

POLICY BRIEF

From evidence to implementation: operationalising water resilience at river-basin scale

Practical lessons from STARS4Water and SOS-Water for implementing the European Water Resilience Strategy

Central message: Water resilience is a process, not a one-off assessment

Europe already has substantial scientific knowledge, data and tools to support water resilience. The pressing challenge is to **turn this evidence into sustained action at river-basin scale**.

STARS4Water and SOS-Water show that resilience should be treated as an **integrated, adaptive and forward-looking operating discipline at the river basin scale**. In practice, this means following a continuous pathway to define management needs with stakeholders; build the evidence base; explore plausible futures; identify risks, thresholds and trade-offs; test measures; act; monitor outcomes; and adjust as conditions change. This requires science, policy and practice to work together over the long term, with research outputs embedded in existing river basin planning and implementation rather than developed as parallel systems that disappear when projects end.

From evidence to implementation — Seven priorities for action:

- **Strengthen science-based decisions:** translate evidence into practical policy and planning guidance.
- **Sustain useful research outputs:** maintain successful tools, data and services beyond project funding.
- **Accelerate uptake:** help authorities integrate proven solutions into operational practice.
- **Invest in capacity:** strengthen skills, digital infrastructure and data-management capabilities.
- **Empower river basin organisations:** give them the resources and mandate to coordinate across sectors.
- **Build lasting partnerships:** sustain collaboration between science, policy, practitioners and stakeholders.
- **Manage basins adaptively:** integrate water quantity, quality, ecosystems, climate risks and socio-economic needs.

This brief synthesises lessons from STARS4Water and SOS-Water Horizon Europe projects, together with stakeholder messages from the joint Brussels Policy Event held in June 2026. It focuses on what European research can do differently to accelerate implementation of the Water Resilience Strategy.



STARS4Water
Supporting Stakeholders for Adaptive,
Resilient and Sustainable Water
Management
www.stars4water.eu

aimed at improving the understanding of how climate change affects the availability of water resources and the vulnerabilities for ecosystems, society and economic sectors at river basin scale.

To achieve this, STARS4Water partnered with river basin organisations from the Rhine, the Danube, the Drammen, the Seine, the Duero, the Messara and East Anglia.

Working closely with the river basin stakeholders, the project developed and delivered new data services and data driven models tailored to their needs and the priorities of river basin organisations. These river basins served as living labs, providing real-world cases to test, validate and demonstrate the value of the new data services, tools and approaches developed, and designed to improve the assessment of climate change impacts on water availability and support more informed decision-making.

The strong co-creation approach, central to STARS4Water, strengthened river basin organisations' capacity to design and implement actionable adaptation strategies in response to increasing variability and uncertainty in water availability.

By supporting science-based planning and decision-making, the project has contributed to safeguarding water-dependent ecosystems, livelihoods, and economic activities while enhancing long-term water resilience.



SOS-Water
Water Resources System Safe
Operating Space in a Changing
Climate and Society
www.sos-water.eu

aimed at developing a science-based framework to define and operationalize the Safe Operating Space (SOS) for water resources.

To achieve this, the project combined advanced water system modelling, Earth Observation and the development of innovative indicators with an inclusive stakeholder engagement based on true collaboration across four case studies in Europe and beyond.

The project engaged key local stakeholders in the Danube, the Júcar, the Mekong and the Rhine to identify local water values and key challenges and co-create future scenarios and define pathways for management actions.

SOS-Water provides tools to assess whether regional and basin water systems remain within ecological and socio-economic boundaries under climate and socio-economic changes. Thus, it tackles urgent challenges related to water scarcity, water quality degradation, biodiversity loss, inefficient water governance, and equity, among other things.

As such, the project contributes to regionally relevant and actionable policies alongside practical water management strategies to inform sustainable water management worldwide.

I. THE IMPLEMENTATION CHALLENGE

Why is acceleration needed now?

Four conditions, illustrated below, are simultaneously changing. And the pace of change is faster than the traditional cycle of diagnosing a problem, commissioning a study and waiting for the next planning round. Water resilience therefore requires greater capacity and faster action to anticipate change and adapt management decisions as conditions evolve.

Climate risks are becoming more persistent and compound



50%

of EU + UK territory was under drought conditions at some level in late July 2026; 9% was at alert level.

JRC/EDO, 2026¹

By mid-August 2026, drought alert conditions extended across France, Benelux, southern Germany, northern Italy and much of the Danube basin. Copernicus reported that average European surface-soil moisture in August was significantly lower than in the summer of 2022².

Resilience planning must therefore prepare for prolonged and compound events rather than reacting to individual droughts or floods after they occur.

The policy context has shifted with the 2025 European Water Resilience Strategy



10%

EU-wide water-efficiency improvement by 2030 is the Strategy's voluntary objective.

EC, 2025³

The European Water Resilience Strategy sets three strategic objectives: restoring and protecting the water cycle; building a water-smart economy; and securing clean and affordable water and sanitation for all. It highlights 5 key enabling areas: governance and implementation, finance and infrastructure, digitalisation and AI, research and innovation/skills, and security and preparedness.

These objectives become real only when they can be translated into decisions at the scale where water is allocated, ecosystems are managed and trade-offs are negotiated: the river basin. This strong policy direction urgently calls for basin-scale operating practice.

Digital capabilities are rapidly advancing



40%

of global water-related patents are held by the EU, while Europe's water-technology market is worth around €111.7 billion annually.

EC, 2026⁴

Earth Observation, data-driven modelling, artificial intelligence and digital twins are rapidly expanding the information and analytical capabilities available for water management. The European Water Resilience Strategy seeks to accelerate digital transition through the EU-wide Action Plan on digitalisation, the Copernicus Water Thematic Hub and the further development of Destination Earth capabilities.

However, technological development can advance faster than the capacity of institutions to adopt, maintain and integrate new solutions into operational practice. The challenge is therefore not simply to develop more advanced technologies, but to ensure that digital innovation remains trusted, interoperable, accessible and aligned with actual river-basin management needs.

Basin stakeholders are being asked to manage sharper trade-offs



34%

of the EU population is affected by water stress in an average year.

EEA, 2025⁵

River basin organisations increasingly need to balance ecosystem requirements with drinking water, agriculture, energy, industry and navigation, often under considerably variable water availability. The 2026 drought exposed these interdependencies.

These conditions make the implementation question concrete: how can river-basin managers anticipate thresholds and tipping points, decide which interventions are feasible, cost-effective, and robust under uncertainty, and adapt before impacts become crises?

¹ European Commission Joint Research Centre, 2026. [Worsening drought and record heat grip Europe, fueling extraordinary wildfires and extremely low river flows](#) (12 Aug 2026).

² Copernicus Climate Change Service, 2026. [Precipitation, relative humidity, soil moisture and river flow for August 2026](#).

³ European Commission, 2025. [European Water Resilience Strategy](#), COM (2025) 280 final.

⁴ European Commission, 2026. [A digital action plan for the water sector – Call for evidence](#). Ares (2026)531017

⁵ European Environment Agency, 2025. [Thematic briefing: Europe's environment 2025 - Water and climate impacts](#) (29 Sept 2025)

LESSON 1 — ANTICIPATE CHANGE

Plan for non-stationarity, thresholds and adaptation pathways

Historical conditions are no longer a sufficient guide to future water management. Across many basins, climate change can alter not only average water availability but also seasonality, low-flow duration, groundwater recharge, snowmelt, water quality and water demand. A basin may become wetter annually while becoming drier in the summer. Measures that improve efficiency may not, by themselves, save water and protect water-dependent ecosystems; and local actions can shift pressures elsewhere in the system. Forward-looking management therefore needs to test the whole water system under combinations of climate and socio-economic change including changes in policy.

From risk assessment to the “Safe Operating Space”

A useful operational question is: Within what conditions can the water system continue to meet ecological, social and economic functions, and what happens when those conditions are approached or exceeded? Safe Operating Space approaches translate this question into a set of locally relevant indicators and thresholds. Depending on the river basin, these may concern abstraction, groundwater levels, environmental flows, water quality, ecosystem condition, water supply reliability or other functions. The value is not a universal threshold imposed from outside; it is a transparent process to connect evidence, stakeholder values and management responses.

Thresholds and potential tipping points should therefore be treated as decision aids rather than isolated numbers. They become more useful when linked to scenarios and adaptation pathways: if an indicator approaches a critical zone, which measure is activated, by whom, with what expected benefit, and what evidence would justify changing course? This is how resilience can be operationalised as adaptive management rather than as a one-off plan.

Júcar: single measures may not be enough SOS-WATER CASE



The [Júcar River Basin](#) in eastern Spain is a highly stressed Mediterranean water system, where intensive agricultural water use, recurrent multi-annual droughts and important ecosystem needs create a fragile balance between water availability and demand.

Key challenges include water scarcity and high irrigation demand, agricultural sustainability, ecosystem protection — including the Albufera wetland and native fish habitats — and the implications of the energy transition. Climate change is expected to intensify drought conditions and irrigation demand, increasing the risk of crossing critical Safe Operating Space thresholds.

The SOS-Water case demonstrates why basin priorities, indicators and thresholds need to be defined together with stakeholders and why adaptation options should be assessed across multiple objectives and stressors. The analysis also shows that individual measures may be insufficient: widely supported options such as water reuse or drip irrigation can improve some aspects of system performance without necessarily restoring a safe operating state, particularly for ecosystems. Building long-term resilience therefore requires combinations of measures that address water demand, environmental needs and wider basin pressures together.

Messara: stress-test the system before the crisis STARS4WATER CASE



The [Messara River Basin](#) in Crete is one of Greece's most productive agricultural areas, but its intensive irrigation demand and strong dependence on groundwater have placed the basin under persistent water stress. In several parts of the basin, groundwater over-abstraction led to declining groundwater levels and water-quality pressures.

Under the historical reference period 1980-2022, around 58% of the basin's agricultural area experienced water deficits almost every year, while irrigation water-supply reliability in the most affected sub-basins was only 0–9%.

Working with local stakeholders, the Safe Operating Space concept was translated into a locally relevant assessment centered on irrigation water-supply reliability. The framework was then used to explore “what-if” scenarios of five and seven consecutive drought years, showing how prolonged drought could further expose weaknesses.

The Messara case shows how resilience planning can move beyond general climate-risk assessments by combining locally meaningful indicators, integrated modelling and stakeholder-defined scenarios. It also illustrates that testing scenarios in advance can help basin authorities identify where current operations may become unsustainable. It can further highlight which interventions could help maintain water availability under more severe future drought conditions.

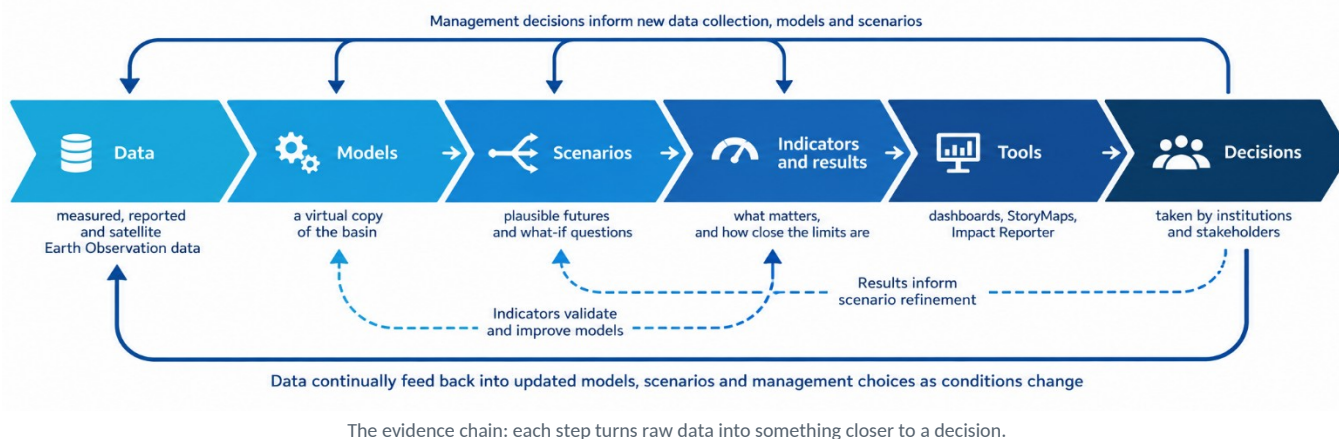
Practical lesson for the EU Water Resilience Strategy

Preparedness should not stop at hazard maps or early warning. EU and national support should enable basin authorities establish forward-looking water balances, scenario stress tests, locally meaningful thresholds and pre-agreed adaptation pathways. This directly supports the Strategy's objectives of restoring the water cycle and building a water-smart economy, while strengthening the enablers on preparedness, governance and research and innovation.

LESSON 2 — BUILD THE EVIDENCE CHAIN

Do not develop isolated tools; build a usable chain from data to decisions

STARS4Water and SOS-Water show that river basin managers rarely need “more data” in the abstract. They need a connected evidence chain that makes data accessible, converts observations into system understanding through models, explores plausible futures, translates results into meaningful indicators and thresholds, and communicates them through tools that support real management decisions. As the projects’ co-creation experience demonstrates, this chain must start from the management questions that its intended users need to answer. Weakness at any of these links can prevent technically strong research from being used.



1. Make existing data easier to find and combine

The [STARS4Water Metadata Portal](#) addresses a basic but persistent barrier: relevant datasets are fragmented across organisations, scales and platforms. Its third release catalogued more than 490 datasets spanning water resources, climate and related themes, at global, European and regional scales. The SOS-Water [SWOT Lake and River Explorer](#) makes satellite hydrology data accessible without large downloads or specialist technical knowledge, while [SOS-Water's EO Prototypes](#) (EOPs) demonstrate how Earth Observation can help fill gaps in variables such as water-surface elevation, surface temperature, crop productivity and snow-water equivalent. The practical lesson is that European data investment should include discoverability, interoperability, clear provenance and the combination of in-situ and Earth Observation data—not only creation of new datasets.

2. Use AI to complement modelling approaches

[STARS4Water data-driven methods](#) demonstrate how process-based modelling can be complemented to estimate and forecast key components of water systems, including reservoir storage and inflows, groundwater availability and quality, and agricultural water use. Machine learning approaches are increasingly important, but their operational value depends on validation, uncertainty communication, continuity of observations and integration with in-situ networks and established hydrological knowledge. AI should strengthen the evidence base, not a substitute for it.

3. Explore futures, identify critical indicators and translate results into decisions

Models become most useful when they help managers explore plausible climate, demand and management scenarios and understand the consequences of different interventions. But scenario results alone are not enough: they must be translated into indicators and thresholds that show what matters, where risks are emerging and how close the system may be to critical limits. Both projects used models and scenarios to explore interactions and trade-offs across sectors and scales. The practical lesson is to stress-test combinations of interventions against plausible futures and to identify when shifting conditions require management strategies to be adjusted. STARS4Water and SOS-Water then used dashboards and visualisation tools to make these results accessible to decision-makers. STARS4Water combined a [Generic Dashboard](#) for comparable indicators with [Tailor-made Dashboards](#). The [SOS-Water Visualisation Tool](#) allows users to compare indicators, scenarios, vulnerabilities and adaptation options across case studies.

4. Decisions are shaped by evidence and experience

The evidence chain does not end when a decision is taken. Monitoring outcomes and learning from previous impacts and adaptation responses should feed back into future management choices, models and scenarios. The [STARS4Water Impact Reporter](#) complements quantitative indicators with evidence on observed biophysical and socio-economic impacts and experiences with adaptation measures, helping identify successes and failures, and how future assessments and adaptation strategies can improve.

Practical tip: Make the evidence chain both operational and adaptive

The evidence chain is iterative rather than linear: monitoring and experience continually feed back into updated models, scenarios and management choices as conditions change.

LESSON 3 — INSTITUTIONS MATTER

Co-creation, science-policy-practice partnerships and well-functioning river basin organisations are core foundations

Experiences from STARS4Water and SOS-Water across European river basins demonstrate that co-creation and sustained science-policy-practice partnerships are essential enabling conditions for adaptive water management. The strongest technical products in both projects were developed through repeated interaction of the scientists with the people expected to use these products. Co-creation is not simply consultation at the end of a research task. It means involving basin organisations and relevant water users in framing the management questions, selecting indicators and tools, identifying plausible scenarios, deciding what uncertainty is decision-relevant, testing outputs and refining the communication of results. This increases relevance, ownership and uptake.

What science adds

Science is most useful when it is tailored to the end-user needs and helps them to look ahead rather than solely explain the past: quantifying uncertainty, exposing cross-sector trade-offs, identifying approaching limits, testing interventions before investment, and defining signals that should trigger adaptation. These should be specified in close interaction with the river basin stakeholders.

River basin organisations are the bridge from strategy to implementation

Water resilience cuts across agriculture, energy, industry, spatial planning, navigation, ecosystems, drinking-water supply and civil protection. River basin organisations are well placed to connect these interests as they work on the hydrological scale where upstream and downstream effects become visible. But many face technical, financial and staffing constraints, fragmented mandates and limited capacity to maintain advanced digital services and tools. Strengthening them therefore means more than purchasing software: it requires skills, data stewardship, durable service arrangements, and administrative or policy mechanisms that enable collaboration with actors outside the water sector.

Danube & Rhine: resilience crosses borders and sectors STARS4WATER and SOS-WATER CASE



The [Danube](#) and [Rhine](#) cases show why river basin organisations are central to turning resilience objectives into coordinated action.

Both are large transboundary systems supporting navigation, hydropower, industry, drinking-water supply, agriculture and ecosystems. Changing low-flow regimes can affect several of these uses simultaneously, with management responsibilities distributed across countries, sectors and administrative levels.

The key lesson is that adaptation cannot be optimised on a basin segment scale. River basin organisations can provide the institutional bridge for shared evidence, comparable indicators, joint scenario development and coordinated responses across jurisdictions and sectors. Their role is therefore not only technical, but also one of convening stakeholders, making trade-offs visible and helping translate basin-wide risks into coherent adaptation priorities.

Drammen: “more water” can still mean greater risk STARS4WATER CASE



The [Drammen river basin](#) in Norway illustrates why river basin organisations need to look beyond changes in average annual water availability. Climate change is expected to bring higher precipitation and annual flows, but also earlier snowmelt, increased rainfall-driven flooding and longer summer low-flow periods.

This creates a more variable hydrological regime in which apparent increases in water availability can coexist with greater seasonal risks.

For river basin organisations, the key lesson is the need to manage variability and competing objectives together. In the Drammen, reservoir operations may need to balance hydropower production, flood protection, ecological flow requirements and summer water availability under changing seasonal conditions. Basin-scale modelling, stakeholder dialogue and adaptive operating rules can help translate these shifting risks into coordinated management decisions rather than relying on historical flow patterns alone.

Implementation principle

Strengthen the institutional conditions that make innovation usable by the river basin organisations: a responsible owner, long-term maintenance, interoperable data, trained staff, cross-sector convening capacity and a clear route from evidence to decision.

Do existing EU legal instruments support or hinder resilience?

The existing EU water legislation provides a strong foundation for water resilience: the Water Framework Directive establishes basin-scale planning and environmental objectives, while the Floods Directive provides a framework for anticipating and managing flood risks. The challenge is therefore less a lack of legal instruments than how effectively these instruments are implemented, connected and adapted to increasingly fast-changing climatic conditions and cross-sector pressures. The Commission's 2025 assessment found only 39.5% of assessed EU surface water bodies in good ecological status/potential and 26.8% in good chemical status, while calling for faster implementation and stronger integration of water into other policies⁶.

The practical question is therefore how to make the established planning framework more adaptive to fast-changing conditions. River Basin Management Plans and Flood Risk Management Plans operate on six-year cycles, while droughts, water availability, technologies and competing sectoral demands can change much faster. Formal river basin planning cycles can be complemented by continuous monitoring, regularly updated scenarios, thresholds and triggers, and adaptation pathways that allow decisions to be revisited during the six-year cycle, rather than waiting for the next formal plan update. Research should help authorities operationalise existing obligations and resilience objectives together, rather than creating parallel frameworks that disappear when projects end.

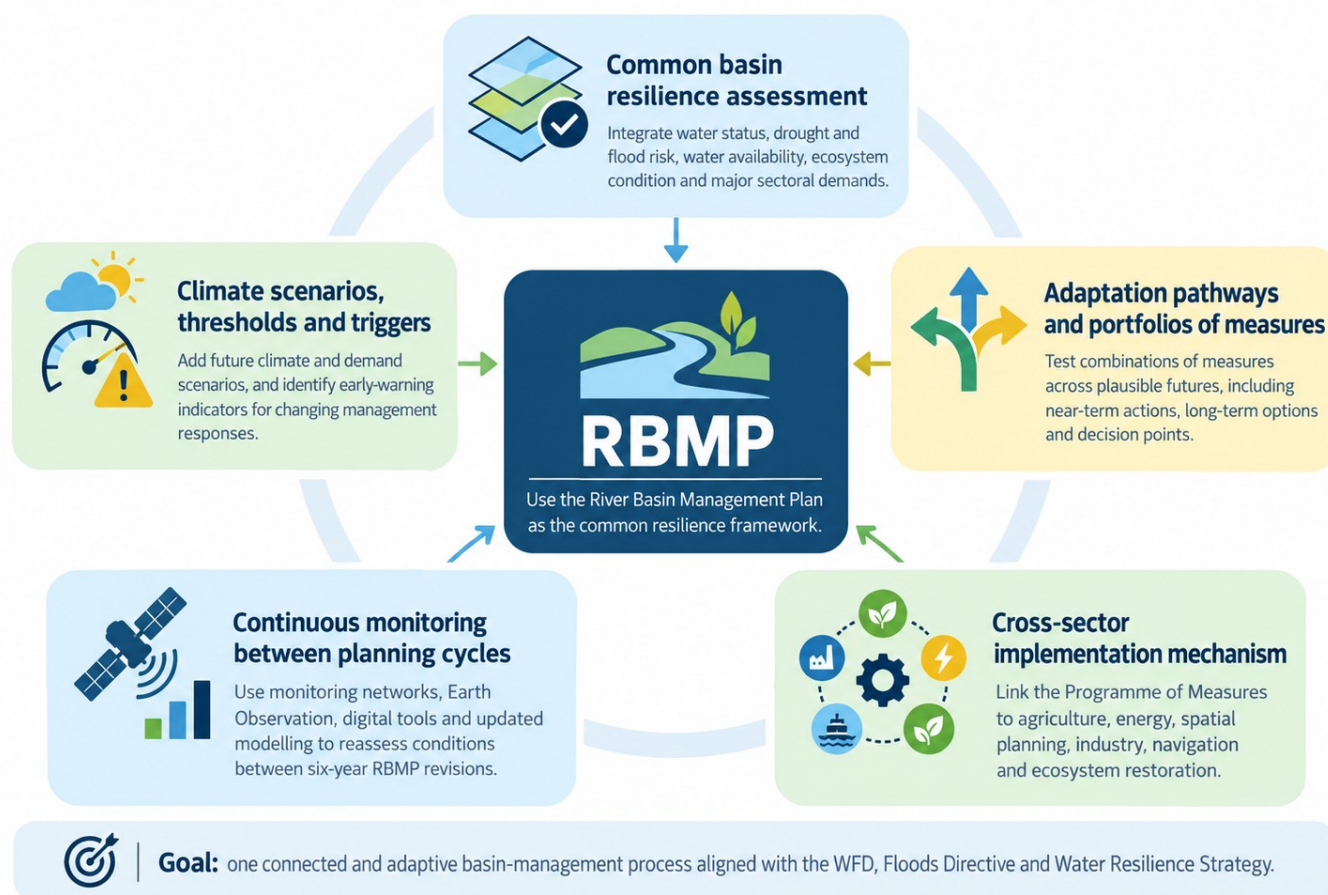
Integrate resilience into the RBMP — do not create another parallel plan process

The missing element is not another planning instrument, but a more forward-looking layer within the existing planning system. In practical terms, future RBMP cycles could strengthen five elements:

- a common integrated forward-looking basin resilience assessment;
- climate and socio-economic scenarios, indicators, thresholds and triggers;
- adaptation pathways and portfolios of measures;
- continuous monitoring between six-year planning cycles;
- a cross-sector implementation mechanism integrating water resilience across sectors

Practical tip: integrate resilience into the RBMP

Do not create another parallel plan



Integrating resilience into River Basin Management Plans (RBMPs).

⁶ European Commission, 2025. 7th Implementation Report of the Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC) (Third River Basin Management Plans and Second Flood Risk Management Plans). COM (2025) 2 final.

II. KEY FINDINGS FROM THE JOINT BRUSSELS POLICY EVENT — JUNE 2026

Europe's main bottleneck is the implementation gap

On the 22nd of June 2026, SOS-Water and STARS4Water brought together science, policy and practice to explore how evidence-based, forward-looking approaches can strengthen Europe's water resilience in a Joint Policy Event held in Brussels. The discussions highlighted that Europe's main challenge is increasingly not the lack of scientific knowledge or technical solutions, but their uptake and implementation. European research and innovation programmes have generated extensive datasets, models, decision-support tools and evidence on water resources, climate adaptation, droughts, floods and ecosystem management. However, translating these outputs into operational river basin management and concrete adaptation measures remains difficult, particularly because of institutional, financial and capacity constraints within public authorities and practitioner organisations.

The discussions converged around six main enablers needed to translate and propagate scientific knowledge, tools and innovation into operational water resilience at river-basin scale.

1. Shift from projects to durable services

Promising tools often lose funding, maintenance and technical support when a project ends. Public authorities need mechanisms to host, update and support mature research outputs beyond the three-to-four-year project cycle.

2. Strengthen the science–policy interface

Scientific output must be organised around policy and management questions, decision timescales and operational constraints. Translation and integration into decision-making are as important as technical sophistication.

3. Treat digitalisation as organisational change

Digital innovation must be accompanied by organisational readiness. Dashboards, Earth Observation, AI and modelling can only improve decisions when organisations have data governance, skilled staff, trusted methods, clear responsibilities and resources to incorporate them into routine procedures.

4. Build capacity where implementation happens

Basin authorities need sustained technical and human capacity to interpret uncertainty, evaluate cross-sector trade-offs, use new data services and move from analysis to adaptation measures.

5. Maintain co-creation and partnerships over the long-term

Co-creation enhances relevance, ownership, and uptake. Trust and shared understanding accumulate over time. Long-term science–policy–practice partnerships are more likely than short consultations to produce tools and evidence that remain relevant and effective as conditions evolve.

6. Empower basin organisations to convene beyond water

Water resilience depends on agriculture, energy, industry, spatial planning, ecosystems and civil protection. Basin organisations are uniquely positioned to coordinate integrated adaptation efforts from source to sea and can become key actors in water resilience. However, they need the mandate, resources and policy interfaces to coordinate these actors around shared evidence and transparent trade-offs.

What does this change for European research and innovation?

The next generation of European water research should be judged not only on whether it produces new knowledge, but also on whether it creates an implementation pathway. Calls and projects can require early identification of the operational owner, links to River Basin Management Plans and sectoral decisions, a maintenance and financing model for successful services, common data and interoperability standards, capacity-building resources, and a realistic route for scaling across basins without erasing local context. This is also where the Water Resilience Strategy's enablers reinforce one another: digitalisation and AI need research, skills and governance; infrastructure investment needs forward-looking evidence; preparedness needs indicators, thresholds, scenarios and decision triggers; and implementation needs institutions capable of acting on all the above.

Key message from the Joint Policy Event

Participants repeatedly emphasised that EU Commission should facilitate making knowledge usable, sustained and embedded in public-sector practice. Research and innovation remain essential, but impact depends increasingly on the pathway from a successful project result to a maintained service, an institutional workflow and an implemented measure.

III. POLICY RECOMMENDATIONS

From evidence to implementation

The [EU Water Resilience Strategy](#) (EU WRS) sets out three core objectives and five cross-cutting enabling areas to ensure secure, clean, and sustainable water management across Europe, as illustrated below.



Achieving the objectives of the EU WRS will depend not only on generating new scientific knowledge, but also on ensuring its long-term accessibility, operational uptake, and integration into river basin management. To support the implementation of the EU WRS, STARS4Water and SOS-Water have the following policy recommendations, each one contributing to different core objectives and addressing various enablers:

I. Strengthen science-based decision-making through targeted policy guidance

Effective implementation of the EU WRS requires clear guidance on how scientific evidence, climate projections, and water management tools can be systematically integrated into planning and decision-making processes at river basin, national, and European levels.



II. Ensure the long-term sustainability of research outputs

Significant investments have been made in developing innovative tools, services, and datasets through European research projects. Dedicated mechanisms are needed to maintain, update, and operationalise these outputs beyond project lifetimes, ensuring their continued value for water managers and policymakers.



III. Accelerate uptake and implementation of available solutions

Many river basin organisations and public authorities face capacity constraints that limit the adoption of new tools and approaches. Targeted support is required to facilitate the uptake of research results and translate scientific innovation into operational water management practices.



IV. Invest in human and technical capacity for water resilience

Building water resilience requires strengthening both technical capabilities and human expertise. Continued investment in skills development, training, digital infrastructure, and data management capacities will enable authorities to better anticipate and respond to water-related risks.



V. Empower river basin organisations as key implementation actors

River basin organisations are central to delivering water resilience on the ground. Providing them with adequate resources, governance support, and access to scientific knowledge will enhance their ability to coordinate stakeholders and implement effective adaptation measures.



VI. Foster long-term partnerships between science and river basin management

Sustained collaboration between researchers, water managers, policymakers, and stakeholders is essential to ensure that scientific knowledge remains relevant, actionable, and responsive to emerging challenges. Long-term science-policy-practice partnerships can accelerate innovation uptake and support adaptive water management.



VII. Promote integrated and adaptive river basin management

Adequately implementing climate resilient water resources management in river basins requires moving beyond fragmented approaches. River basin management should integrate water quantity, water quality, ecosystems, climate risks and socio-economic needs within a coherent and adaptive framework.

