TREND OBSERVATORY ON WATER

TREND SHEET

From data to decision: digital pathways in water governance

18.12.2024

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Digital solutions and new data sources hold immense potential for improved governance and better sustainable management of water. Satellite technology, new sensors, global databases, Artificial Intelligence (AI), and advanced online tools for assessment and monitoring are providing promising solutions. They range from predictive maintenance of infrastructure to participatory information collection to effective crisis management. Numerous user-friendly, scalable, and cost-effective options are not only prototypes but already available for implementation at scale. Digital tools are transforming water governance into a model of efficiency, transparency and sustainability.

Explore this Trend Sheet for the latest insights into digitalisation and data management in the water sector and learn about innovative approaches to improve water governance.

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Definition of terms

Artificial intelligence (AI): is a term used to describe the theory and development of computer systems that are able to perform tasks normally requiring human intelligence (IWA 2020).

Blockchain: enables the verification of transactions (e.g. in payment transactions with cryptocurrencies) without a central authority in a trustworthy and transparent manner (Federal Office for Information Security 2024).

Digital technologies: include e.g. sensors, smart pumps, and meters but also software solutions, artificial intelligence or machine learning applications (Walter 2024).

Information and communication technology (ICT): covers all technical means used to handle information and aid communication. This includes both computer and network hardware, as well as their software (Eurostat 2024).

Machine learning (ML): is the study of computer methods and algorithms that improve automatically through experience (IWA 2020).

Water governance: range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision makers are held accountable for water management (OECD 2015).

Water management: refers to the activities of analysing and monitoring water resources, as well as developing and implementing measures to keep the state of a water resource within desirable bounds (Pahl-Wostl & Gupta 2015).

Introduction


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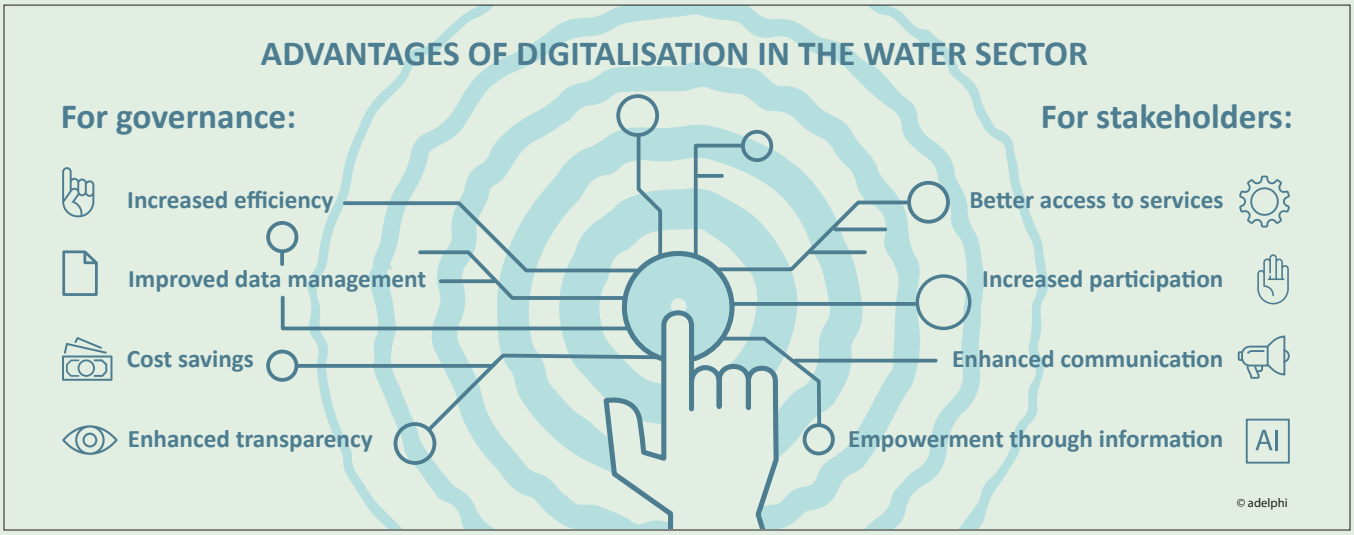
Digitalisation is increasingly recognised as a key driver for sustainable development, offering promising perspectives for addressing water governance challenges by bringing stakeholders closer to discuss, decide and find common solutions. Digitalisation is empowering people by improving "access to timely information and lowered transaction costs, boosting educational outcomes, labor force participation, income, consumption, and welfare". Communities from the rural heartlands to the tech savvy technocrat are accessing a diverse array of digital mediums and tools to shape governance. By facilitating real-time data collection and analysis, digital technologies enhance informed decision-making. Moreover, digital technologies have the potential to foster greater trust and engagement among stakeholders by providing more transparent and accessible information.

Today's water governance is benefitting from digitalisation. Five years ago, the Trend Observatory on Water already explored how digital technologies helped reducing inequalities in water security with its first Trend Sheet. Today, as digitalisation continues to drive sustainable development, this Trend Sheet provides an update and explores how digitalisation is supporting water governance. Although most digital investments in the water sector focuses around technical solutions (see part on financing digitalisation), this Trend Sheet ventures into emerging trends around three OECD elements of water governance: effectiveness, efficiency, trust and engagement, associated with stakeholders and beneficiaries.

Advantages and challenges of digital water governance

Digitalisation is understood as umbrella term for tools and technologies which are not only linked to the world wide web but involve digital components themselves (e.g. sensors, data analytics, remote sensing, blockchain, and artificial intelligence/machine learning). Water governance encompasses a range of political, institutional and administrative rules, practices and processes through which decisions are taken and implemented. Governance and digitalisation interact through the implementation of digital platforms that enable more efficient public service delivery, enhance policymaking with data-driven insights, and foster greater citizen participation in democratic processes. Digitalisation is transforming governance by enhancing transparency, efficiency, and citizen engagement. Digital technologies and innovative strategies are increasingly integrated into the everyday life, including for shaping the social dimension of the water sector.



Before venturing into exploring the enriching examples of digitalisation on water governance, it is important to delve into the **caveats and challenges of digitalisation**, especially for diverse stakeholder groups (**see Table 1**). The **digital transformation of water governance** is often framed through the lens of new technologies that are being tested, implemented, envisioned, or developed for the future. As this always takes place within a spatial, temporal, ecological, and socio-economic framework, this process is profoundly political with significant implications at various levels. Especially controlling the access to and the use of digital tools is a driver of reshaping power dynamics in terms of "who counts" and who controls the processes. Thus, it deeply impacts organisational structures and governance, opening a terrain of complexities and obstacles around power, conflicts of interest, privacy, equity among skills gaps, data protection and the digital divide – with roughly half of the world's population still not having access to internet and other digital mediums and tools. Addressing these requires fair and responsible digital transformation, as emphasized by the Dutch Special Envoy for Water Meike Van Ginneken in her keynote at World Water Week 2024 in Stockholm. Engaging diverse stakeholders ensures digital solutions meet real needs. Thereby, investments should not only be appropriate to the development of digital solutions but also to the protection of their users, namely common citizens.

Table 1: Stakeholder specific roles and challenges related to water and data governance (Source: Akvo 2022).

Stakeholder group	Water and data governance	
	Roles	Challenges
NGOs and civil society	Key role in collecting and sharing data on inclusion to boost advocacy efforts. Data collecting for reporting on their own projects, mostly funded by the Government of Netherlands.	Data is not archived once the programme cycle comes to an end. Data is not integrated into national data systems. Adapting to complex and changing regulatory environments and policies. Limited access to technical knowledge and capacity-building opportunities. Lack of meaningful participation and collaboration. Water losses, ageing assets, and water scarcity due to climate change.
The private sector	Produces data to generate revenue. Invest in generating data. Requires data from the public sector to plan their investments.	Market dependency. Data protection issues with private sector.
Academia, universities and research programmes	Generating niche data on various aspects of water governance and management.	Integrating data streams into policy making.
National governments	Play an important role as aggregators and validators of data.	Data culture is still very linked to power structures. Data is not shared with other stakeholders (including countries' local governments). Fragmentation of institutions, the interconnection with other essential services and overlapping competences. Water losses, ageing assets, and water scarcity due to climate change.
Donors	Crucial for shaping the various reporting needs and thus data streams in the water sector (e.g. due to international standards).	Alignment of local data formats with global standards is often a challenge.

Financing digitalisation

Can digitalisation lead to a more efficient water sector? Between 2016 and 2020, digital technologies generated approximately 300 billion EUR in savings in capital and operating expenditures across the global water industry – equivalent to 0.29% of the global gross domestic product (GDP). These savings were achieved in key water segments, including wastewater treatment, water distribution, customer management, and drinking water metering. The rise of digital-led innovations and cost savings attracts increasing interest and capital within the water sector. The water sector is gradually gaining more attention and investment as digital-led innovations promise enhancements in asset management. According to Morgan Stanley's 2024 report on individual investor sentiment in sustainability, "water solutions" have become the top area of interest globally for investors in both the United States (US) and Europe, with many expressing they are "very" or "somewhat" interested. Experts predict a growing interest from non-water entities in the water sector, such as tech companies, climate, and alternative energy investors. Still, estimate shows that additional investments of around 125 billion EUR are needed per year in the European Union (EU) for digital transition. With view to the European landscape of climate technology investments, 455 million USD out of 53 billion USD were invested in 2021 into water-related technology which is less than 1%.

From the perspective of investment from multi-lateral development banks, the World Bank (WB) has been investing billions in digital infrastructure and water management projects. For example, the WB Digital Development Partnership and GovTech, with a special focus on governance, has supported numerous projects targeted at enhancing digital capabilities. In 2021, the European Investment Bank (EIB) financed projects that connected 3.5 million households to fixed fibre and 5G services. These investments often include components aimed at improving water management through better data collection and analysis. The Asian Development Bank (ADB) has invested in smart water management systems across Asia, integrating Information and communication technology (ICT) to improve water distribution and reduce losses.

The sustainable investment themes investors are most interested in

RANKED BY INTEREST ('VERY' AND 'SOMEWHAT INTERESTED')

GLOBAL		U.S.		EUROPE		JAPAN	
Water Solutions	**74%**	**Water Solutions**	**78%**	**Water Solutions**	**77%**	**Climate Action**	**68%**
Healthcare	**74%**	**Healthcare**	**77%**	**Climate Action**	**76%**	**Healthcare**	**67%**
Circular Economy	**73%**	**Nature & Biodiversity**	**74%**	**Circular Economy**	**76%**	**Water Solutions**	**67%**
Climate Action	72%	Education	74%	Healthcare	76%	Circular Economy	64%
Nature & Biodiversity	72%	Community Development	74%	Nature & Biodiversity	75%	Nature & Biodiversity	64%
Education	68%	Circular Economy	72%	Education	71%	Just Transition	59%
Community Development	66%	Climate Action	72%	Community Development	71%	Education	58%
Just Transition	65%	Just Transition	69%	Just Transition	66%	Community Development	55%
Financial Inclusion	61%	Financial Inclusion	66%	Financial Inclusion	65%	Multicultural Diversity	52%
UN SDGs	60%	UN SDGs	64%	UN SDGs	64%	Financial Inclusion	48%
Multicultural Diversity	58%	Multicultural Diversity	63%	Multicultural Diversity	59%	UN SDGs	47%
Gender Diversity	53%	Gender Diversity	59%	Gender Diversity	56%	Gender Diversity	42%
Faith-Based Values	45%	Faith-Based Values	55%	Faith-Based Values	47%	Faith-Based Values	28%

TOP SUSTAINABLE INVESTING THEMES, RANKED #1

GLOBAL		U.S.		EUROPE		JAPAN	
Climate Action	**15%**	**Healthcare**	**14%**	**Climate Action**	**17%**	**Climate Action**	**15%**
Healthcare	**13%**	**Climate Action**	**14%**	**Healthcare**	**12%**	**Circular Economy**	**15%**
Water Solutions	**11%**	**Education**	**10%**	**Water Solutions**	**11%**	**Healthcare**	**14%**
Circular Economy	11%	Water Solutions	9%	Circular Economy	9%	Water Solutions	11%
Education	8%	Circular Economy	8%	Nature & Biodiversity	9%	Nature & Biodiversity	8%
Nature & Biodiversity	8%	Faith-Based Values	8%	Education	8%	Community Development	7%
Financial Inclusion	7%	Financial Inclusion	7%	Financial Inclusion	7%	Education	6%
Community Development	5%	Nature & Biodiversity	7%	UN SDGs	5%	Financial Inclusion	6%
UN SDGs	5%	Community Development	5%	Multicultural Diversity	5%	UN SDGs	5%
Multicultural Diversity	5%	Multicultural Diversity	5%	Just Transition	5%	Just Transition	4%
Just Transition	5%	Just Transition	4%	Gender Diversity	4%	Multicultural Diversity	4%
Faith-Based Values	4%	UN SDGs	4%	Community Development	4%	Gender Diversity	3%

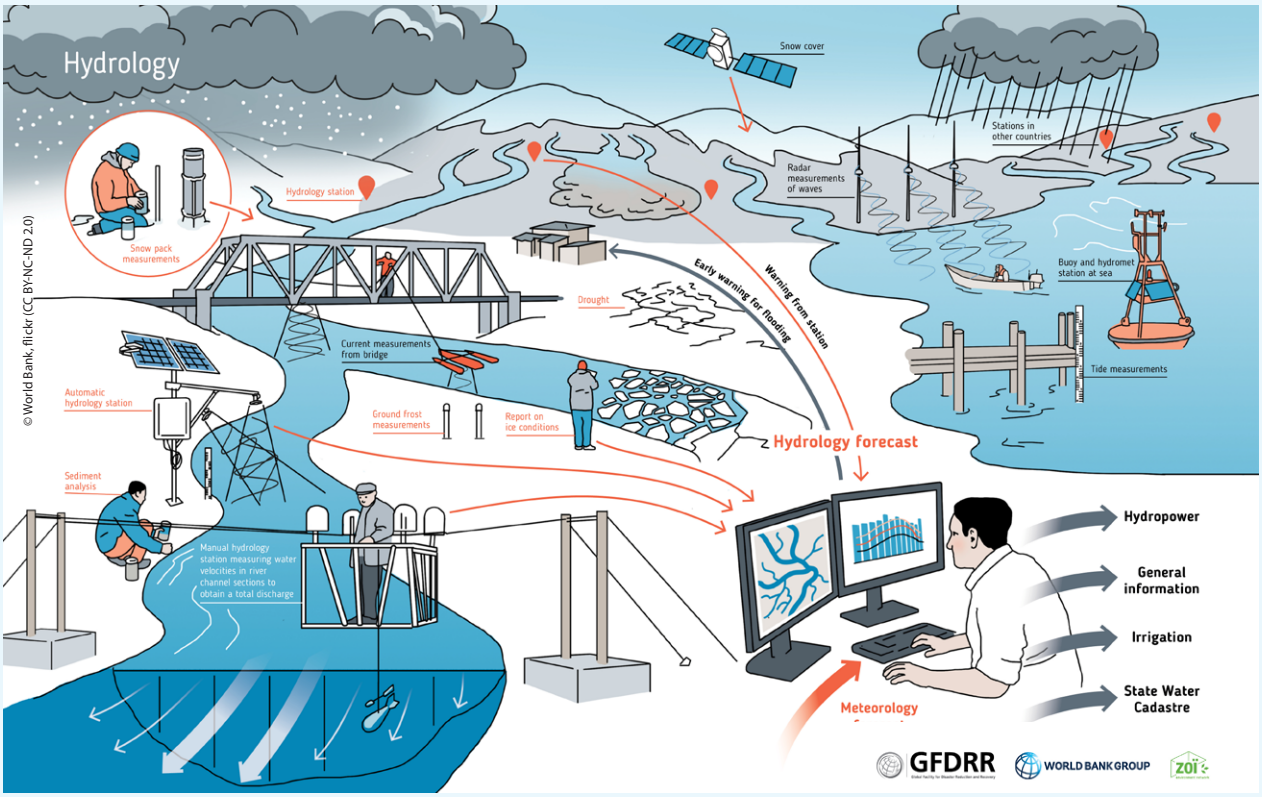
Elements of digitalisation and innovations

How can digitalisation contribute to a more resilient and equitable path of water governance? By analysing trends and promising examples from the AGUASAN Workshop 2023 and other initiatives, the following examples clustered around the OECD elements of Water Governance aim to showcase the diverse measures being on digital water governance.

Effectiveness

According to the OECD Principles on Water Governance, effectiveness refers to the contribution of governance to define, implement and meet goals for sustainable water policy. Thereby, digitalisation can improve effectiveness in water governance at various levels. With view to institutional challenges, such as overlapping competences or poor coordination mechanisms, it supports **shaping clear roles and responsibilities** by providing tools for better communication and coordination. As an effect, conflicts reduce, and processes run more smoothly. Through adequate data management, digitalisation makes **policy coherence** more effective. Furthermore, digital tools strengthen **capacities** in data management. Digitalisation produces volumes of information that needs to be processed, understood and applied. This is where trainings on how to appropriately implement digital solutions make it effective.

Keeping up with the data flood of modern gauging stations

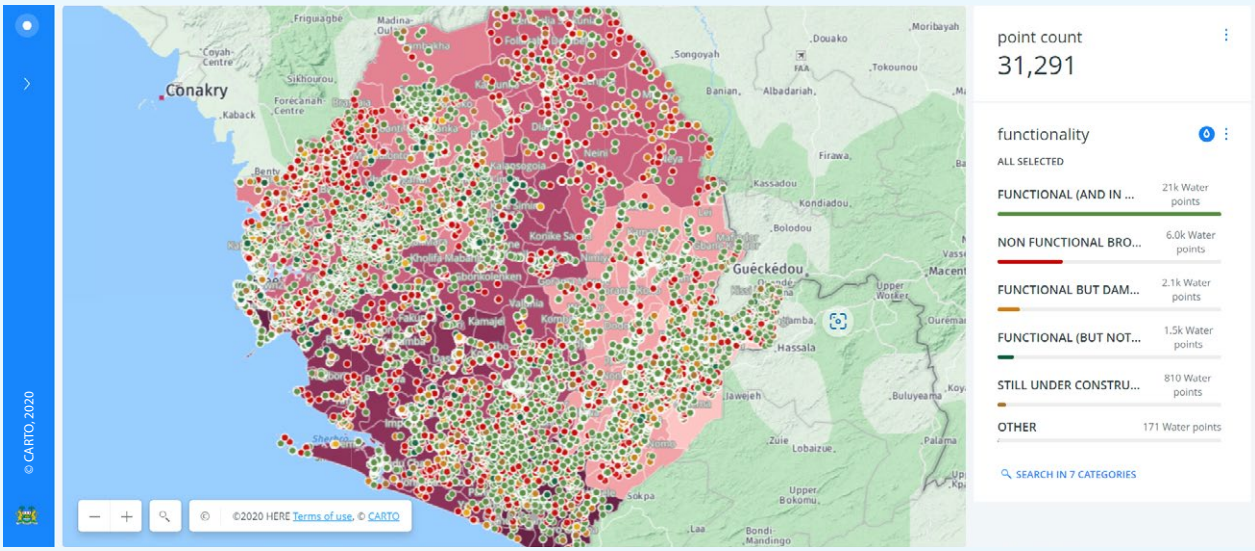


The SAPPHIRE project stands for **S**mart and **P**recise **P**rognostic **H**ydrology for **I**nnovative Risk Management and **R**esource Use **E**fficiency in Central Asia. Supported by the Swiss Agency for Development and Cooperation (SDC), the Swiss-based consulting company hydrosolutions is implementing the project from 2023 to 2026. It focusses on the resolution of technological and institutional challenges that the Central Asian National Hydrometeorological Services are facing after an **extensive modernisation of the old gauging station system.**

Traditionally, Central Asian families living in mountainous areas have been responsible for measuring water levels and discharge data twice a day manually. This system has been replaced by autonomous modern monitoring infrastructure. The new automatic stations collect high-frequency data on water level, discharge, and temperature every ten minutes. As a result, a data flood, up to 200 times higher than before, exceeds by far the National Hydrometeorological processing capacities.

To address this shortcoming, the SAPPHIRE project improves data management through the integration of a digital assistant solution. Measures such as the implementation of in-house methodological guidelines, quality control, and adapted technical capacity to manage and process high-frequency data, aim at improving the discharge forecast accuracy. Furthermore, the project also strengthens institutional capacities by integrating several exchange and learning formats to valorise gauging station data appropriate. SAPPHIRE target stakeholder from different Central Asian countries and sectors and thus fostering regional and cross-sectoral cooperation in the long term.

Map on water point functionality



Digital water atlases improve policy coherence and capacity

The Dutch foundation Akvo empowers citizens and governments to become data literate empowering them to solve complex problems related to water, agriculture, and climate. In cooperation with five countries, Benin, Ghana, Liberia, Mali, and Sierra Leone, and with international NGOs, Akvo created **National Water Atlases**. They encompass **open data portals with interactive maps and data analytics**. This open data supports citizens to assert their WASH (Water Sanitation and Hygiene) rights and interests more effectively and allows governments to take informed and coherent decisions at both, local and national level.

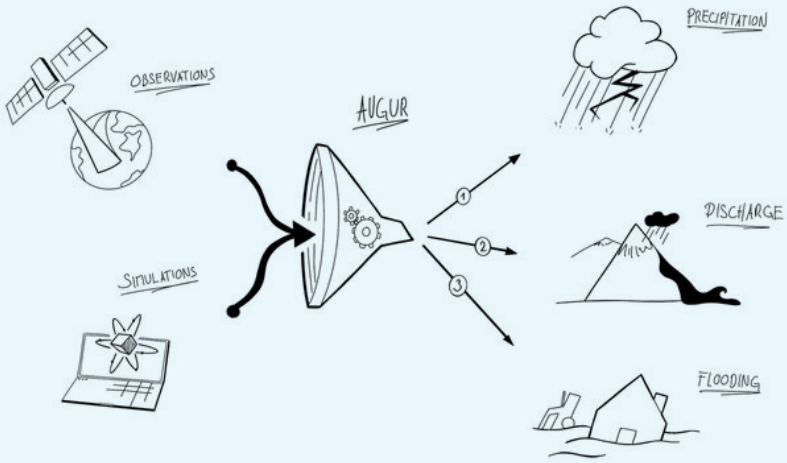
Before the smartphone-based mapping of water points was implemented, the countries relied on pen-and-paper methods for data collection, which were often not even reliable. Through the introduction of the digital tools Akvo Flow (for data collection) and Akvo Sites (for creating online water data portals), data accuracy was improved and overall costs reduced. Regarding capacity building, Akvo trains local data collectors and staff from ministries on how to use, update and maintain these tools and portals. Through the harmonisation and aggregation of data at national level, the five West Arican governments are now able to monitor the state and progress of WASH infrastructure and track progress towards the Sustainable Development Goals (SDGs). From a citizens-perspective, the use of digital tools made it possible to engage with their governments in dialogues for improved water services. The project has achieved significant milestones, with tens of thousands of water points monitored across the participating countries.

Efficiency

According to OECD Principles of Water Governance, efficiency is understood as the contribution of governance to maximise the benefits of sustainable water management and welfare at the least cost to society. The use of digital tools can improve efficiency in water governance by providing better **data and information** (e.g. more cost-efficient, easy applicable, and with adequate accuracy). Implementing sensors, remote sensing, data analytics, ICT solutions or technology-based citizen science enables new forms to generate information on hazards, monitor water infrastructure (in real-time) or identify and manage trade-offs between different water uses. (see examples below).

Open-source toolkit for local flood hazard assessment

Since 2021, the AUGUR initiative (Automated Geospatial User Ready), implemented by Bellprat Climate Consulting, and funded by SDC, has developed a digital toolkit for local "do-it-yourself" flood assessment. It aims at addressing the lack of available and reliable quantitative data needed for the assessment of hazards. Prior to that, this knowledge was often not accessible, and stakeholder, often from low and middle-income countries, relied on external sources for the prediction of extreme weather events.



© Bellprat Climate Consulting

The digital toolkit integrates satellite data and climate models to examine extreme precipitation as well as river discharge, in addition to flood assessment in the field. Thereby, the project reduces financial and administrative costs for consulting external sources and enhances local understanding of water-related hazards. It is open source and tailored for humanitarian and international development organisations. The existing proof of concept developed by the Swiss Red Cross has been applied in Honduras, Bolivia, and Switzerland.


© Millenium Water Alliance

Real-time data and carbon financing for maintenance and repair of boreholes

The Millenium Water Alliance (MWA) approaches with its DRIP-FUNDI initiative the issue of poor maintenance and delayed repairs of malfunctioning boreholes. It provides reliable data via remote solar-powered sensors to secure sustainable access for rural communities in arid regions of Kenya and Ethiopia.

While previous sensors working with cellular connections produced unreliable and delayed diagnoses, the new sensors are satellite-connected, low-cost and compatible with a wide range of borehole infrastructures. They assess the functionality, on-and-off hours and extraction rates of 254 strategic boreholes, supplying several million people.

In addition, the project is linked to innovative financing. As inadequate funding continued to inhibit the repair of broken boreholes, the initiative made use of carbon funds that includes private sector financing also. Making use of carbon financing for a water project was possible through the argumentation, that emissions from boiling untreated water can be avoided through the use of pumps that provide clean water.

Environmental context scan tool

The **environmental context scan tool "Omgevingsscan"** was developed by the Dutch water authority HHNK (Hoogheemraadschap Hollands Noorderkwartier) in cooperation with the Vrije Universiteit Amsterdam (VUA). It is a decision-support tool to identify **locations with the least environmental impact.**

The tool provides a comprehensive overview on context-specific impacts on a location of a planned project (e.g. the construction of a wastewater treatment plant). It considers aspects of flood risk management, water quality, and the protection of natural habitats, aiming to avoid potential socio-ecological trade-offs and enhance synergies between diverging interest groups. It is based on a methodology, uniting all relevant environmental parameters in the catchment, such as soil contaminants or protected species, and is not limited to water infrastructure, but can be applied for real estate project also. Information is visualized in a map.

Watch the video on the environmental context scan tool here.

Trust and engagement

The third dimension of OECD Water Governance – trust and engagement – relates to the contribution of governance to building public confidence and ensuring inclusiveness through democratic legitimacy and fairness for society at large. Digitalisation can improve trust and engagement in water governance in terms of **monitoring and evaluation**, decreasing **inequalities** (across gender, social strata, generations or between rural and urban areas and communities), **stakeholder engagement** and **integrity and transparency**. Digital tools such as remote sensing and technology-based citizen science initiatives provide innovative ways to monitor water quality and management, ensuring more accurate and timely data collection. Empowerment and reduction of inequalities are supported by implementing digital solutions in rural and small-town water services. It aims at improving access for excluded segments of the population, particularly benefiting women. Moreover, digitalisation enhances stakeholder engagement by connecting diverse groups, from local citizens to researchers. This connectivity fosters collaboration and ensures that various perspectives are considered in water management decisions. Finally, integrity and transparency are further strengthened, as digitalisation facilitates better access to information for all stakeholders, including marginalized and vulnerable groups. By disseminating knowledge more widely, digitalisation democratizes access to water data, reshaping interactions among different stakeholders but also in relation to sharing water resources in a more equitable manner.

Empowering civil society for autonomous river quality assessment

The consulting company GroundTruth developed a water monitoring tool **miniSASS** – a **m**ini **s**tream **a**ssessment **s**coring **s**ystem. It is a citizen science tool that enables anyone to assess data on water quality, and the health of stream and river systems worldwide.

Aquatic macroinvertebrates such as worms, shrimps, mayflies, and snails serve as indicators for the current state of a stream or river system. Depending on the type of macroinvertebrates (scored from highly sensitive to tolerant) and the number of detected groups in the sample (thirteen in total), a miniSASS score indicates the condition of the respective sample site from natural to very poor. The results can be uploaded via the miniSASS app or on the website. All results are easily accessible via a map.

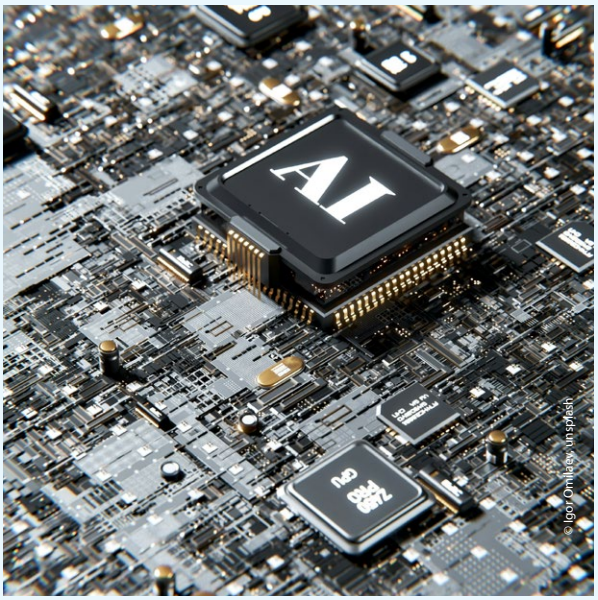
Traditional monitoring methods can be expensive and time consuming. They often exceed local technological, logistic and financial capacities, and data is often available only in low resolution. Citizen science instead, offers an intuitive and easy to handle solution, or alternative which furthermore contributes to public education.

Affordable and unlimited drinking water around the clock

Any Time Water (ATW) is a project of the Indian nonprofit organisation Bala Vikasa. It aims at **providing safe drinking water via a digital dispensing technology** to three million people across 8,000 villages. The treated water is sold at ATW kiosks, using a digital ATM payment system.

ATW helps to deliver safe drinking water at lower costs. The dispensing technology together with an affordable purification plant is community-owned and therefore not profit-driven. The digitalisation of water dispensation plants addresses additional challenges arising from manual dispensing. While the latter was only available during certain hours and with limited supply, leading to long queues and controlled consumption, the self-operational ATW technology is always available and provides unlimited access and accurate dispensing to equal conditions for all customers. Manual bookkeeping is no longer necessary and mobile recharge of the attached ATW card guarantees fairness. Over 1,550 purification plants have been installed.

Prior to the technical implementation, Bala Vikasa engages with the communities to inform and discuss regarding rules and regulations, pricing, supply timings, pre-paid card system, operators' recruitment and maintenance with the community. A plant is only implemented if there is a buy-in from at least 80% of the concerned communities which is checked through in-person consultation meetings.



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Understanding AI in the water sector

According to IDSIA (Dalle Molle Institute for Artificial Intelligence Studies), a Swiss-Italian institute, **AI presents significant opportunities for the water sector** by effectively interpreting data, learning from historical data, and generating and analysing future scenarios. As highlighted in the 37th AGUASAN workshop report, AI algorithms thrive on data, which allows them to learn, adapt, and make objective decisions.

Their interaction with the real world finds expression through drones, actuators (mechanisms through which the agent interacts with its environment), smart meters, and sensors. Large Language Models, like ChatGPT, Undermind, can be used to access and synthesize research from water-related studies. As a result, AI holds tremendous potential to **enhance research and informed decision-making**. In terms of decision making, for the detection of water supply failures through digital twins, AI enables real-time data comparison. This supports the prediction and prevention of failures and optimises maintenance schedules. With view to distribution networks, AI plays a crucial role by precisely predicting water demand, which reduces water wastage. AI-enabled technologies are also improving flood mitigation efforts through better prediction and response strategies. Regarding wastewater treatment, AI optimizes processes to enhance energy efficiency by reducing consumption. To foster climate resilience, AI also helps in drought prediction by analysing diverse data sets to forecast and mitigate drought risks. Furthermore, smart irrigation systems driven by AI optimise water use on farms, boosting crop yields while minimising waste.

However, as AI is still evolving, and with any technology, there are certain limitations. AI lacks the ability to provide meaningful explanations – that is why it should be rather seen as an **unconscious assistant**, capable of processing large volumes of hydrological data to detect changes and identify correlations. AI needs to be trained to analyse by precise prompts. Human oversight and fact checking remains an essential precondition for AI application. Another and often hidden side of AI concerns its significant water footprint. To train and run AI, data centres provide physical infrastructure which require water for cooling servers and for producing their energy. By 2027, these water withdrawals are projected to range from 4.2 to 6.6 billion cubic meters.

Conclusion

The spectrum of digital opportunities and new avenues for an improved water governance is wide and continuously growing. Hence, the present Trend Sheet can't and doesn't want to provide a comprehensive overview but rather stimulate the interest of the readers to engage in becoming more acquainted with the digital future of smart water management. We are happy to receive comments on the Trend Sheet and possibly more examples that would help to enrich the Trend Sheet thereby nurturing an interesting albeit modest repository of initiatives and respective experiences.

Further reading

AGUASAN (2023): Digitalisation and Data Management in the Water Sector: Using Data for Action and for Impact. 37th AGUASAN Workshop Report.

Link to project websites: RETOUCH NEXUS, INN WATER, GOVAQUA.

Global Water Partnership (2024): The AI imperative: accelerating water management processes in the era of climate change.

The International Water Association (2019): Digital Water: Industry leaders chart the transformation journey.

Suggested citation: Aufdembrinke, Lilly, Brauner, Raban, Das, Binayak, and Semmling, Elsa 2024: From data to decision: digital pathways in water governance. Bern, Switzerland: SDC Trend Observatory on Water.

The "**Trend Observatory on Water**" of the Swiss Agency for Development and Cooperation (SDC) aims at informing the RésEAU, SDC's Water Network, and interested parties about relevant emerging trends and innovative approaches for development cooperation in the water sector. Initiated by SDC's Water Section and run by adelphi, it analyses how major global trends can affect water resources and management practices in the future. Through various communication formats and its website https://hazu.swiss/deza/trend-observatory-on-water it aims to raise awareness of opportunities that arise for more sustainable solutions, but also of the risks and challenges that might come along with them.

Contact:

SDC - Swiss Agency for Development and Cooperation
Section Water
Eichenweg 5, CH-3052 Zollikofen, Switzerland
Phone: +41 (0)58 465 04 06
Focal Point Water E-Mail: daniel.maselli@eda.admin.ch

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