HIC 2018
13TH INTERNATIONAL CONFERENCE ON HYDROINFORMATICS

The HIC 2018 Special sessions

(updated on February 2018)

S1. Data Assimilation of spatial information for hydrologic and hydraulic models

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Description of the session
The session is focused on advanced Data Assimilation technics used into hydrologic and hydraulic models. In particular, the use of satellite observations will be particularly addressed, alone or in combination with ancillary and/or in-situ data.
The availability of observations of continental water bodies (rivers and lakes) from space has been increasing during the last decade. Recent altimetry missions such as Envisat, Jason 2 & 3, Saral, Sentinel 3A and Cryosat, have already proven to be of sufficient quality to be used in complement of in-situ data to develop, calibrate and use hydrologic and/or hydraulics models. One main interest raising challenging issues is linked to the estimation of river discharges. Future satellite missions such as SWOT (Surface Water and Ocean Topography) are also already studied and are expected to provide better observations in terms of quantity (spatial density and temporal frequency) and quality (reduced uncertainties). The session aims at describing methodologies, tools and applications of such spatial data in combination with hydrologic and hydraulic models in the so-called Data Assimilation framework.

S2. Complex Network Theory and Applications to Water Systems

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Description of the session

Complex Network Theory (CNT) in the last decades has become one of the most powerful tool to study, describe, and understand the world. CNT allows the study and interpretation of a huge number of systems, e.g., physical, social, infrastructural, since the most part of them works as network. These systems are represented by networks made of multiple interconnected components (nodes and links) structured in complex configurations in which the network behavior is largely affected by the structure, depending on organizational complexity and level of interaction among the components. Research in the field of complex networks and their structural properties has grown rapidly. Novel approaches, metrics and theories to explore and understand network features have been proposed, and although each network exhibits its own topological and structural peculiarities, apparently very different networks share amazing similar features.

Several studies about CNT have focused on understanding the behavior of infrastructure networks, such as road, energy, water distribution networks (WDNs), etc. and their susceptibility to damage. WDNs are infrastructure networks, whose topology is constrained by external environmental factors, e.g. streets and buildings, which drive their planning and construction. This fact imposes severe limitations on network connectivity and layout, and hence WDNs are studied differently from other complex networks. In the last decade, the study of WDNs using the CNT has grown rapidly and has attracted many researchers.

The proposed session aims at showing CNT concepts looking at their application and usefulness for WDNs analysis, planning and management. From the definition of the network connectivity structure, to the evaluation of vulnerability, robustness and reliability, to the optimal segmentation and districtualization of WDNs with respect to topology and asset characteristics, as well as any other issues, the proposed session would present, highlight and summarize the benefits that CNT use brought to the WDNs applications.

A collateral aim is to provide new research perspectives for specialists in WDNs analysis, also favoring the interaction with CNT specialists.

S3. Climate change impacts on urban water systems: flooding forecasting and warning (updated)

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Albert Chen, Centre for Water Systems, University of Exeter, Exeter, UK
Jorge Leandro, Lehrstuhl für Hydrologie und Flussgebietsmanagement, Technische Universität München, Germany

Description of the session
Urban water systems are particularly vulnerable to both rapid population growth and climate change. Climate change can also bring about increased variability. The effects of climate variability on various meteorological variables have been extensively observed in many regions around the world. Atmospheric circulation, topography, land use and other regional features modify global changes to produce unique patterns of change at the regional scale. As the future changes to urban water systems cannot be measured in the present, hydrological models are critical in the planning required to adapt our management strategies to future climate conditions.

In the presence of climate change induced uncertainty, urban water systems need to be more resilient and multi-sourced. For example, decreasing volumetric rainfall trends have an effect on reservoir yield and operation practices, while severe intensity rainfall events can cause failure of drainage system capacity and subsequent urban flood inundation problems. Policy makers, end users and researchers need to work together to develop a consistent approach to interpreting the effects of climate variability and change on water resources.

This Special Session on *Climate Change Impacts on Urban Water Systems* will include papers by international experts who have investigated climate change impacts on a variety of urban water systems, including water supply systems, urban drainage systems and water sensitive urban design systems. It will allow experts from across the world to jointly explore the various issues and challenges facing various communities in dealing with climate change impact assessment and adaptation for urban water systems.

Urban floods have long been considered as inevitable natural disasters. Continuously increasing urbanization has escalated flood risk whereas the recent technological advancement could support various new strategies to predict and manage this risk.

Most of the urban drainage networks are aging and have been designed to manage a maximum rainfall, or so-called design rainfall, which refers to a design return period (usually between 1 to 30 years).
Under the climate change and urban growth circumstances, most existing urban drainage networks (both surface and subsurface) are struggling to convey the runoff resulting from more frequent extreme weather events in urban areas.
Thus, being able to forecast flooding is one of the main issues of integrated flood risk management. Various flood forecasting systems have been developed and applied using a large range of advanced tools and some as part of integrated decision support systems. This session will invite leading experts to share their latest research development in urban flood forecasting. The topics will include the innovative technologies for weather monitoring, the integration of flood models with real time observations and numerical weather predictions, the enhanced performance of hydrologic and hydraulic modelling, the application of flood warning systems, etc..

S4. Integrated use of the water reservoirs

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Co-conveners
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Daisuke Nohara, DPRI, Kyoto University, Gokasho, Japan

Description of the session

The session takes reports dedicated to scientific development of approach to river flow regulation by water reservoir.
The role of reservoirs in human life and in the safety of people has increased significantly over the last century. The area of all reservoirs of the world exceeds the area of such countries as France, Spain, etc. The water areas of the reservoirs have an impact on the changes in water balance elements and climatic characteristics of the surrounding area. Currently, there are new technologies and experiences of their application (neural networks, geoinfomatic technologies, etc.) that expand the possibilities of studying, modeling processes and obtaining positive effects in the regulation of reservoir flow. Any positive scientific achievement and dissemination of experience of theory and practice in this field gives an economic effect or increases the safety of the population.
Among possible expected outcomes: the new methods and models for river flow regulation by water reservoir which should allow to produce water reservoir control more profitably and safely and to give evaluation of the impact at environmental. In particularly, the new methodical approaches and methods for the safe and profitable control floods by water reservoirs: mathematical models of routing through spillways and the downstream of the dam; stochastic models of levels and water drafts of water reservoirs during floods; dam-break flood risk assessment etc. The catastrophic floods occur in the world every year. Regulation of river flow by water reservoir can mitigate flood disasters.

S5. IA techniques for Smart Water Systems: Smart Sensors, Smart networks and Serious Gaming (updated)

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Description of the session
Water systems provide vitally resource for human societies, and constitute an important vector for their development. The water is a sustainable resource that has to be preserved and managed efficiently. This resource has to be fairly shared between uses as drinking water, irrigation, industry and transport. In addition, sewer networks have also to be considered amongst water systems. The water system management in a global change context with an expected population growth will be more challenging in next years. Hence, new techniques and methodologies for the optimal water resource management have to be designed. These techniques will be dedicated to large scale and complex water systems, will deal with multi-criteria often antagonistic and have to take into account economic aspects linked to transport, water cost and electricity consumption due controlled devices (pumps, gates, etc.). Techniques from Artificial Intelligent and Operation Research are nowadays sufficiently mature to develop intelligent system in an industrial context and seem suitable to address challenges of Smart Water Systems. Possible contributions include but are not limited to:

- distributed AI for smart water systems, including multi-agent based control and holonic control,
- exact optimization and metaheuristics for cost reduction of water transport,
- planning approach for water management,
- use of stochastic approach to deal with uncertainties in water systems,
- Bayesian networks for sustainable management of water resource,
- consensus decision process for water resource management,
- neural networks and similar learning approaches for extreme event impact prediction (drought, …),

The objective of this invited session is to share the knowledge, to exchange experience and to discuss about new contributions on intelligent approaches for smart water systems.

ICT4WATER is a cluster of 27 EU funded research projects linked also to the SWAN EIP Water Action group (https://www.eip-water.eu/CTRL_SWAN). ICT for water management and water efficiency is the key common theme for all the projects and the Action Group, as a policy issue with potential for new research areas that includes decision supporting system for the

measurement of water quality and quantity including the recycling and water reuse processes. Under the patronage of DG Connect and EIP Water, we meet in special sessions every year presenting the latest cutting-edge techniques, results and research outcomes, reflecting the research fields in the wider domain of "ICT and Water" funded and promoted by the EC.
This special session will focus on the following special themes: (a) Smart Sensors: Development and implementation of innovative smart sensors for monitoring water networks (water quantity and quality monitoring, early warning systems, etc.) (b) Innovative technologies and methodologies for water systems(sensors, software, analytics, gaps, operational management and standardisation issues), i.e. transforming the traditional Water Distribution Systems (WDSs) in modern Smart WAter Networks (SWANs), (c) Serious gaming and related applications in the domain of water systems, (d) ICT for efficient water management and re-use- as part of the three themes above.

S6. Model predictive control for water management

Contact person: Klaudia Horváth, hklau85@gmail.com

Convener
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Description of the session

The session is about the use of model predictive control in the field of water management. Mathematical optimisation and model predictive control can improve water management to a large extent. By controlling hydraulic structures, pumps it is possible to optimize water resource management, save energy and ensure a safe environment. Moreover, model predictive control on water systems is an efficient tool to prepare for the effects of climate change.

Nowadays more and more people are researching this topic. There are researchers working on this topic from several fields, like mathematics, mechanical engineering or hydrology. Though the topic has been researched for a while, there are still few practical implementations due to the challenges in research and practice. This session aims at sharing this knowledge, in order to make the development faster. The meeting of these different approaches can result in vivid discussions and new ideas. This session will be a step to get closer to the implementation of solutions requiring model predictive control.

S7. Development and application of the next generation of shallow flow models

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Description of the session
The Shallow Water Equations (SWE) and their variants, which are depth-averaged formulations of the Navier-Stokes equations, are proved to be an effective physical description of a broad range of environmental free-surface flow processes including river flows, overland flows, debris flows and coastal waves The development of robust SWE-based models are essential for a variety of applications such as flood forecasting and risk assessment, early warning of tsunamis and rainfall-runoff simulations in natural catchments. The research on developing SWE-based models remains vibrant though significant progress has been made in the past decades. The frontier of research on developing the SWE-based model is currently focusing on 1) leveraging cutting-edge computing technologies such as Graphic Processing Units (GPU) to enable large-scale and high-resolution simulations, such as city/catchment scale flood forecasting; 2) developing adaptive and multi-scale methods to effectively utilise high-resolution topography data; 3) developing higher-order numerical schemes such as the discontinuous Galerkin (DG) method to increase the model accuracy; 4) tackling the numerical challenges of handling complex source terms when simulating accompanying physical processes such as sediment/pollutant transport; and 5) incorporating stochastic components into shallow flow models to deal with model uncertainties. Researches on these important topics are undoubtedly opening a new chapter of environmental free-surface flow modelling. As an effort to create a platform to exhibit the progresses that have been made at the frontier of developing and applying the next generation shallow flow models, we are proposing this special session to hold presentations on both the methodological advances in the aforementioned five aspects and the novel applications that demonstrate the benefit of recent model developments. We believe that the proposed session will significantly increase the exposure of recent progresses on model developments and applications to inform the hydroinformatics research community, industrial partners and policy makers how cutting-edge modelling technology can help to gain fundamental understanding of the water system and facilitate more sustainable water resources management. We also believe that the proposed session will provide a forum for the model developers to share their thoughts and generate new ideas that will lead to future collaborations to tackle the research challenges collectively.

S9. Long-term resilience of water systems: input data analysis

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Conveners

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Carla Tricarico, Università degli Studi di Cassino e del Lazio Meridionale, Cassino, Italy

Description of the session

Water systems are currently identified as critical infrastructure due to their impact on energy, food and agriculture, healthcare and public health. Resilience is a concept that is being used increasingly to refer to the capacity of infrastructure systems, composed of interacting parts that operate together to achieve a function, to be prepared for and able to respond to long-term variations of the socio-economic and environmental contexts. As property of a system, common attributes of resilient systems include redundancy, robustness and adaptability and in general the ability to acquire new capabilities in dealing with the difficulties in the tackling critical issues. Systems analysis and simulation can incorporate the complexities and interdependencies of water systems, allowing to understand the potential tradeoffs of resilience enhancement strategies. Both qualitative and quantitative physical infrastructure, customers, governance and services data, at the appropriate scales, can support various metrics to measure the resilience of water systems, that in a long-term perspective is to be seen in terms of scenarios so as to incorporate the uncertainty. The term "resilience" is also used frequently when describing desired characteristics of critical infrastructure, but a standard quantification has not been adopted: network connectivity can improve resilience to pipe breaks, infrastructure failures, and loss of access to a single source; hydraulic reliability and entropy can be used to measure resilience to pressure loss, service disruptions, as well as loss of access to sources or other infrastructure; additional common performance metrics include cost, pressure, and water quality. Great influence at the optimal solution to adopt for resilience enhancement is given by the input characteristic of the network, as the topology, the water requested by users, pressures at network nodes, etc. All these characteristics, which usually are adopted as input data of the problem, need to be deeply analyzed in order to increase the resilience of the system.

S10. Monitoring network optimization and model choice: information for predictions and value for decisions

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Convener
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Co-conveners
Luciano Raso, TU Delft, Delft, the Netherlands
Grey Nearing, University of Alabama
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Description of the session

As George Shackle wrote in 1961: "In a predestinate world, decision would be illusory; in a world of perfect knowledge, empty; in a world without order, powerless. Our intuitive attitude to life implies non-illusory, non-empty, non-powerless decision. Since decision in this sense excludes both perfect foresight and anarchy in nature, it must be defined as choice in the face of bounded uncertainty".

For decision problems in water resources, we have the choice to take decisions under this bounded uncertainty, given the information that we have. On the other hand, we can also choose to collect more information for our decision in the hope of improving it. This information is extracted from our environment through sensors which need to be chosen and placed to optimize a utility function expressing value or information. Subsequently, this information flows through models, predictions, and decisions (e.g. done by automatic control algorithms, or human operators) that feed the information back to the environment in the form of actions.

The purpose of this session is to highlight the study of how information flows through different portions of this feedback loop, with a focus on the role of monitoring network layout and model choice. In particular, this includes, but is not limited to, contributions related to:

1. Design of monitoring networks (optimal experimental design)
2. Flow of information through models
3. Value, quantity and quality of information from models and /or predictions for decisions or control algorithms

S13. Simulation of fluvial eco-hydraulic and morphodynamic processes

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Description of the session

Rivers can be considered as self-formed features whose shapes are the result of feedback processes among water flow, sediment transport, resistant boundaries, and vegetation. Understanding the complex interplay linking flow patterns with bed deformation and bank erosion is extremely useful for interpreting river response to both natural and anthropogenic forcings, and identifying effective intervention strategies. Along with the specific mechanisms by which perturbed channels adjust to shifting equilibrium conditions, the time scale over which these adjustments occur is of fundamental importance in many problems. This session is focused on morphodynamic processes in rivers as induced by man-made and/or natural changes. We encourage submissions that: 1) simulate mechanisms of flow-sediment interaction, two-phase erosion modeling, including the influences of ecologic, hydrologic, or geomorphic processes over a range of spatial and time scales; and 2) present new insights derived from simulating or modeling these interactions in experimental, field, or computational settings.

S14. Advance in uncertainty estimation of hydro-science in changing environment

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Zhenxing Zhang, IL State Water Survey, Champaign, IL, USA

Description of the session

This session will address the understanding of sources of the quantification and reduction of uncertainty in hydrologic forecasting and hydrological regime change evaluation, including the case of hydrologic extreme events and hydrological simulation. Uncertainty estimation in hydrological systems is becoming more and more a hot issue. However, a significant research challenge, and central interest of this session, is to understand the sources of predictability and to develop new approaches, methods and techniques to enhance predictability (e.g. accuracy, reliability, etc.) as well as to quantify and reduce predictive uncertainty due to climate change and intensive human activities which result in a changing environment.

Providing uncertainty estimates for integrated catchment models involving forecasting models are an issue of interest to this session. Methods that help update forecasts in real-time to reduce bias and increase accuracy, and case study demonstrations of their use, are also of interest to this session. Method that can provide important ways for understanding hydrological regime change under changing environment and cases study are also expected to this session.

S16. Time series analysis for climate change detection

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Co-conveners
Van Thanh Van Nguyen, Mc Gill University, Canada
Ramesh Teegavarapu, University of Florida, USA

Description of the session
The objective is to share results of traditional and innovative techniques and tests for detecting changes in long term time series especially applied to climatic and hydrological time series. It is observed indeed that today the 'traditional' Mann-Kendall test is still applied in a large majority of time series analyses to detect non-stationarity, but other tests and more modern analyses techniques, as those based for instance on the wavelet transform, did not yet become a standard practice. One of the goals is to find a consensus in the water engineering and hydrological community on the most appropriate and powerful statistical tests and analyses techniques to be applied for climate analyses. Both theoretical aspects and results of trend detection are welcome, with a special emphasis on data sets longer than one century. Precipitation, river flow, groundwater sea and lake water levels are the variables of major interest for the session.