

Towards a new EU Climate Resilience Framework

Enabling waterway authorities to take up their responsibility for increased resilience and preparedness

Executive Summary

Inland waterways are critical multi-functional infrastructure in Europe, supporting navigation, water supply, energy, agriculture, tourism, and ecosystem services. Managed by waterway authorities, these systems simultaneously protect, preserve, and produce—maintaining infrastructure and flood defenses, hosting ecological corridors, and supplying water for industry, communities, and agriculture.

Climate change is increasingly affecting these waterways through slow-onset changes, extreme weather events, droughts, floods, and ecological degradation. These impacts cascade across transport, industry, energy, agriculture, public health, and tourism, creating systemic risks that cannot be addressed by individual Member States alone.

Investing in inland waterways generates triple dividends: it protects lives and critical infrastructure, preserves ecosystems, and produces long-term economic and strategic resilience. Proactive, integrated, and cross-sectoral approaches—supported by coherent policies, adaptive planning, and sustained financing—are essential to maximize synergies, avoid maladaptation, and ensure Europe’s water security, climate resilience, and economic competitiveness.

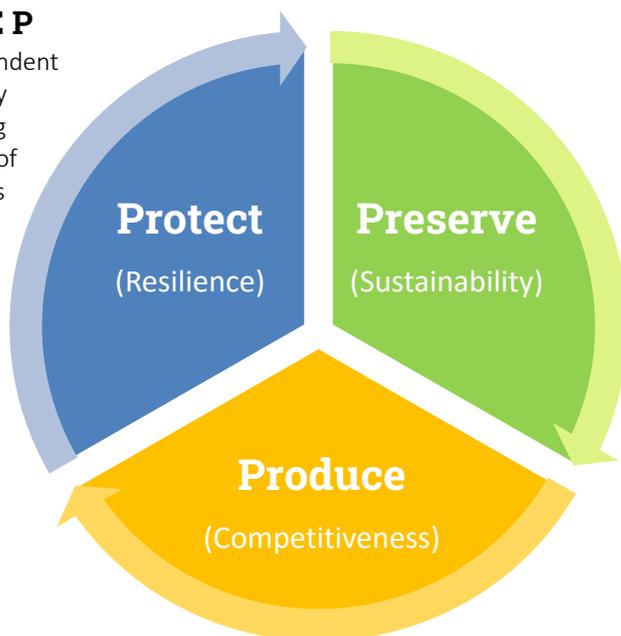
1. Waterways are critical, multi-purpose assets

Waterway authorities manage and operate navigable rivers, canals and lakes in Europe which cross EU cities and landscapes while hosting communities, economic activities and nature. Waterways and their ancillary infrastructure store a significant percentage of Europe’s surface water. According to their mandates, waterway authorities’ responsibilities extend from safe and seamless navigation to integrated management of water resources and infrastructure, water supply, flood mitigation and ecosystem services.

The multi-functional role of inland waterways is essential to Europe’s economies, society, and environment:

TRIPLE P

Interdependent & mutually reinforcing functions of waterways



PROTECT critical infrastructure for economic & civilian security

- Maintenance & modernization of waterways, dams, locks, dikes, reservoirs, retention areas
- Flood mitigation & relief for riparian communities, utilities and industries
- Water scarcity & drought management

PRESERVE by hosting ecological corridors

- Biodiversity maintenance & restoration
- Nature-based solutions

PRODUCE by providing water supplies for

- Navigation that enables low-carbon transport for EU industry, dual-use, tourism and recreation
- Drinking water for citizens
- Agriculture to ensure food security
- Hydropower, heating & cooling of energy plants

These three roles are mutually enforcing because interdependent systems are collectively vital to the cohesive functioning and security of the EU economy and society. Beyond navigation, the surface waters of navigable waterways are essential for the strategic nexus drinking water, agriculture, and industry. Sponge landscapes are created to absorb water during heavy rainfall and release it again slowly in periods of droughts, ensuring water security for multiple sectors. The maintenance and modernization of infrastructure are essential to keeping economic and social systems functioning effectively. These are far from marginal responsibilities. In Belgium, the Albert Canal is a major transport artery while also supplying around 40% of Flanders’ drinking water. Additionally, its surface waters meet more than 75% of industrial water demand—primarily from the chemical clusters in and around the Port of Antwerp. In France, the waterways managed by Voies navigables de France provide drinking water for 50% of the population, irrigation for 45% of agricultural land, and cooling water for 20% of the country’s electricity generation capacity.

This guides waterway authorities towards integrated and multidisciplinary planning, design and management of projects, acknowledging **interdependencies** and combining functions wherever possible to maximize synergies and co-benefits for all.

2. How does climate change affect waterways and overall water resilience?

The strategic and multi-purpose role of inland waterways is increasingly evident in the interdependencies between functions and in the context of climate change, which threatens the availability, safety, and resilience of this critical infrastructure. The EEA Climate Risk Assessment identifies 16 of 36 key EU climate risks as water-related and these risks do not exist in isolation: they spread through supply chains, public services, and communities. Inland waterways operate within a system of systems, where disruption in one system cascades across many others.

Waterway authorities managing navigable rivers and canals are therefore at the frontline of resilience. Attention mainly goes to extreme weather conditions and event such as prolonged water scarcity, droughts, and flooding. We also need to pay close attention to slow-onset changes—such as shifts in rainfall intensity and seasonality, and rising water temperatures—that affect water availability and physico-chemical quality, and are increasingly becoming the new normal. This results inter alia in:

Climate change threats 	Cascading effects 	Impacts 
<p>Water scarcity and drought often exacerbated by conflicting use between sectors</p>	<p>Cargo capacity of shipping decreases, disruptions lead to transport costs increase, and supply chain disruption plus congestion on saturated land networks.</p>	<p>Transport & Logistics: Increasing carbon emissions, decrease in multimodal capacity and economic losses for industry, undermining competitiveness.</p>
	<p>Production capacity of water-dependent industry clusters are affected (chemical and energy sectors).</p>	<p>Industry & Energy: Decreased production capacity, undermining energy security and competitiveness.</p>
	<p>Water shortages lead to stressors on crop production.</p>	<p>Agriculture: Income loss and affecting food security.</p>
	<p>Drinking water shortages and decrease in reliable drinking water supplies for emergency services.</p>	<p>Public Health: Health and wellbeing of citizens.</p>
	<p>Water availability affects tourism on and along rivers and canals.</p>	<p>Tourism: Revenue loss in tourism sector and for small towns and rural areas that depend on income for employment as well as preservation & promotion of cultural & natural heritage.</p>
<p>Floodings and overtopping</p>	<p>Increased discharges, flow velocities and high water levels lead to significant changes in sedimentation and river morphology. Driftwood and fallen trees create clogging and barriers. Flooding damages water-related and adjacent structures and endangers human life.</p>	<p>Transport & Logistics: Disruption and economic losses for industry, undermining competitiveness.</p>
		<p>Critical Infrastructure, Industry, Energy, Agriculture: Disruption, outages, and economic losses.</p> <p>Public Health & Ecosystem Services: Health and wellbeing of citizens.</p>
<p>Ecological degradation</p>	<p>Harm to biodiversity and the natural environment increases the presence of invasive species and algal bloom while affecting the conservation and restoration of vital water habitats.</p>	<p>Ecosystem services: Loss of ecosystem services affect the functioning of economy and society.</p>
		<p>Transport & Tourism: Invasive species and harmful algal blooms clog ship and boat</p>

		propellers, damage marinas, and disrupt waterfront activities, while the resulting landscape degradation diminishes the area's appeal for both residents and visitors.
Soil degradation, erosion, and hydrological instability, undermining structural integrity and safety of infrastructure	Shipping disruptions lead to an increase in transport costs and supply chain disruption as well as congestion on saturated land networks.	Transport & Logistics: Increasing carbon emissions and economic losses for industry, undermining competitiveness.
	Damage and subsidence of critical infrastructure including fairways, embankments, dams, dikes, reservoirs, bridges, terminals, roads, railways, hosted utilities including energy networks, pipelines, fiber-optic and data cables, drainage and sewerage systems.	Critical infrastructure: Disruption and outages of essential services including water, energy, transport, data traffic, waste systems plus compromising safety of buildings.

This table is not exhaustive and does not take into account the climate change induced feedback loops that amplify risks. For example, drought-induced subsidence weakens infrastructure just before storm seasons. This increases flood damage amidst a backlog in maintenance and renovation of infrastructure, decreases in funding, and increasing danger of hybrid warfare. This causes a systemic risk to multiple and interdependent vital functions of our society and economy.

The impacts described in the table and the cross-border nature of many European waterways imply that building effective resilience cannot be addressed by individual Member States alone.

3. How can we respond more effectively to climate change and increase resilience?

Water is a strategic asset. European climate resilience depends on proactive adaptation and cooperation among stakeholders, citizens, and governments. Resilience is defined as the capacity to withstand, absorb, recover, adapt, and transform when faced with expected and unexpected changes and disruptions. As such, **climate resilient infrastructure calls for a continuous and dynamic process.**

Every euro invested in climate-resilient inland waterway infrastructure should be compared to the costs of inaction as it avoids multiple euros in damage and cascading economic losses. Infrastructure failure leads not only to transport disruption but also to drinking water shortages, ecosystem degradation, and risks to energy and food supplies. Well-maintained and properly invested waterways act as important buffers during extreme events, absorbing excess water during floods and releasing it during dry periods. These functions reduce pressure on infrastructure, lower long-term costs, and safeguard water availability for its many uses. Many industries and their supply chains depend on water reliability, and regions with adaptable water systems will be better positioned to sustain economic activity.

Barriers	EU Policy Toolbox
	
<p>Knowledge</p> <ul style="list-style-type: none"> Low understanding of the multi-functionality of inland waterways Gaps in monitoring, modeling, and forecasting capacity including the granularity of risks, reinforcing effects and feedback loops 	<p>Raise political awareness and understanding about the multi-purpose role of inland waterways as critical infrastructure, ensuring policy frameworks reflect interdependencies across numerous sectors. Being fully aware of interconnectedness and leveraging synergies will strengthen our resilience.</p> <p>Invest in research, development, and innovation to create a structural and shared understanding of present and future climate conditions with sufficient granularity, particularly regarding the multi-functional assets that waterways represent, to inform the design of effective and integrated measures. This includes advanced forecasting and monitoring tools that enable to continuously optimize waterway management with short-, medium- and long-term hydrological projections supported by a high-quality data-to-services value chain, fully integrable with existing information systems and platforms. The effort should also strengthen modelling and risk-assessment capabilities, including the analysis of feedback loops to anticipate cascading failures across interconnected infrastructure networks. This also includes piloting of innovative solutions that complete the waterway management toolbox such as flexible measures, smart locks and circular water use systems.</p>
<p>Institutional</p> <ul style="list-style-type: none"> Fragmented sector-based policy approaches. Conflicting priorities on the demand side between those that use waterways for transport, 	<p>Embed climate resilience-by-design into coherent, system-wide approaches that align risk assessments, resilience plans, governance processes and concrete projects. We strongly support this principle and understand the prioritization of the sectors most exposed to climate impacts. At the same time, we warn against isolating sectors as it can obscure the interdependencies and shape real-world vulnerabilities. Waterways illustrate why a cross-sector</p>

<p>agriculture, drinking water, industry, and energy at local, national and EU level leading to partial, suboptimal solutions and maladaptation.</p>	<p>perspective is essential. Because they serve transport, energy, ecosystems, agriculture, industry, tourism and local communities - sector-specific measures can easily create unintended spillovers. An integrated climate-resilience-by-design approach helps ensure that interventions generate co-benefits, avoid maladaptation, and strengthen the overall performance of the waterway system. Recognising multifunctionality also supports a shared understanding of current and future climate conditions among decision-makers across Europe. Siloed planning often leads to conflicting uses, weak points in infrastructure, and fragmented adaptation efforts. Strengthening collaboration across administrative levels and sectors—while acknowledging geographic diversity—creates more coherent EU-level policies and more robust local implementation. Joint assessment and planning frameworks that reflect the interests of all users enable more efficient and sustainable resource management. Droughts, floods and seasonal changes increasingly interact, placing additional pressure on water-related infrastructure. Comprehensive modelling and monitoring, integrated approaches and proactive risk management are indispensable for addressing these combined risks. For this reason, coordinated implementation of the Water Resilience Strategy and the EU Climate Resilience Framework is essential to ensure consistency, efficiency, and long-term impact.</p>
<p>Financial</p> <ul style="list-style-type: none"> • High cost of inaction when chronic underinvestment, lack of repair or maintenance leads to increased system-level risks to economy and society and higher remediation costs due to unpreparedness. • Fragmented and insufficient funding levels • Inflexibility of grant agreements hinder application of evolving knowledge. 	<p>Shift strategically from fragmented financing to integrated, stable and long-term financing. This is essential to expand capacity and strengthen investment in the preparedness and resilience of waterway infrastructure. Today’s funding landscape is fragmented and insufficient; even as maintenance backlogs grow, renovation needs accelerate and overall public budgets decline. Meeting escalating climate-related pressures requires the full chain of modelling, monitoring, planning and implementation, which demands predictable investment levels that waterway authorities cannot meet on their own. A coherent, long-term funding strategy should adapt the current straightjacket of sector-based instruments to the present and future needs. To support climate-resilient waterways, both existing and future programmes need built-in flexibility that enables integrated solutions and generates co-benefits across sectors such as transport, energy, biodiversity, agriculture, industry and tourism. Cross-sector eligibility — allowing projects that deliver multiple benefits to combine multiple funding streams in a straight-forward, fit-for-purpose and burden-free way ensures that investments are efficient, future-proof and aligned with broader societal and economic objectives.</p> <p>Enable adaptive planning through flexible programme design because effective climate adaptation depends on emerging knowledge, continuous monitoring and systematic evaluation. European funding programmes should therefore allow for phased implementation and adjustments as knowledge and risks evolve. Flexibility can be strengthened by structuring projects into stages, enabling learning and recalibration at each step. Adaptive planning benefits from:</p> <ul style="list-style-type: none"> • Room for iterative design, allowing authorities to incorporate new data and refine measures over time within grant agreements to achieve better results. • Support for no-regret options, which deliver benefits under a wide range of climate scenarios. • Tailoring to geographic diversity, ensuring that measures reflect local hydrology, climate impacts and socio-economic conditions.
<p>Regulatory</p> <ul style="list-style-type: none"> • Fragmented rules prevent coherent cross-border resilience measures. • Follow-up of complex monitoring drains scarce administrative resources 	<p>Strengthen climate resilience implementation with coherence and clarity. A coherent set of climate-resilience measures should prioritize simplification and clarity that strengthens effectiveness without adding administrative burden. Waterway authorities must navigate a dense landscape of EU and national regulations, directives, and guidance documents. Waterway authorities face:</p> <ul style="list-style-type: none"> • A proliferation of monitoring requirements and guidance documents, each with its own reporting logic, timelines and data standards. • Divergent interpretations of EU directives, which complicate cross-border coordination and delay joint action. • Shrinking administrative capacity, making it increasingly difficult to manage overlapping obligations while still delivering on-the-ground resilience measures. <p>This regulatory sprawl diverts time and resources away from planning, implementation, and innovation—precisely the areas where climate resilience needs to accelerate. Effective adaptation therefore depends on consistent regulatory frameworks, aligned monitoring frameworks and clear, streamlined procedures, reducing delays and freeing capacity for technical work, stakeholder engagement and</p>

	<p>long-term planning. Coherence ensures that resilience measures reinforce one another rather than creating gaps, overlaps or contradictions. A coherent regulatory environment should therefore:</p> <ul style="list-style-type: none"> • Integrate related requirements into unified frameworks rather than adding new layers. • Favour regulations over directives to harmonize interpretations across Member States to support cross-border waterway management. • Reduce duplication in monitoring and reporting, especially where data already exists or can be shared. • Provide stable, coherent and predictable guidance based on consensus between stakeholders instead of a multiplication of guidance documents, allowing authorities to plan multi-year resilience strategies with confidence. <p>Simplification is not about lowering ambition; it is about making ambition deliverable.</p>
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Europe’s inland waterways are at the heart of climate resilience and economic strategy across the continent. Failing to invest in their maintenance, modernization and management amplifies risks, increases costs and undermines water, energy, and food security. Strategic, sustained, and dynamic investment and policy measures ensures these multifunctional systems continue to protect communities, preserve ecosystems and produce economic value. Inland waterways are far more than transport corridors; they are fundamental to a resilient, sustainable and competitive Europe.

Annex: Examples of integrated climate resilience measures



An integrated waterway management approach to address drought and riverbed erosion

Drought-induced low water levels cause river bed erosion. Climate change effects associated with the withdrawal of water for irrigation of agricultural areas, increased cooling of power plants, etc. can outweigh the direct climate impacts like changes in water availability, which creates negative cascading effects.

Measures to stop river bed erosion have benefits for navigation (stabilized fairway depth), and for agriculture and natural habitats adjacent to these waterways (stabilizing ground water levels). Measures are combined with optimisation of groynes, creation of fish migration routes, water body networking, wetland restoration, and ecological riverbank stabilization to ensure a [systems approach](#).



A rolling programme for integrated waterway management

Because of climate change and rising sea levels, the [Sigma Plan](#) in Flanders combines higher and wider levees in populated areas with a chain of flood areas along tidal rivers and local depoldering to make room for rivers. The aim is to protect the entire region of Flanders from flooding from those tidal rivers at storm tides.

Restoration of natural bends and meanders creates natural buffers during periods of high precipitation, while they are barriers against drought.

It is a rolling programme to ensure water safety and security, protect nature, improve navigation and protect large adjacent areas and infrastructure from flooding.



Smart water use is multiple use

Although canals are less sensitive to direct climate change effects, in severe drought periods problems can arise as they are fed by river water, and extractions for drinking water, farming and industrial activities further lower the water level.

Locks on the Albert Canal, Bruxelles-Charleroi canal, and the Upper Scheldt in Belgium have been equipped with large Archimedes screw pumps. In case of drought, water is pumped upstream to avoid water flowing downstream after lock passages. In normal circumstances, the pumps generate hydroelectricity for lock operations and households. This dual role of the pumps enables smart water use.

The locks on the Seine-Nord Canal will also be climate proof, even under very unfavourable climate conditions. All water is recycled thanks to pumping stations and lateral savings basins.



Dynamic river management

As part of the [FAIRway Danube project](#) [add hyperlink], flexible infrastructure elements have been tested on the Austrian Danube. A loaded barge is positioned temporarily at a critical section to act as training wall during low water. The barge is removed when no longer needed to help provide a reliable fairway. The first test was successful.

Flexible infrastructure can be removed after low water periods and has no further impact on the riverbed. In this way, the reliability of inland navigation will be improved without any permanent impact on water habitats and ecosystems. The pilots will also be rolled out in Croatia, Romania and Bulgaria with varying numbers and angles during upcoming low-water periods.

Inland Navigation Europe (INE) is the European platform of national & regional waterway authorities and bodies promoting multifunctional waterways for transport and resilience. INE is a neutral organisation without commercial interests.

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