Urban Agenda for the EU

Water Sensitive City Partnership

Digital tools for indicators of water sensitive cities

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Briefing Note

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1. About this briefing note

Digitalisation is increasingly recognised as a cornerstone of modern urban water management and a key enabler of the transition towards water sensitive cities in Europe. By integrating sensors, data platforms, and advanced analytics into water infrastructures, municipalities can shift from reactive approaches towards more proactive, efficient, and resilient systems. In parallel, digitalisation supports compliance with European water and environmental legislation, enhances transparency, and strengthens data-driven decision-making across governance levels. Despite these opportunities, the implementation of digital solutions remains, however, uneven across municipalities (UAEU Thematic Partnership WSC 2026, 2025).

Building on the indicator mapping of the Thematic Partnership on Water Sensitive City (UAEU Thematic Partnership WSC and Georgi-Haake 2026), this briefing aims to support moving towards a more systematic and automated approach to urban water data management. The initial mapping of indicators supplemented with available technology highlights the **feasibility of digital tools** for monitoring approaches and identifies remaining gaps in implementation.

Thereby, this briefing builds on a consolidated list of indicators for water sensitive cities, derived from (i) the analysis of EU regulatory indicators (UAEU Thematic Partnership WSC and Georgi-Haake 2026) and (ii) a survey conducted among members of the Thematic Partnership on Water-Sensitive Cities (31/03/2026). Relevant digital tools were identified through desk research and practitioner input, guided by a broad understanding of digitalisation as the integration of sensors, data collection, and computerised management systems into water infrastructures. The analysis considers both the digitalisation of data collection and the use of analytics for enhanced management.

2. Overview on digital tools for water sensitive cities

2.1. Digitalisation status and ongoing processes

The **EU Rolling Plan for ICT Standardisation** (RP2026) underscores digitalisation as a key enabler for more efficient, resilient and sustainable water management in Europe. It promotes the use of technologies such as IoT, AI, cloud platforms and decision-support systems to improve monitoring, reduce water losses and support integrated management across the water cycle. The EU aims to advance interoperability, common data standards and European data spaces, aligning water digitalisation with broader priorities such as climate adaptation and the digital single market (European Commission and interoperable Europe, n.d.).

At the same time, the plan highlights persistent challenges, particularly the fragmentation of systems, lack of interoperability and limited uptake of standards across the sector. Despite available technologies, implementation remains uneven due to weak data integration, limited capacities and insufficient alignment between digital tools and regulatory frameworks. Addressing these gaps requires stronger coordination, accelerated standardisation and scaling up from pilot solutions to widespread deployment (European Commission and interoperable Europe, n.d.).

Unlike more integrated sectors, **wate management in Europe remains highly decentralised across numerous utilities and authorities**, limiting interoperability, data sharing, and the effective use of advanced technologies such as IoT, AI and big data analytics. This situation is now being addressed through strengthened EU policy frameworks, most notably the **Water Resilience Strategy (WRS)**, which positions digitalisation as a core enabler for improving water efficiency, resilience and decision-making. The WRS aligns water policy with broader EU priorities on digital transformation, climate adaptation and cybersecurity, and foresees the development of a dedicated Digitalisation Action Plan for the water sector. At the same time, recent assessments of the Water Framework Directive (WFD) highlight that insufficient uptake and scaling of digital tools remain a key barrier to achieving regulatory objectives, underlining the urgent need for more coordinated, standardised and interoperable digital solutions across Europe (WaterEurope 2025; European Commission, n.d.).

Despite these opportunities, the current state of digitalisation in urban water systems in Europe remains highly uneven. Many municipalities have already implemented individual digital solutions—such as smart meters, supervisory control and data acquisition (SCADA) systems or geographic information systems—but these are often deployed in isolation. As a result, data remains fragmented, difficult to interpret, and insufficiently linked to strategic decision-making processes. In parallel, municipalities face structural challenges, including limited financial resources, a lack of technical capacity, and the absence of standardised guidance on how to prioritise and scale digital investments (UAEU Thematic Partnership WSC 2026)

Against this backdrop, there is a growing need for a more structured and comparable approach to water digitalisation. In particular, the development of a coherent indicator framework for planning, linked to stepwise digitalisation levels and concrete technological solutions, can support municipalities in understanding their current status, identifying gaps, and planning targeted investments (UAEU Thematic Partnership WSC 2026).

2.2. Available digital tools

Digitalisation has become a key enabler of the transition toward water sensitive cities by supporting integrated, adaptive, and data-driven urban water management. Various tools are available (**Table 1**).

At the **data acquisition level,** distributed sensors, smart meters, and Internet of Things (IoT) networks enable high-resolution monitoring of hydrological variables, infrastructure performance, and consumption behaviour. These technologies provide real-time data on flow, water quality, groundwater levels, and stormwater dynamics, forming the empirical basis for responsive system management (European Commission and interoperable Europe, n.d.). At the **data integration and storage level**, cloud services facilitate scalable processing and interoperability across institutional and spatial boundaries, aligning with European digital infrastructure strategies promoted by the European Commission.

At the **analytical level**, artificial intelligence (AI) and advanced data analytics enhance predictive capabilities by identifying anomalies, forecasting demand patterns, and supporting preventive maintenance. These approaches are increasingly embedded in Decision Support Systems (DSS), which synthesize monitoring data and modelling outputs to evaluate alternative management strategies, optimize infrastructure investments, and support compliance with European water directives. Simulation tools and geohydrological models further strengthen planning capacity by enabling scenario testing under conditions of climate variability, urban growth, and land-use change. In particular, integrated surface–groundwater models contribute to sustainable aquifer management and urban infiltration planning.

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At the **system integration level,** digital twins represent an advanced framework that combines real-time monitoring, simulation models, and predictive analytics into dynamic virtual replicas of urban water systems. European research initiatives, such as the digital-water city project funded under Horizon 2020, demonstrate how digital twins, AI-based forecasting, and interoperable DSS platforms can enhance operational efficiency, water quality control, and stakeholder communication across cities (Digital Water.City 2026). Complementing in-situ technologies, remote sensing and satellite data from the Copernicus Programme provide large-scale environmental observations — such as land-use change, soil moisture, and flood extent — that support model calibration, drought assessment, and early-warning systems at regional and catchment scales.

The complexity of the digital water management system requires a **structured ecosystem of technologies**. At its core are measurement tools such as sensors and smart meters, which generate high-frequency data. These are complemented by operational systems such as SCADA, which enable real-time monitoring and control, and by data platforms and cloud-based infrastructures that allow storage, integration and processing of large datasets. On top of these layers, dashboards and visualisation tools support reporting and communication, while advanced analytics, including artificial intelligence, enable predictive functions such as leak detection or maintenance optimisation. More advanced concepts, such as digital twins and decision-support systems, represent the next stage of development, allowing scenario simulation and strategic planning (Expósito and Díez Cebollero 2025).

Despite the opportunities, **several critical gaps** limit the effective use of digitalisation in water management. Most importantly, there is a lack of standardised indicator framework that link digital measurements to policy objectives and regulatory requirements. As a result, data is often collected without a clear connection to decision-making needs. In addition, digital systems are frequently implemented in isolation, leading to fragmented data landscapes and limited interoperability. Challenges related to data governance, including data ownership, access and sharing, further constrain the use of digital information. Finally, institutional barriers—such as limited technical capacity, insufficient funding and the absence of long-term digital strategies—prevent municipalities from fully exploiting available technologies (Expósito and Díez Cebollero 2025).

Table 1: List of available digital tools for water-sensitive city indicators

Digital tool / technology	Typical indicators served	Main governance level using them
Distributed environmental sensors	Water level, rainfall intensity, soil moisture	Local / utility
Water quality sensors	pH, turbidity, nutrient concentration, temperature	Local / regional
Groundwater monitoring sensors	Groundwater level, aquifer recharge rate	Local / regional
Smart water meters	Household consumption, peak demand	Local / utility
Stormwater monitoring sensors	Runoff volume, drainage performance	Local
IoT sensor networks	Integrated real-time system monitoring	Local / regional
Remote sensing	Land cover change, surface water extent	Regional / EU
Satellite observation data	Soil moisture, drought indicators, flood extent	Regional / EU
SCADA systems	Pump efficiency, system pressure, reservoir levels	Local / utility
Telemetry systems	Infrastructure performance indicators	Local / utility
Cloud data platforms	Integrated water balance indicators	Regional / national
Urban data platforms	Cross-sector sustainability indicators	Local / regional
Data lakes / big data infrastructure	Large-scale environmental indicators	National / EU
Geospatial data infrastructures (GIS/SDI)	Spatial water indicators, flood risk mapping	Local / regional
AI analytics	Leak detection rates, anomaly detection	Local / utility
Machine learning models	Water demand forecasts, risk indicators	Local / regional
Statistical analytics tools	Trend analysis for water consumption or climate	Local / regional

Table 1: List of available digital tools for water-sensitive city indicators

Digital tool / technology	Typical indicators served	Main governance level using them
Predictive maintenance systems	Infrastructure failure probability	Local / utility
Hydrological models	Runoff, infiltration, catchment water balance	Regional / national
Hydraulic network models	Pipe capacity, flood risk indicators	Local
Geohydrological models	Aquifer recharge, groundwater sustainability	Regional
Climate scenario models	Climate resilience indicators	National / EU
Land-use simulation models	Urban sealing, infiltration potential	Local / regional
Decision Support Systems (DSS)	Policy performance indicators	Local / regional
Multi-criteria planning tools	Cost–benefit indicators for adaptation measures	Local / regional
Scenario analysis platforms	Climate adaptation effectiveness	Regional / national
Digital twins	Real-time system performance indicators	Local
Predictive system control platforms	Operational efficiency indicators	Local / utility
Dashboards	KPI reporting for water management	Local / regional
GIS visualisation platforms	Spatial resilience indicators	Local / regional
Public transparency portals	Sustainability indicators	Local
Urban water observatories	Integrated water-sensitivity indicators	Local / national

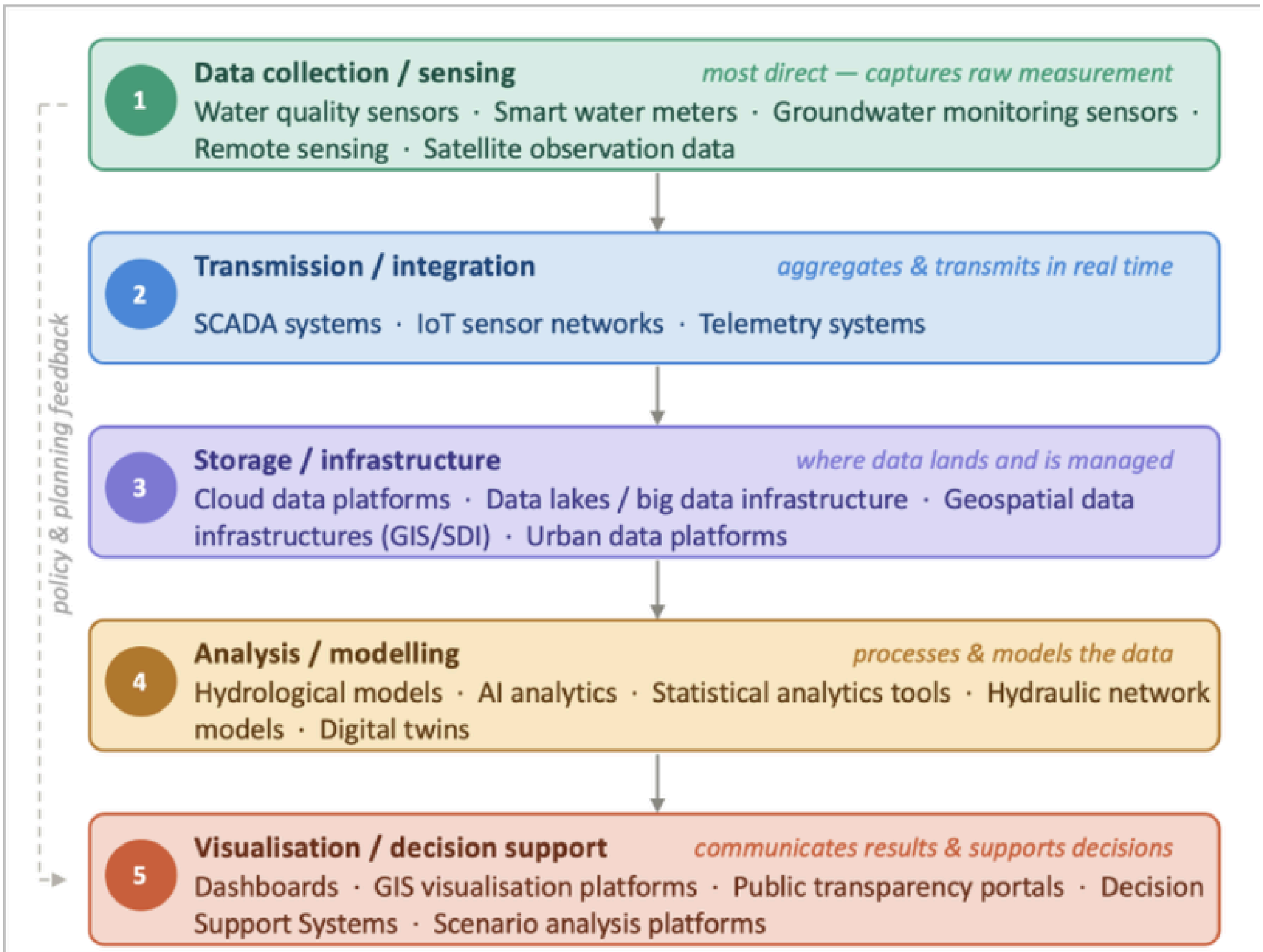
3. Results of mapping indicators and digital tools

3.1 Indicator -digitalisation matrix

While digitalisation for water-sensitive cities covers different stages of the planning and implementation process, here the focus is supporting the monitoring and reporting of indicators. The attached indicator-digitalisation-matrix (Annex) lists the previously identified 248 indicators and parameters and attaches potentially supportive digital tools to it.

It became evident that rarely only one digital tool would match per indicator. In many cases, alternative digital solutions for measuring and data collection exist. Additional tools become relevant in the specific phases in monitoring, reporting or planning process in which the indicators are used. Hence, the matrix includes **different types of potential tools per indicator**, as shown in **Figure 1**.

Figure 1: Digital tool domains for water sensitive city monitoring



Furthermore, it needs to be noted that in practice, the tools are partially used interchangeable, and a clear distinction cannot always be made. The attached indicator-digitalisation-matrix provides, therefore, an orientation, which can be adjusted and further detailed to specific cases by the user.

3.2 Lessons learned

The systematic mapping of indicators to digital tools reveals several important patterns that are relevant for both practice and policy.

First, the analysis demonstrates that **a relatively small set of mature technologies is sufficient** to collect and sense the large majority of indicators. In particular, four tool types dominate the data collection role across the matrix: water quality sensors, smart water meters, groundwater monitoring sensors, and remote sensing / satellite observation data. SCADA systems appear almost universally in the transmission and integration role, acting as the operational backbone for real-time data relay. Cloud data platforms and geospatial data infrastructures follow consistently in the storage layer. This suggests that the technological requirements for monitoring water-sensitive city indicators are, in most cases, not excessively complex or experimental, and that a core set of proven tools can cover the large majority of both EU-required and locally used indicators.

Second, the results show **a clear distinction between measurement-oriented and analysis-oriented tools.** The majority of indicators rely on direct measurement technologies in the sensing and transmission roles, while more advanced tools such as AI analytics, Decision Support Systems, and digital twins appear in fewer than 10% of indicators, and almost exclusively in the flood risk, governance, and infrastructure planning domains. These advanced tools operate at a higher level, supporting optimisation and strategic planning rather than compliance monitoring. This indicates that current indicator frameworks remain largely descriptive and retrospective in nature, with limited systematic integration of predictive or adaptive digital capabilities.

Third, a **strong dependence on supra-local data sources** becomes evident. Many indicators — particularly those related to climate risks, hydrology, or land use — cannot be generated solely at the municipal level. For the entire ecological status domain, covering river, transitional, and coastal water bodies, remote sensing and satellite observation data are the primary collection tool in virtually every case, with municipal-level sensing alone being structurally insufficient. These indicators rely on regional monitoring networks or European data services such as the Copernicus Programme. This highlights the importance of multi-level data infrastructures and challenges the assumption that municipalities can independently fulfil all monitoring requirements.

Fourth, the **level of digitalisation varies significantly across thematic domains**. Water quantity and consumption indicators are relatively well supported by smart meters and SCADA systems — mature, widely deployed technologies that cover this domain comprehensively. Water quality monitoring relies heavily on water quality sensors and IoT sensor networks in the matrix; however, Finally, and perhaps most importantly, the matrix addresses rather technological readiness but cannot by itself capture institutional dimensions. Nevertheless, the mapping strongly suggests that the primary barriers to effective digitalisation are not technological but institutional. The tools required to support the full indicator set are largely available and proven. What the matrix cannot show — but what the broader literature and practice confirm — is that challenges related to data governance, interoperability, organisational capacity, and funding continue to limit their effective deployment. In many cases, data is collected without a clear link to decision-making, and responsibilities for data provision and management remain fragmented across administrative levels. Addressing these institutional conditions is therefore at least as important as ensuring technological availability.

4. Implications and recommendations

4.1 For municipalities

Municipalities can adopt a pragmatic and phased approach to digitalisation. Priority should be **given to a core set of robust and widely available tools**, including sensors for key variables, smart meters, basic modelling capabilities, and the systematic use of external data sources.

A **tiered implementation strategy** can support this process. At an initial stage, municipalities can rely on existing administrative data and simple analytical tools. This can be complemented by targeted investments in monitoring infrastructure and modelling at an intermediate stage. More advanced systems, such as AI-based analytics or digital twins, should only be considered once sufficient data and institutional capacity are in place.

The use of external data sources, particularly satellite data from the Copernicus Programme, can significantly reduce costs and technical requirements.

Finally, **improving the integration and interoperability** of data that is sourced from many different places and owners is essential to ensure that collected data can effectively support planning and decision-making.

Beyond data, municipalities need to enhance digital skills and capacities and exploit options for funding the digital transformation.

4.2 For national and sub-national governments

National governments rely on local data needed for reporting on EU regulations and play, at the same time, a crucial role in enabling municipal digitalisation. Providing a shared monitoring infrastructure, including groundwater and water quality networks, as well as national data platforms that **facilitate access and standardisation** would support this.

Aligning indicator frameworks across EU, national, and local levels is essential to ensure coherence and efficiency. **Clear links between indicators and policy objectives** can help avoid fragmented and redundant data collection efforts.

In addition, national authorities can effectively **invest in capacity building, including technical guidance, training, and shared services**, particularly for smaller municipalities. Establishing clear frameworks for data governance and sharing is equally important to ensure accessibility and interoperability.

4.3 European level

The analysis confirms that digitalisation challenges in the water sector are primarily linked to fragmentation, limited interoperability, and weak alignment between regulatory frameworks and digital tools. Addressing these challenges requires **stronger coordination across policy domains and governance levels.**

A first priority is to **embed digitalisation more systematically within EU water policy frameworks**, in particular the EU Water Resilience Strategy. The forthcoming Digitalisation Action Plan for the water sector should support the operational use of digital tools for monitoring and reporting under the Water Framework Directive and the Urban Waste Water Treatment Directive. This includes modernising reporting processes through the use of real-time and high-resolution data, thereby improving data quality while reducing administrative burden.

In parallel, there is a need to develop a coherent, cross-policy indicator and data framework that **links regulatory requirements with measurable data** and differentiates between local and supra-local data provision. Such a framework would enable more consistent and efficient implementation across Member States.

Accelerating **standardisation and interoperability** is another key priority. Building on the EU Rolling Plan for ICT Standardisation (RP2026) and the EU Digital Strategy, efforts should focus on establishing common data standards, promoting their uptake, and advancing European data spaces for water. This would help overcome the current fragmentation of systems and facilitate data sharing.

European data services, particularly the Copernicus Programme and its planned Copernicus Water Thematic Hub, need to be further developed to better meet municipal needs. Improving accessibility and integration of these datasets into local tools would allow municipalities to complement or replace local monitoring with high-quality external data.

Finally, a **structured multi-level governance approach** is required to clarify responsibilities for data provision and ensure that, at the end, local authorities are not overburdened with monitoring requirements beyond their capacity. Aligning water, digital, and urban policy initiatives—including frameworks related to smart cities—will be critical to achieving this.

5. Conclusion

From this initial analysis, it can be concluded that **digital tools required to support water-sensitive city indicators are largely available, mature, and sufficient for most purposes.** The main challenges lie not in technology, but in governance, coordination, and the alignment of data systems with policy needs as well as local capacity building and funding.

A pragmatic approach to digitalisation — based on a core set of tools, supported by shared data infrastructures, and implemented through phased strategies — can enable municipalities of all sizes to participate in the transition towards more resilient and water sensitive urban systems.

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