters for Household Water	Data management	Demand Management, Smart





Consumption Feedback: Knowns and Unknowns	and Smart City services	Technology, Water Meter, Feedback, Behaviour Change
Prioritizing Use Cases for Water Smart Technology Development: Similarities and Differences from Portugal and UK Case Studies	Water-energy nexus	Brainstorming, Use Cases Ranking, Use Cases Validation, Water Efficiency, Smart Water Management
Identifying Typical Urban Water Demand Patterns for a Reliable Short-term Forecasting - The ICeWATER Project Approach	Water supply and distribution	Urban Water Demand, Forecasting, Categorization, Pattern, Time Series Clustering, Support Vector Regression
Estimating Water Demands in Buildings	Management of the water cycle in industry	Peak Water Demand, Hunter's Curve, Monte Carlo Simulation, Dimensionless Design Chart
Urban Water Demand Forecasting for the Island of Skiathos	Water supply and distribution	Water Distribution Networks, Urban Water Demand, Forecasting, Time Series, Arima, Artificial Neural Networks
Dynamic Day-ahead Water Pricing Based on Smart Metering and Demand Prediction	Sustainable development, Circular Economy, & Ecosystem services	Day-Ahead Dynamic Water Pricing, Smart Metering, Convex Optimization
Smart Metering, Water Pricing and Social Media to Stimulate Residential Water Efficiency: Opportunities for the SmartH2O Project	Sustainable development, Circular Economy, & Ecosystem services	ICT For Water Management, Smart Meters For Water Consumption, Social Media And Water, Water Pricing Policies
DAIAD: Open Water Monitoring	Data management and Smart City services	Real Time Water Monitoring, Big Data, Interventions, Water Demand Management
Water Analytics and Intelligent Sensing for Demand Optimised Management: The WISDOM Vision and Approach	Water-energy nexus	Water Awareness, Monitoring And Management, User-Centred Predictive Platform, ICT
Interactive Water Services: The WATERNOMICS Approach	Data management and Smart City services	Interactive Water Services, Decision Support, Gamification, Linked Data, Fault Detection
Integrated Support System for Efficient Water Usage and Resources Management (ISS- EWATUS)	Data management and Smart City services	Saving Water, Decision Support Systems, Information Technology
Challenges and Benefits of an Open ICT\Architecture for Urban Water Management	Data management and Smart City services	Information Communication Technologies, Integration Platform, Integrated Water Management, Open Platform
Analytical Leakages Localization in Water Distribution Networks through Spectral Clustering and Support Vector MACHINES. The ICeWATER Approach	Water supply and distribution	Leakage Management, Leak Localization, Spectral Clustering, Support Vector Machine, Simulation
Contamination Event Detection in Water Distribution Systems Using a Model-based	Quality of water	Contamination Event Detection, Fault Diagnosis, Monte Carlo





Approach		Simulations, Adaptive Bounds
Towards an Enhanced Knowledge-based Decision Support System (DSS) for Integrated Water Resource Management (IWRM)	Data management and Smart City services	Knowledge Base, Decision Support System, Rule-Based Reasoning, Case-Based Reasoning, Water Management Ontology, Intelligent System
Smart Meters, Smart Water, Smart Societies: The iWIDGET Project	Sustainable development, Circular Economy, & Ecosystem services	Smart Meters, Water Efficiency, ICT, Water Distribution Systems, Water Demand, Water And Energy Nexus
An eLearning Approach for Improving Household Water Efficiency	Sustainable development, Circular Economy, & Ecosystem services	Smart Metering, Online Application, Online Education, Water Efficiency, Water Demand Management, Moodle Platform, E-Learning
Web Services for Water Systems: The iWIDGET REST API	Data management and Smart City services	Hydroinformatics, Web Services, Data Standards And Protocols
A Web-based Platform for Water Efficient Households	Data management and Smart City services	Smart Metering, Web Applications, ICT, Urban Water Management, Water-Energy Nexus, Analytics, End-User
Design and Performance of District Metering Areas in Water Distribution Systems	Water supply and distribution	District Metered Areas, Performance, Non-Dominated Solutions
Water Distribution Network Sectorization Using Structural Graph Partitioning and Multi- objective Optimization	Water supply and distribution	Water Distribution Network (WDN), District Metered Area (DMA), Graph Partitioning, Multiobjective Optimization, Nsga-li
Modularity Index for Hydraulic System Segmentation	Water supply and distribution	Water Network Segmentation, Districtualization, Sectorization, Modularity Index, Infrastructure Segmentation
Sensor Placement and Leakage Localization Considering Demand Uncertainties		Stochastic Modelling, Genetic Algorithm, Differential Evolution, Sensitivity Analysis, Leak Isolation, Fault Detection And Isolation, Monte Carlo Simulation
Segment-based Reliability/Supply Short Fall Analysis of Water Distribution Networks	Water supply and distribution	Reliability, Segment Analysis, Shortfall Analysis, Water Distribution System
Divide and Conquer Partitioning Techniques for Smart Water Networks	Quality of water	Water Network Partitioning, District Meter Areas, Graph Theory, Water Leakage, Smart Water Networks
Simplification of Water Distribution Network	Quality of water	Clustering, Water Distribution





Simulation by Topological Clustering - Investigation of its Potential Use in Copenhagen's Water Supply Monitoring and Contamination Contingency Plans		Network Simplification, Monitoring, Sampling, Graph Theory
Identifying the High-level Flow Model of Water Distribution Networks Using Graph Theory	Water supply and distribution	WDN, Graph Theory, Primary Network, Simplification, Algorithms, Igraph
Automatic Multi-objective Sectorization of a Water Distribution Network		District Metered Areas, Water Distribution Network Sectorization, Multi-Objective Optimization, Pressure Management, Water Losses
Water Supply Network Sectorization Based on Social Networks Community Detection Algorithms	Water supply and distribution	Water Supply Networks, Sectorization, Social Networks, Community Detection, Resilience
Comparison of WDN Segmentations Based on Modularity Indexes	Water supply and distribution	Disinfection By-Products, Drinking Water, Water Distribution Network, Chlorate
The Dependence of District Minimum Night Flow on Pressure Head: The Case Study of Lenola	Water supply and distribution	Leak, Leak Exponent, Minimum Night Flow
Aquifer Characterization and Monitoring by Active and Passive Seismic Surveys	Water supply and distribution	Aquifers, Monitoring, Seismic, Elastic Inversion, Tomography, Ambient Noise
Monitoring Aquifer Quality for Artificial Recharge within the WARBO Project	Quality of water	Artificial Recharge Of Aquifers, Biodiversity, Macroinvertebrate Community, Temperature, Phytodepuration
Artificial Recharge of Phreatic Aquifer in the Mereto Di Tomba Area (Upper Friuli Plain)	Water reuse and recycling	Water Reborn Techniques, Phreatic Aquifer, Geophysical And Hydrogeological Studies, Finite Element Three- Dimensional Variably-Saturated Flow Model, Upper Friuli Plain
Geophysical Methods as Support to Aquifer Recharge	Water reuse and recycling	GPR, Seismic, ERT, Aquifer Recharge, Hydrogeology
Data-driven modelling of the Dynamic Response of a Large Deep Karst Aquifer	Water supply and distribution	Data-Driven, Karst Aquifer, Water Table, Dynamic Response, EPR
Optimal Management of the Jucar River and Turia River Basins under Uncertain Drought Conditions	River Basin Management	Optimization, Risk Assessment, Drought, Water Resources Planning And Management, Aquatool
LES and DNS Simulations of Imperfect Mixing for Double-tee Junctions	Wastewater and storm water collection (including Flood risk management)	Transport Model, CFD, LES, DNS, Imperfect Mixing, Double-Tee Junction





Improved Real-time Monitoring and Control of Water Supply Networks by Use of Graph Decomposition	Water supply and distribution	Real-Time Monitoring, Graph Decomposition, Network Simplification, Inverse Problems, Adaptivity
Smart Grid for Optimal Provider-consumer Collaboration	Data management and Smart City services	Water Distribution Systems, Smart Grid
An Energy Approach to Studying Pipe Network Transients	Water-energy nexus	Water Hammer, Hydraulic Transients, Pipe Networks, Energy Analysis
Experimental Quantification of Intrusion Due to Transients in Distribution Systems	Drinking water production	Contaminant Intrusion, Water Distribution Systems, Transients, Intrusion, Negative Pressures
Experimental Investigation of Wave Scattering Effect of Pipe Blockages on Transient Analysis	Water supply and distribution	Experimental Verification, Pipe Blockage, Transient Analysis, Wave Scattering, Wave Propagation
Effect of Uncertainty Demand Location on Transient behaviour of WDS	Customer Relationship	Customer Demand, Water Distribution System, Pressure Transient, Water Hammer, Pipe Network, Lagrangian Model
Bi-level Optimization of Closed Surge Tanks Placement and Sizing in Water Distribution System Subjected to Transient Events	Water supply and distribution	Hydraulic Transient, Optimization, Surge Tank, Genetic Algorithm, Bi-Level Optimization
Condition Assessment in Hydraulically Noisy Pipeline Systems Using a Pressure Wave Splitting Method	Water supply and distribution	Hydraulic Transients, Pipeline Condition Assessment
Transmission Main Survey by Transient Tests: The Case of Villanova Plan in Mantova (I)	Water supply and distribution	Transients, Field Tests, Water Distribution System, Wavelet Transform, Lagrangian Model
Inverse Transient Analysis for a Branched Pipeline System with Leakage and Blockage Using Impedance Method	Water supply and distribution	Branched Pipeline System, Inverse Transient Analysis, Leakage
PIV Characterization of Transient Flow in Pipe Coils	Water supply and distribution	PIV, Water Hammer, Velocity Profiles, Wall Shear Stress
A Non-oscillatory Preissmann Slot Method Based Numerical Model	Water supply and distribution	Transient Mixed Flow, Preissmann Slot Method, Numerical Instability, Numerical Viscosity, Approximate Riemann Solution
Dynamic Metabolism modelling as a Decision- Support Tool for Urban Water Utilities Applied to the Upstream of the Water System in Oslo, Norway	Management of the water cycle in industry	Dynamic modelling, Urban Metabolism, Water Treatment, Water Supply, Water Distribution
Life Cycle Energy and GHG Emission within the Turin Metropolitan Area Urban Water	Water-energy nexus	Urban Water And Wastewater, Life Cycle Assessment, Energy





Cycle		Consumption, Greenhouse Gas Emission
Mechanistic, Probabilistic Model to Estimate the Factor of Safety of Large-diameter Cast Iron Water Mains: Sensitivity Analysis	Water supply and distribution	Water Mains, Cast Iron, Factor Of Safety, Sensitivity Analysis, Monte Carlo Simulation, Reliability
Using Wireless Vibration Monitoring to Enable Condition-based Maintenance of Rotating Machinery in the Water and Wastewater Industries	Management of the water cycle in industry	Wireless Sensor Networks, Wireless Instrumentation, Condition-Based Maintenance, Real-Time Monitoring, Asset Management
Estimation of the Efficiency for Variable Speed Pumps in EPANET Compared with Experimental Data	Water supply and distribution	Variable Speed Pumps, Epanet, Affinity Laws, Efficiency, Pump Curves
Comparative Study of Intake and Exhaust Air Flows of Different Commercial Air Valves	Water supply and distribution	Air Valves, Test Bench, Entrapped Air, Air Flow Curves, Laboratory
The Assessment of the Technical Condition of the Water Distribution Systems	Water supply and distribution	Water Infrastructure, Asset Management, Technical Audit, Renewal
Infrastructure Value Index: A Powerful Modelling Tool for Combined Long-term Planning of Linear and Vertical Assets	Sustainable development, Circular Economy, & Ecosystem services	Long-Term Planning, Asset Management, Vertical And Linear Assets, Rehabilitation, Investment Planning
Mains Condition Assessment by Echopulse, a Validation of Results	Water supply and distribution	Drinking Water Mains, Condition Assessment, Acoustic Inspection, Validation
Identification of Buried Pipes Using Thermal Images and Data Mining	Water supply and distribution	Thermographic Imaging, Temperature, Cost Lowering, Pipes, Water Distribution Systems
Analysing SCADA to Understand the Contribution of Hydraulic Pressures to Trunk- main Failure	Water supply and distribution	Pipe Failure, SCADA, Multiple Lines Of Evidence, Mode Of Failure, Pump Off Peak
Evaluating Infrastructure Alternatives for Regional Water Supply Systems by Model- assisted Cost-benefit Analysis - A Case Study from Apulia, Italy	Water supply and distribution	Regional Water Supply Systems, Cost-Benefit Analysis, Simulation, Reliability
Water Accounts and Water Stress Indexes in the European Context of Water Planning: The Jucar River Basin	Sustainable development, Circular Economy, & Ecosystem services	Jucar River Basin, Water Availability, Drought Indexes, Exploitable Water Resources
Risk and Reliability Analysis of Open Reservoir Water Shortages Using Optimization	Wastewater and storm water collection (including Flood risk management)	Risk, Reliability, Water Resources, Open Reservoir, Reservoir Operation, Genetic Algorithm, Non-Dominated Shorting Genetic Algorithm,





		Nsga li, Water Demand, Water Shortage
Using Predictive Model of Mean Monthly Flows for Large Open Reservoirs Hydropower Control	Water reuse and recycling	Adaptive, Evolution Algorithms, Hydropower Function, Large Open Reservoir, Operative Control, Optimization, Predictive Model
Probabilistic modelling of Rainwater Tanks	Wastewater and storm water collection (including Flood risk management)	Rainwater Tanks, Probabilistic modelling
Rainwater Harvesting, Risk Assessment and Utilization in Kosice-city, Slovakia	Wastewater and storm water collection (including Flood risk management)	Rainwater Management, Rainwater Harvesting, Urban Water Cycle, Risk Assessment, Sustainability, AHP
Potential for Peak Flow Reduction by Rainwater Harvesting Tanks	Wastewater and storm water collection (including Flood risk management)	Rainwater Harvesting, Rainwater Tanks, Peak Flow Reduction
Rainwater Management in Compliance with Sustainable Design of Buildings	Wastewater and storm water collection (including Flood risk management)	Rainwater Management, Rainwater Harvesting, Sustainable Urban Drainage
Water-harvesting Tradition in Syrian Steppe	Sustainable development, Circular Economy, & Ecosystem services	Syrian Steppe, Irrigation Systems, Hydraulic Works, Roman Technology
The Concept of Rainwater Management in Area of Kosice Region	Wastewater and storm water collection (including Flood risk management)	Urban Drainage, Rainwater Management, Infiltration, Percolation
Applying the FAVAD Concept and Leakage Number to Real Networks: A Case Study in Kwadabeka, South Africa	Water supply and distribution	Pressure, Leakage, Leakage Number, FAVAD
Losses Identification in Uncalibrated Water Distribution Networks: A Case Study	Water supply and distribution	Leakage Assessment, Data Assimilation, Water Distribution Network, Calibration
Robustness Analysis of Sensor Placement for Leak Detection and Location under Uncertain Operating Conditions	Water supply and distribution	Sensor Placement, Leak Location, Clustering, Robustness Analysis
Methodology for Leakage Isolation Using Pressure Sensitivity and Correlation Analysis in Water Distribution Systems	Water supply and distribution	Water Distribution Systems, Pressure Sensitivity, Leakage Localization, Sensor Placement
Research on an Optimized Leakage Locating Model in Water Distribution System	Water supply and distribution	Leakage Locating, Genetic Algorithms, Bayesian Decision Theory, Water Distribution





		Networks, Model Calibration
Reducing Uncertainty of Infrastructure Leakage Index - A Case Study	Water supply and distribution	Water Distribution Systems, Performance Indicators, Pi,
		Uncertainty, III





6. Reports and White Papers

Title: ICT as an enabler for smart water management	Date:2011	
Authors: Venkatesen Mauree	Institution: ITU Telecommunication Standardization Bureau	
URL: http://www.itu.int/dms_pub/itu-t/oth/23/01/T23	010000100003PDFE.pdf	
Tags: ICT for water, Smart water management		
Topic: Data management and Smart City services		
Abstract:		
Smart water management has become a key policy issue for the 21st century, as a growing number of factors are impacting the delivery of already scarce fresh water to millions of people. Economic growth		

seasonal climatic conditions and rising population are all affecting availability of water resources. Moreover, a number of effects linked to climate change, such as lengthy droughts and extreme weather events, are worsening the situation.

This ITU-T Technology Watch Report provides an overview of how ICT can be a strategic enabler for smart water management policies and surveys upcoming ICT standards that will enable smart water initiatives.

Title: Can we make water systems smarter?	Date:2013	
Authors: Paul F. Boulos and Amanda Wiley	Institution: Innovyze	
URL: http://innovyze.com/news/showcases/SmartWaterNetworks.pdf		
Tags: Smart water systems, Smart water, ICT for w	ater	
Topic: Data management and Smart City services		
Abstract:		
Pecent advances in smart water network techno	loav have armed control room operators with a	

Recent advances in smart water network technology have armed control room operators with a comprehensive set of decision-making capabilities that position operators as a major force for system

improvement, regulatory compliance, and financial planning.

Title: Making Wastewater Systems Smarter	Date:2013	
Authors: Paul F. Boulos	Institution: Innovyze	
URL: http://www.innovyze.com/news/published_research/MakingWastewaterSystemsSmarter.pdf		
Tags: Smart Water Systems, ICT for Water, Watewater		
Topic: Data management and Smart City services		
Abstract:		
The US wastewater infrastructure is aging. One s system performance - is helping utility operators b	solution - using smart water networks to optimize become more proactive in sewer collection-system	

management and control.





Title: Smartwater for a healthy economy	Date:2013	
Authors: Global Water Technologies	Institution: Global Water Technologies	
URL: http://www.gwtr.com/smart_water_for_Indiana.pdf		
Tags: Smart Water, ICT for Water, smart water distribution		
Topic: Data management and Smart City services		
Abstract:		

Indiana is uniquely positioned to benefit from an emerging new technology sector: smart water distribution, which combines sensors and software with data analytics to reduce loss and improve efficiency in drinking water systems. The following information has been prepared by Global Water Technologies to outline the opportunities available to our state and encourage immediate action and collaboration among its public and private sectors to realize these opportunities. A combination of recent efforts with in the state and Great Lakes region and a growing national awareness of water infrastructure needs make this the perfect time for Indiana to launch a living laboratory for new water technologies... and to prepare for federal funding opportunities that are likely to facilitate public - private investment for such pilot projects across the country.

Title: Using ICT For Monitoring Rural Water Services: From Dara To Action	Date:2013
Authors: Nicolas Dickinson and Kristof Bostoen	Institution: IRC International Water and Sanitation Centre
URL: http://www.ircwash.org/sites/default/files/wp4_	ict_monitoring.pdf
Tags: ICT for water, monitoring, water services	
Topic: Data management and Smart City services	
Abstract:	
Information and communication technology (ICT) has	as the potential to help improve rural water supplies

Information and communication technology (ICT) has the potential to help improve rural water supplies and address the systemic problems faced by the sector, but until now, this potential has remained largely untapped in many developing countries. Although access to rural drinking water supplies has improved, with more than two billion people gaining access to improved drinking water sources between 1990 and 2010, keeping these water supplies running is becoming difficult. Information delivered at the right time and place can make the difference between a rural water supply that remains broken and unused for years and a water service with little interruption. ICT has led innovations in other service sectors such as health but is often poorly resourced in the rural areas, and in the water sector in particular. Information systems are often available only for specific projects or in limited administrative areas, for example.





Title: Water20/20: Bringing Sr Networks Into Focus	mart Water D	Date:2012			
Authors: SENSUS	Ir	nstitution: SENSUS			
URL: <u>http://sensus.com/documents/10157/1577608/Sensus_Water2020-USweb.pdf/d67d0a75-255a-4a20-86f1-d4548bfcdf78</u>					
Tags: Smart Water, ICT for water					
Topic: Data management and Smart City services					
Abstract:					
Smart water networks can save utilities across the globe up to \$12.5 billion a year according to research commissioned by Sensus.					
A smart water network is an integrated set of products, solutions and systems that enable utilities to remotely and continuously monitor and diagnose problems, prioritize and manage maintenance issues and use data to optimize all aspects of the water distribution network.					
Improvements in system performance, such as leakage and pressure management, and network operations and water quality monitoring, coupled with informed decision making about the allocation of capital expenditures can stimulate dramatic savings when driven by real-time data that a smart water network provides.					

The findings, published in Water 20/20: Bringing Smart Water Networks Into Focus, provide insight from more than 180 utilities worldwide. Download your copy now.

Title: Information Technology Today and Tomorrow For Managing Water Resources	Date:2011			
Authors: Paul D. Campbell	Institution: Campbell Scientific, Inc			
URL: http://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1129&context=jcwre				
Tags: ICT for water, smart water management				
Topic: Data management and Smart City services				
Abstract:				
From wireless communication to the Internet, the information age with advanced digital electronics and				

sophisticated software offers a plethora of tools for water resources managers. Let us review "state of the art" technology now available, problems and priorities for equipment suppliers, and speculate where future developments may take us.





Title: Smart Water Systems	Date:2011			
Authors: Hope, R., Foster, T., Money, A., Rouse, M. , Money, N. and Thomas, M	Institution: Oxford University			
URL: http://r4d.dfid.gov.uk/PDF/Outputs/Water/SmartWaterSystems_FinalReport- Main%28Reduced%29_April2011.pdf				
Tags: Smart Water Systems, ICT for Water				
Topic: Data management and Smart City services				
Abstract:				
Smart Water Systems (SWS) present a new appr significant future risks from population growth, intensifying water allocation demands across wa Strategic and transparent water resource decision This is in turn contingent upon the accurate, tim	oach to promote water security with uncertain but hydrological variability and extreme events, and ter supply, agriculture, industry and ecosystems. making is central for water security to be achieved. elv and reliable collection and communication of			

This is in turn contingent upon the accurate, timely and reliable collection and communication of information relating to water abstractions and use, and the primary resource base. With mobile networks expanding globally across national territories, SWS offer a mechanism to capture and communicate data on water resources through hydroinformatics systems on abstraction from surface water and groundwater, soil moisture content, storage levels and network leaks or theft. Within a new architecture of accurate, integrated and timely water resource data, water risks can be reduced and water security enhanced.

Title: Smart Water Pilot Study Report	Date:2011			
Authors: Milind Naphade Institution: IBM Research				
URL: http://www.cityofdubuque.org/DocumentCenter/Home/View/3116				
Tags: Smart Water, ICT for Water				
Topic: Data management and Smart City services				
••• · · · ·				

Abstract:

The pilot leveraged increment read data of smart water meter from Neptune Technology Group and used information including weather, demographics, and household characteristics. IBM Research created a portal that allowed volunteer households to understand their water consumption in near real-time, be alerted about potential anomalies and leaks, get a better understanding of their consumption patterns, compare and contrast it with others in the community, participate in games and competitions aimed at promoting sustainable behaviour and therefore get fully engaged and informed about their consumption and the impact of the changes they made to it. Using cloud computing to deliver this portal as a web-based service, IBM Research experimented with various ways to get households to understand the impact of their actions on consumption. IBM Research leveraged IBM Smarter City Sustainability Model to create this service for the Dubuque households participating in the pilot. IBM Smarter City Sustainability Model is a solution that allows for rapid integration of disparate sources of sensor data, business intelligence, and business analytics that allow decision support for multiple stakeholders and an engagement mechanism for interacting with the stakeholders. Care was taken to protect individual privacy. All data collected and used were de-identified. Each pilot household was identified only by an anonymous unique ID.





Title: Blue Book 2: Technology Road Mapping	Date:2010			
Authors: Céline Hervé-Bazin	Institution: ACQUEAU			
URL: http://www.acqueau.eu/s/ACQ-Blue-Book-part-2.pdf				
Tags: Technology roadmap				
Topic: Data management and Smart City services				
Abstract:				
The technological areas and major programmes of ACQUEAU have been selected from the societal, economic and technological needs. Experts selected the projects from such key drivers for the water				

economic and technological needs. Experts selected the projects from such key drivers for the water sector as public health, the environment, cost reduction, regulation and technological breakthroughs. Based on this work and expertise, ACQUEAU will support projects that contribute to the implementation of its strategy and the development of new market solutions for water applications.





7. Conclusions and Future Work

The collected literature covers major of the topics presented at the beginning of this document, however, as the literature review has been focused in ICT applied to the water sector, there are some topics which are more represented than others. This graphics, are not complete, as more iterations in literature collection are going to be done. However, these are the results at the moment.



Figure 18 Topics coverage in 2014



Figure 19 Topics coverage in 2015





Another important thing to remark, is the majority of Open Access (or freely available) and sources of information. This issue is being heavily supported by the EC, making research results having a greater impact in citizen and industry.

Other interesting graphics to analyse are the kind of topics used on each type of publication.



Figure 20 Topics in Books



Figure 21Topics in Book chapters







Figure 22 Topics in Conference papers



Figure 23 Topics in EU funded projects



Figure 24 Topics in Journal papers

The previous graphics denote how all EU funded projects publications are Open Access, following EC principles and recommendations. However, Journal papers are the ones with more restrictive access. Conference papers covered in this study are free available in their vast majority.



Figure 25 Tag cloud





This cloud tag graphic represents the most used tags in the keywords of ICT for Water related publications. Predictably, water is the most common keyword, but words as network, distribution and management represent important trends too. Other terms include demand and sensor. A first conclusion from this study is the evidence of the interest on the projects and the publications in general in the smart management of water demand and distribution systems and, as normal, the suitability of sensors in these tasks.





8. References

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9. Annex I: WIDEST Thematic Areas

Table 20 WIDEST Thematic Areas

WIDEST Thematic Areas	EIP Water	EU	Water Technology Companies
Drinking water production	Water and wastewater treatment, (including recovery of resources	Drinking water	Drinking water production
Quality of water			Quality of water
Wastewater treatment (including recovery of		Water pollution	Wastewater treatment
resources)			Recovery of resources
Water reuse and recycling	Water reuse and recycling	Blueprint	Water reuse and recycling
Water-energy nexus	Water-energy nexus		Energy recovery
Water supply and distribution			Water supply and distribution
Wastewater and storm water collection (including Flood risk management)	Flood and drought risk management	Flood Risk Management	Wastewater and storm water collection
Water Scarcity and droughts		Water Scarcity and Droughts	
Sustainable development, Circular Economy & Ecosystem services	Ecosystem services		Sustainable development
River Basin Management		River Basin Management	
Sea Water		Bathing Water	
Data management and Smart City services			Data management and Smart City services
Customer Relationship			Customer Relationship
Management of the water cycle in industry			Management of the water cycle in industry