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Hydrolink

Hydroinformatics: Solutions for global water challenges

By Dragan Savić

Global water security is a multi-dimensional and enduring human goal. These multiple dimensions reflect human desire to manage risks related to water, including droughts, floods, landslides, desertification, pollution, epidemics and diseases, as well as disputes and conflicts.

Over the last 30 years, we have been whitenesses to modern digital technologies transforming our society (e.g. banking, transportation, tourism, entertainment). However, while digital banking (e.g. payment apps), transport apps (e.g. Uber), tourism platforms (e.g. AirBnB), and video and music streaming services (e.g. Netflix, Spotify) have disrupted traditional sectors, improving planning and management of those global water-related risks through digital transformation has been slow. With 90% of the data in the world today that has been created in the last two years alone, the quantity of information available is unprecedented in human history. We can measure, sense and monitor the condition of almost anything. The question is then, what is the situation with the digital transformation of the water sector?

The field of *hydroinformatics* has been at the forefront of the digital transformation of the water sector. Although in the past hydroinformatics was often identified by its technological dimension through applications of information and communications technologies (ICT) and artificial intelligence (AI) methods to solving complex water and societal challenges, it is much more than that – *it is a management philosophy developed to respond to global water challenges and made possible by rapidly advancing technologies!*

Digital technologies and hydroinformatics

Hydroinformatics is not a completely new concept. It has its roots in computational hydraulics (Abbott, 1991) and simulation modelling dating even before digital computers, e.g. electric-analogue groundwater models of the late fifties and early sixties. Hydroinformatics began to flourish with digital technologies afforded by the advent of desktop computers in the early eighties.

Modern digital technologies include various forms of AI and Machine Learning, such as data-driven modelling for leakage detection and localization, where machine learning methods are used to predict future signal values and deviations from those values indicate a potential leak. Another AI technology that has found its application in the water sector is nature-inspired computing (e.g. genetic algorithms, particle swarm optimization, etc.) for planning and management of complex water networks.

A Digital Twin is a digital copy of a physical system, which has roots in modelling and simulation. Classical offline models can be enhanced by bringing in real-time (and/or near real-time data) to update a model, making it a dynamic replica of the physical system. This type of modelling has the potential to change decision support and management of water systems from being reactive to becoming proactive.

Extended Reality is another group of digital technologies (including augmented, mixed and/or virtual reality) that is particularly useful for field personnel to, for example, see the augmented view of buried water infrastructure and locate possible problems and solutions, or for the training of personnel in a virtual environment. This risk-free troubleshooting and training technology allows utility personnel to immerse themselves in a virtual environment with a set of superimposed images, thus navigating an augmented reality. Visualisation of data and measurements made by different sensors allows utility personnel to access remote sites virtually and undertake quality control processes with ease.

Serious gaming has also found its way into water management, similar to flight simulator games for training and consensus building among stakeholders. These games, whose main purpose is not entertainment, allow players to experience interactively and visually what it is like to be a water manager facing constant challenges, e.g. droughts, flooding or water recycling.

Digital portals and online dashboards, such as those for monitoring and visualising performance data in a control room could be also enhanced by AI/Machine Learning technologies to analyse and controls the performance of water systems through predictive analytics. Another application of online dashboards helps in engaging water customers and empowering them towards more sustainable behaviour, thus enabling change in attitudes toward resource wastage and supporting demand management.

Remote sensing via satellite and UAV (Unmanned Aerial Vehicle) imagery has become an important source of data for water resource management, particularly for agricultural applications. Small UAVs can carry various sensors including embedded cameras, which are low-cost but have a high spatial resolution. UAV for remote sensing can improve real-time water management and irrigation control in agriculture. Similarly, satellite-based information can help identify trends in precipitation, evapotranspiration, soil moisture, snow and ice cover, melting, as well as runoff and storage, thus supporting and improving water management.

Finally, advances in robotics have brought about the prospect of water infrastructure in which robots are inserted or remain permanently, and are equipped with various sensors providing a continuous stream of data about their condition.

Future water management challenges, including progressing climate disruption, population growth and urbanisation, are increasingly complex and interdependent, which makes it near impossible to make informed decisions without using digital tools. However, using these tools in isolation, i.e. without taking advantage of various data streams will not make disruptive innovation breakthroughs in water management. Hydroinformatics, as a management philosophy, is the key enabler for integrating data across data silos and providing data analytics that improves knowledge and eventually leads to making informed decisions.

Human factor

The impact of digitalisation and automation in the water sector can mainly be felt by people involved in water management. The culture of fear that surrounds digitalisation and AI in particular, spans decades from fear of losing jobs to AI as an existential threat to humanity. However, this attitude is largely to do with media coverage of the topic. Therefore, future progress in digitalisation is not only about technology as equally, if not more importantly, about the human factor that can create more challenges than technology but is often neglected. We can learn from other sectors such as the automotive and aircraft industries, where huge investments in innovation and implementation of automation have happened, about the human factor and its role. For example, operating systems on airplanes or in cars require the highest possible level of safety and still rely on trained airline pilots and vehicle drivers (Savic, 2022). For the water sector this means that despite smart software, including AI and ML solutions, these automation systems will still require a highly-skilled workforce to ensure safe future operation of water systems. In other words, digitalisation and automation require more training for the personnel, not less.

Conclusions

Global water security risks associated with diminished water supply in quantity or quality, increased water demand, and extreme flood events, are only going to grow in future. It is clear that the digitalisation of the water sector (serving agricultural, domestic, industrial and commercial sectors) will help in mitigating those risks. However, digitalisation cannot be the goal by itself and it is not an option anymore, but a necessity. Digitalisation technologies and hydroinformatics solutions are largely available and the water sector is already benefiting from hydroinformatics advancements. However, it is essential not to focus on technologies alone and devote enough, if not more, efforts to cultural change and the human component of the digital transformation. Cultural transformation takes time and effort and should be part of the digital transformation from planning to implementation.

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Professor Savić is an international expert in smart water systems with over 35 years of experience working in engineering, academia and research consultancy. His work has resulted in patentable innovation and spinout companies. In addition to innovation and leadership skills, he is known for believing in bridging science to practice in the wider water sector and utilities in general.

References

Abbott, M.B., 1991. Hydroinformatics. *Information Technology and the Aquatic Environment, Avebury Technical,* pp.1-85628.

Savić, D., 2022. Digital water developments and lessons learned from automation in the car and aircraft industries. *Engineering,* Vol. 9, pp. 35-41.