



IDEATION

Policy Brief #2

Accelerating Europe's Water Digitalisation through Interoperable and Participatory Digital Twins

T 6.3: Set-up and promotion of networking activities

WP 6: Dissemination, exploitation, communication, and networking

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Date: June 2026



**Funded by
the European Union**

1.0 Introduction

[IDEATION](#) is an EU-funded project focused on preparing the development of the Digital Twin of the inland waters (rivers and estuaries, lakes, reservoirs, wetlands, snow and ice, urban water, groundwater, and coastal water; DITWs) interoperable with the Digital Twin Ocean (DTO). IDEATION aims to integrate inland water data, models, and digital tools with the DTO to combine real-time and historical data from various sources, reflecting the different inland waters physical characteristics and dynamics. It offers valuable insights for scientists, researchers, and policymakers to make informed decisions about freshwater health and management. The project's success depended on the collaboration of an experienced consortium of 11 European partners.

The Digitalisation Action Plan for the water sector (DAP)¹ represents a strategic opportunity to accelerate the digital transformation of Europe's water sector while supporting the objectives of the European Water Resilience Strategy², and the Water Framework Directive (WFD)³, and the Marine Strategy Framework Directive (MSFD)⁴. Current challenges include limited interoperability between water-related data systems, fragmented governance arrangements, insufficient data sharing, lack of common standards, and barriers to the deployment of advanced digital technologies such as artificial intelligence, digital twins, and predictive analytics⁵.

Successful deployment of Digital Twins requires more than technological readiness. It depends on stakeholder co-creation, interoperability, governance integration, and sustainable data frameworks from the outset. Through 65 stakeholder engagement activities conducted across 18 reference scenarios and involving more than 600 stakeholders, IDEATION assessed the technical, governance, interoperability, and implementation requirements necessary to scale digital twins across Europe⁶. IDEATION encourages the EU Commission to consider the following recommendations in developing the DAP.

Main Recommendations

- 1. Establish a European interoperable digital ecosystem for water management.**
- 2. Mainstream stakeholder-centred digital twin development.**

¹ European Commission, [Call for evidence, Water sector – accelerating digitalisation for better management and sustainability](#), 2026.

² EUR-LEX, European Water Resilience Strategy, [COM/2025/280 final](#), June 2025

³ EUR-LEX, [Directive 2000/60/EC](#) of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

⁴ EUR-LEX, [Directive 2008/56/EC](#) of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

⁵ See footnote 1.

⁶ IDEATION. 2026. Deliverable 2.4: MSF results and functional and nonfunctional requirements. Brussels: IDEATION Project Consortium.

- 3. Accelerate water efficiency and climate resilience through predictive digital twins.**
- 4. Use digitalisation to support the implementation of the EU water acquis.**
- 5. Create enabling conditions for large-scale deployment of water digital twins.**

2.0 Establishing a European Interoperable Digital Ecosystem for Water Management

A central challenge identified in the Digitalisation Action Plan Call for Evidence is the fragmentation of digital systems, data infrastructures, and governance arrangements across the European water sector. IDEATION demonstrates that interoperable Digital Twins of Inland Waters can provide the foundation for a European digital ecosystem connecting monitoring systems, models, data spaces, and decision-support tools across inland, transitional, coastal, and marine waters⁷.

Interoperability must be considered a governance requirement rather than solely a technical feature. The project developed a Reference Architecture for Digital Twins of Inland Waters (DTIW) specifically designed to ensure interoperability across inland water systems while maintaining compatibility with the Digital Twin Ocean (DTO) and contributing to a unified digital representation of the hydrosphere⁸.

Further, IDEATION's OpenKIWAS⁹ demonstrates the importance of structured and accessible knowledge ecosystems as a foundation for digital twin deployment and evidence-based decision-making. Stakeholder engagement activities also identified interoperability as one of the key prerequisites for successful digital twin deployment¹⁰. The IDEATION experience demonstrates that interoperable digital twins can deliver significant governance benefits by:

- enabling seamless integration of monitoring, modelling, and forecasting systems;
- facilitating data sharing across local, regional, national, and European levels;
- improving coordination between inland, coastal, and marine water management authorities;

⁷ IDEATION. 2025. *Deliverable 4.1: Reference Architecture and Interoperability Guidelines (KER3) V1*. Brussels: IDEATION Project Consortium; IDEATION. 2025. *Deliverable 3.1: OpenKIWAS (KER2) V1*. Brussels: IDEATION Project Consortium.

⁸ IDEATION. 2026. *Deliverable 4.2: Reference Architecture and Interoperability Guidelines (KER3) V2*. Brussels: IDEATION Project Consortium.

⁹ An open and shared inventory of knowledge about inland water systems that brings together policies, standards, research outputs, data sources, models, simulations, digital twins, and information systems relevant to water management (IDEATION D3.1 2025). <https://openkiwas.ideation-euproject.eu/>

¹⁰ IDEATION. 2025. *Deliverable 2.3: MSF Results and Functional and Non-Functional Requirements (KER1) V1*. Brussels: IDEATION Project Consortium.

- supporting source-to-sea approaches promoted by the European Water Resilience Strategy;
- reducing duplication of data collection and management efforts; and
- creating the conditions for more efficient and evidence-based policymaking.

Recommendations

- Develop a European interoperability framework for water digital twins aligned with FAIR principles, INSPIRE, the Data Union Strategy, Destination Earth (DestinE), and the DTO.
- Promote common standards, semantic interoperability, open APIs, and harmonised data governance frameworks across the European water sector.
- Support the development of interoperable digital ecosystems that connect inland, transitional, coastal, and marine waters through a source-to-sea approach.
- Promote interoperability as a prerequisite for reducing administrative burden and improving implementation of the EU water acquis.

3.0 Mainstreaming Stakeholder-Centred Digital Twin Development

IDEATION demonstrates that stakeholder engagement is a critical condition for successful digital twin deployment and there is no “one-size-fits-all” digital twin¹¹.

The project implemented a participatory methodology involving Multi-Stakeholder Forums, bilateral meetings, focus groups, questionnaires, and networking activities across Europe¹². Covering 18 countries and mobilising more than 600 stakeholders, it contributed to the identification of requirements, co-creation of reference use cases, and assessment of governance and interoperability needs¹³.

Different water systems and territorial contexts require tailored approaches in the development of the digital twins. Stakeholders consistently highlighted the need to:

- co-design reference use cases related to digital twins from the start;
- integrate governance considerations into technical design;
- ensure interoperability with existing systems and infrastructures;
- adopt modular and iterative implementation pathways; and

¹¹ Munaretto, Stefania, 2025. *Stakeholder Engagement and Key Learnings for the Development of Digital Twins of Inland Waters*. IDEATION presentation, Water Market Europe; IDEATION, 2025. Deliverable 2.3: Multi-Stakeholder Forum Results and Functional and Non-Functional Requirements.

¹² See footnote 5.

¹³ Vargiu, Eloisa, 2025. *IDEATION at a Glance: Results and Project Overview*. IDEATION presentation, Water Market Europe.

- establish robust data governance frameworks¹⁴.

The IDEATION experience also demonstrates the value of Water-Oriented Living Labs (WoLLs) as practical environments for experimentation, co-creation, and territorial scaling of digital solutions.

Recommendations

- Require stakeholder engagement and co-creation plans in EU-funded digital twin initiatives.
- Support Water-Oriented Living Labs as key deployment mechanisms for the DAP.
- Promote governance-by-design approaches integrating technical, institutional, legal, and operational considerations from the outset.
- Encourage modular deployment pathways adapted to local conditions and digital maturity levels.

4.0 Accelerating Water Efficiency and Climate Resilience through Predictive Digital Twins

The Digitalisation Action Plan should recognise digital twins as strategic infrastructures supporting the implementation of the Water Efficiency First principle and the objectives of the European Water Resilience Strategy.

IDEATION reference use cases demonstrate that digital twins can shift water management from reactive responses to predictive and adaptive management approaches. By combining real-time monitoring, Earth observation data, AI-enabled analytics, forecasting tools, and simulation models, digital twins can support:

- predict future water availability based on demand and meteorological forecasts;
- support infrastructure planning and optimisation;
- improve monitoring of water quality and quantity;
- enable early warning systems for droughts, floods, leaks, and saline intrusion;
- facilitate management of alternative water resources enabling integrated modelling of reservoirs, groundwater, urban reuse systems, cascading water approach and coastal interactions within a unified operational framework; and
- support evidence-based decision-making for utilities and public authorities.

IDEATION identified forecasting, simulation, regulatory compliance, climate resilience, and early warning capabilities among the principal strengths of digital twins across all inland water categories.¹⁵

¹⁴ IDEATION, 2025. Deliverable 4.1: Reference Architecture and Interoperability Guidelines.

¹⁵ IDEATION, 2026. Deliverable 5.3: SWOT Analysis (KER4) V2. Brussels: IDEATION Project Consortium.

Particularly, the Spanish reference use case of digital twins is thought to support utilities facing growing water scarcity, declining reservoir levels, and climate-related stress. Stakeholders identified predictive modelling, advanced forecasting, and integration of multiple data sources as essential functionalities for resilient water governance.

Recommendations

- Recognise digital twins as enabling infrastructures for water efficiency and climate resilience.
- Promote the integration of alternative water resources, groundwater management, and reuse scenarios into digital twin applications.
- Support predictive and scenario-based approaches for climate adaptation planning.

5.0 Establishing an Interoperable Digital Governance Architecture for Water

A central challenge identified in the DAP Call for Evidence is the fragmentation of digital systems and the absence of harmonised standards across Europe's water sector¹⁶. IDEATION directly addresses this challenge through the development of an interoperable reference architecture for Digital Twins of Inland Waters.

IDEATION demonstrates that interoperability must be treated as a governance requirement rather than solely as a technical feature. Successful deployment depends on semantic interoperability, common standards, FAIR data principles, cybersecurity, data governance, and compatibility with existing infrastructures.¹⁷

Stakeholder consultations identified interoperability, data governance, cybersecurity, maintenance, and institutional coordination as key enabling conditions for long-term deployment. Faster access to harmonised and interoperable data can support:

- faster and harmonised reporting efficiency under the WFD and MSFD;
- enhanced coordination across river basin and marine authorities;
- more consistent environmental assessments;
- better integration of monitoring and forecasting systems; and
- stronger support for evidence-based policymaking.

By connecting inland water systems with marine ecosystems through interoperable digital infrastructures, IDEATION contributes directly to the source-to-sea approach promoted under the European Water Resilience Strategy.

¹⁶ See footnote 1.

¹⁷ IDEATION. 2026. Deliverable 5.4: Recommendations including assessments results (KER5). Brussels: IDEATION Project Consortium.

Recommendations

- Develop a European interoperability framework for water digital twins aligned with FAIR principles, INSPIRE, the Data Union Strategy and the Digital Twin Ocean.
- Promote common standards, open APIs, and harmonised data governance frameworks.
- Support interoperability across local, basin, national, and European governance levels.
- Facilitate digital reporting and implementation of the EU water acquis.

6.0 Creating Enabling Conditions for Large-Scale Deployment

The IDEATION assessments confirm that the deployment of digital twins is technically feasible but depends on the establishment of appropriate governance and enabling conditions.

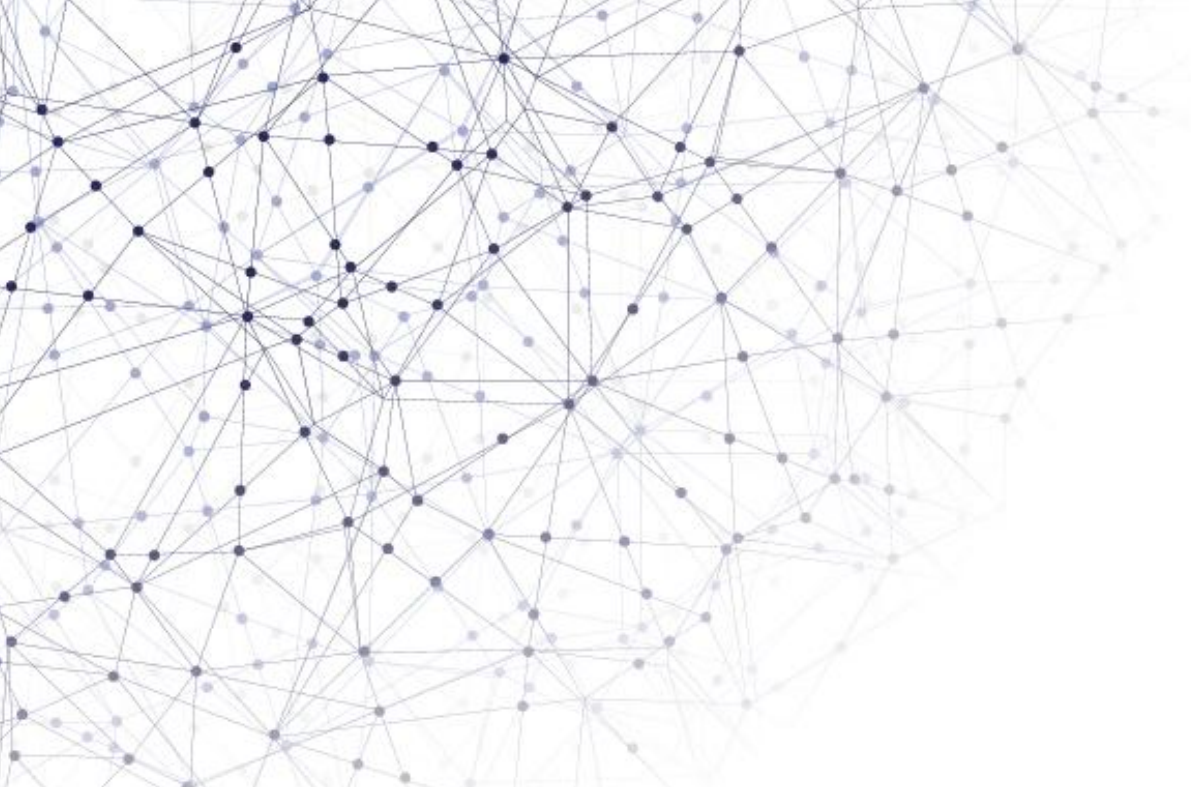
Stakeholders identified several barriers that mirror those highlighted in the DAP Call for Evidence:

- fragmented governance structures;
- insufficient interoperability;
- data quality and accessibility challenges;
- cybersecurity concerns;
- skills shortages;
- high implementation and maintenance costs;
- legacy systems; and
- uncertainty regarding ownership and long-term responsibilities.

The DAP should therefore go beyond technology deployment and establish a framework supporting long-term operation, maintenance, capacity building, and trust.

Recommendations

- Support cybersecurity-by-design and trusted AI approaches.
- Invest in digital skills and capacity-building programmes.
- Develop sustainable financing mechanisms for deployment and maintenance.
- Promote open standards and avoid proprietary lock-in.
- Strengthen data governance and ownership frameworks.



IDEATION to prepare the development of the digital twin of the inland waters (rivers, lakes, reservoirs, wetlands, snow, and ice) addressing activities to be developed and to make it integrated and interoperable with the DTO for a unified digital twin of ocean and waters.



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