



Climate change and water governance in the European Union: A brief analytical overview

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Abstract. Climate change represents one of the most complex and far-reaching challenges facing contemporary societies, with impacts extending beyond environmental degradation to affect economic stability, public health, social cohesion, and the sustainability of natural resources. Within the European Union, climate responses are increasingly embedded in integrated governance frameworks that combine binding legal instruments, strategic policy programs, and cross-sectoral coordination, with particular attention to water resources and aquatic ecosystems. This study provides an analytical overview of the main climate-related pressures affecting water systems in the European Union and examines how its environmental and climate governance framework addresses risks related to water management and ecosystem resilience. The analysis highlights persistent implementation gaps between legal ambition and practical outcomes, especially in water and biodiversity governance, and emphasizes the roles of institutional capacity, policy coherence, and societal legitimacy in shaping effective climate action. The paper argues that sustainable water governance under climate change depends not only on robust regulatory frameworks, but also on implementation quality, adaptive capacity, and public acceptance, positioning water governance as a central pillar of long-term environmental resilience in the EU.

Key Words: climate change, environmental governance, water resources, aquatic ecosystems.

Introduction. Over the last few decades, environmental issues have progressively moved from the margins to the very core of political, economic, and academic debates. Climate change, biodiversity loss, air and water pollution, and the degradation of natural resources are no longer perceived merely as isolated ecological problems, but as complex and interconnected challenges that directly affect human health, economic stability, social cohesion, and institutional resilience (Moldan et al 2012; Morgan 2012; Purnawati et al 2025). In this broader context, environmental protection has become a fundamental component of sustainable development strategies and an increasingly important dimension of contemporary governance (Craig & de Búrca 2011).

Climate change represents one of the most far-reaching transformations of the Earth system in modern history. Rising global temperatures, the growing frequency of extreme weather events, and shifting precipitation patterns have profound implications for food security, water availability, infrastructure, and public health (Hamilton & Keim 2009; Petrescu-Mag 2022; World Health Organization 2023). These impacts are unevenly distributed across regions and social groups, generating new forms of vulnerability and inequality, which reinforce the perception of climate change as a structural societal risk rather than a purely environmental one (Gürpınar 2016; World Bank 2022).

Within the European Union (EU), climate change governance has evolved into a highly institutionalized and legally structured policy field. The EU has developed one of the most ambitious climate and environmental frameworks globally, combining legal instruments, strategic action programs, and cross-sector policy integration (European Parliament and the Council 2021). The European Green Deal and the European Climate Law illustrate a shift from fragmented environmental regulation toward a comprehensive governance model that seeks to integrate climate action, biodiversity protection, and economic transformation (Hainsch et al 2022; European Parliament and the Council 2024).

Among natural resources, water occupies a particularly strategic position, as it connects climate processes with ecosystem functioning, food production, public health, and socio-economic development. Scientific sources confirm that climate-induced changes are dramatically transforming water systems (Dahal et al 2025). Rising global temperatures are disrupting thermal regimes in aquatic ecosystems, intensifying extreme weather events, and altering precipitation patterns (Mishra et al 2021). These changes place mounting stress on water resources, threatening both ecological stability and human security (Conway 2013). The hydrological cycle's vulnerability makes water security a central component of environmental security, with impacts spanning ecosystem resilience, agricultural productivity, and societal adaptation (Wheater & Gober 2015). This evidence suggests an urgent need for integrated, adaptive water management strategies to mitigate these systemic challenges.

The EU has strategically positioned water governance as a critical climate adaptation strategy, integrating ecosystem-based management approaches across environmental policies. Scholarly sources confirm this approach. The EU Water Framework Directive represents a pioneering effort to promote sustainable water resource management (Green et al 2013). Researchers highlight that EU environmental policies increasingly support ecosystem-based management, particularly through directives spanning freshwater, coastal, and marine environments (Rouillard et al 2018; Demetropoulou et al 2010). The governance framework emphasizes adaptive capacity, with a focus on multilevel coordination, public participation, and flexible implementation (Keessen & Van Rijswick 2012). Critically, these policies recognize aquatic ecosystems' multifaceted roles, from drinking water and agriculture to biodiversity conservation, and aim to maintain their core functions under changing environmental conditions (Soininen & Platjouw 2018).

From the perspective of aquatic systems, these policy developments are particularly relevant for the sustainability of freshwater and marine ecosystems, including fisheries, aquaculture, and biodiversity conservation. Climate-related pressures, such as rising water temperatures, altered hydrological regimes, and declining water quality, directly affect aquatic productivity and ecosystem functioning, underscoring the centrality of water governance to the EU climate agenda. Brander et al (2017) underscore that climate change is fundamentally transforming aquatic habitats, threatening biodiversity and ecosystem services, and necessitating integrated, adaptive policy approaches to ensure long-term sustainability. However, the existence of sophisticated legal frameworks does not automatically guarantee effective outcomes. A growing body of research highlights persistent gaps between policy ambition and practical implementation, especially at national and local levels, where administrative capacity and institutional coordination remain uneven (Lieberink et al 2011; European Commission 2012). Moreover, environmental governance is not only a technical or legal process but also a deeply social one, influenced by public perceptions, trust in institutions, and citizens' willingness to support or resist environmental measures (Hamilton & Keim 2009; Moreno-Llamas et al 2024).

The main objective of this study is to provide a brief analytical overview of the impacts of climate change on water resources and aquatic ecosystems in the EU and to reveal how the EU's policy and governance framework addresses these challenges through legal instruments, strategic policies, and institutional mechanisms. More specifically, the paper explores the relationship among climate-related risks, governance capacity, and societal legitimacy in water management, arguing that effective climate action and sustainable aquatic systems depend not only on regulatory ambition but also on implementation quality and public acceptance. By adopting this perspective, the present study seeks to contribute to understanding climate and water governance as an integrated, multidimensional process within the broader context of sustainable development.

Climate change and water-related environmental risks. In recent years, climate change has increasingly been integrated into broader discussions on environmental risk and sustainability. Traditional approaches focused primarily on economic growth and

sectoral development, but contemporary perspectives emphasize non-traditional risks such as resource scarcity, environmental degradation, and climate-induced instability (Gürpınar 2016; Craig & de Búrca 2011). From this perspective, environmental risk refers to the capacity of societies to protect the ecological foundations of human well-being and to prevent environmental change from undermining social and economic stability (Moldan et al 2012; World Bank 2022).

Climate change is often described as a “threat multiplier”, meaning that it amplifies existing vulnerabilities rather than creating entirely new ones. Regions already affected by air pollution, water stress or soil degradation are likely to experience more severe impacts under changing climatic conditions (World Health Organization 2023; European Parliament and the Council 2024). Extreme weather events can damage infrastructure, disrupt supply chains, and increase health risks, generating cumulative effects that extend beyond the environmental sphere into economic and social systems (Fuller et al 2022; Morgan 2012).

From a water governance perspective, water resources play a central role in mediating the impacts of climate change. Alterations in precipitation regimes, increased frequency of droughts and floods, and rising water temperatures directly affect freshwater availability, aquatic biodiversity, and ecosystem services. These processes pose significant risks to drinking water supply, agriculture, fisheries, and aquaculture, underscoring the importance of water sustainability as a core component of environmental and societal resilience (World Health Organization 2023; European Parliament and the Council 2024).

Public perceptions play a crucial role in shaping how climate risks are understood and politically addressed. A global survey of 280,000 respondents found that over 86% express concerns about climate change, with worry levels varying substantially between developed and developing economies (Chen & Liao 2025). Empirical studies show that perceptions of climate change vary significantly across regions and social groups, depending on local environmental experiences, political ideologies, and media narratives (Hamilton & Keim 2009; Moreno-Llamas et al 2024). In many contexts, climate risks are perceived as abstract or exaggerated, which can weaken public support for ambitious climate and water policies and limit behavioral change (Gürpınar 2016; Moldan et al 2012).

From an applied policy perspective, this implies that climate-related risks must be addressed not only through technical solutions but also through communication strategies and participatory governance mechanisms that strengthen public trust and institutional legitimacy. Weak institutional responses and lack of coordination can transform environmental stress into broader social crises, particularly in regions with limited adaptive capacity (Hainsch et al 2022; World Bank 2022). Ghorbani et al (2023) further emphasize that governance transformations are crucial for climate resilience, noting that institutional adaptations must accommodate both incremental and abrupt societal changes. The evidence consistently shows that technical solutions alone are insufficient; instead, building institutional trust, promoting transparent communication, and enabling participatory governance are critical for effectively managing climate-related risks (Ghorbani et al 2023).

Environmental governance and water management in the EU. Environmental governance in the EU is built on complex, multilayered legal and policy architecture. At the primary law level, EU treaties establish environmental protection and climate action as core objectives of Union policy, requiring the integration of environmental considerations across major sectors such as energy, transport, agriculture, and industry (Craig & de Búrca 2011; European Parliament and the Council 2021). This principle of policy integration recognizes that environmental challenges cannot be addressed in isolation from broader economic and social processes (Moldan et al 2012).

Water governance occupies a strategic position within the EU environmental framework, particularly through the Water Framework Directive (2000/60/EC), which aims to achieve good ecological and chemical status for all water bodies. The Directive represents one of the most ambitious attempts at integrated water resources

management, linking climate adaptation, ecosystem protection, and sustainable water use under a single legal framework (Liefferink et al 2011; European Commission 2012).

One of the key strategic instruments in this architecture is the 8th Environment Action Programme (EAP8), which provides a long-term framework aligned with the objectives of the European Green Deal. EAP8 prioritizes greenhouse gas reductions, climate neutrality by 2050, resilience and adaptation, circular economy, and zero pollution for air, water, and soil (European Parliament and the Council 2024; Singh et al 2026). Rather than functioning as a single policy, EAP8 serves as a coordination mechanism linking climate action with biodiversity protection and public health objectives (Moldan et al 2012; Morgan 2012).

At the level of binding legislation, the European Climate Law (Regulation (EU) 2021/1119) transforms political climate targets into legal obligations, establishing climate neutrality by 2050 and intermediate emission reduction targets for 2030 (European Parliament and the Council 2021; Hainsch et al 2022). This regulation introduces governance mechanisms such as monitoring procedures and scientific advisory inputs, aiming to ensure long-term policy coherence across member states (Craig & de Búrca 2011).

Environmental protection is further reinforced through sector-specific legislation. The Water Framework Directive (2000/60/EC) seeks to restore and protect water quality across Europe, while the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC) form the backbone of EU biodiversity policy (Liefferink et al 2011). More recently, the Nature Restoration Law (Regulation (EU) 2024/1991) introduces binding restoration targets for degraded ecosystems, reflecting a shift from mere conservation toward active ecological recovery (European Parliament and the Council 2024). Shen & Normand (2026) emphasize the law's innovative approach, calling for restoration targets based on fundamental ecological processes that are resilient to environmental change. In addition, new regulatory instruments address emerging environmental risks. The revised Ambient Air Quality Directive (EU) 2024/2881) strengthens standards for major pollutants and emphasizes public health protection (World Health Organization 2023; European Parliament and the Council 2024). The Soil Monitoring Directive (EU) 2025/2360) establishes a unified framework for assessing soil health and contamination, linking soil protection to food security, biodiversity, and climate resilience (Moldan et al 2012; European Parliament and the Council 2025).

Together, these instruments illustrate a shift from reactive environmental regulation to proactive governance, aimed at increasing ecosystem resilience and reducing long-term systemic risks associated with climate change, particularly in aquatic ecosystems and water-dependent socio-economic systems.

Implementation gaps and governance challenges. Despite the sophistication of the EU's environmental legal framework, implementation remains a major challenge. In the case of the Water Framework Directive, more than two decades after its adoption, many water bodies have not achieved good ecological status due to administrative fragmentation and delayed enforcement (European Commission 2012; Voulvoulis et al 2017). Recent EU-wide assessments indicate that only around 60% of surface water bodies are currently in good or high ecological status, meaning that approximately 40% still fail to meet the Directive's objectives (European Commission 2024). These shortcomings illustrate how legal flexibility, while useful, can also generate uneven national responses (Liefferink et al 2011; Morgan 2012).

Similar patterns can be observed in biodiversity governance. Although the Habitats and Birds Directives provide strong legal protection, biodiversity loss continues across Europe, particularly among insects and forest ecosystems (Cliquet 2020). Local resistance, competing land-use interests, and limited monitoring capacity often undermine conservation outcomes, highlighting the gap between legal norms and ecological realities (Moldan et al 2012; Petrescu et al 2020; Petrescu-Mag et al 2025).

In the context of aquatic ecosystems, climate change further exacerbates these governance challenges by increasing water scarcity, altering hydrological regimes and intensifying pollution pressures. These phenomena complicate the achievement of

ecological objectives and long-term sustainability (Voulvoulis et al 2017; World Bank 2022), as climate-related extreme events have generated economic losses exceeding around EUR 50 billion in a single year at EU level, while drought-affected areas have expanded markedly since 2000 (European Commission 2024).

Energy transition research also confirms that achieving EU climate targets depends on the quality of governance. Scenario analyses show that technological innovation alone is insufficient without consistent policies, strong institutions, and social acceptance (Hainsch et al 2022; Hahn & Stavins 1992). This diagnosis is reinforced by the Environmental Implementation Review, which estimates an annual environmental investment gap of around EUR 122 billion (approximately 0.8% of EU GDP), a nearly 48% of which is linked directly to pollution control and water management, while stressing that “the cost of implementation is much lower than the cost of non-implementation” (European Commission 2025).

From a governance perspective, societal legitimacy is a key condition for successful climate and water policies as public trust and perceived fairness directly influence behavioral change and policy compliance. This aspect is echoed by the Commission’s conclusion that “full, timely and fair implementation” (European Commission 2025) is a prerequisite for long-term environmental resilience and security from a governance perspective and societal legitimacy. Social inequalities and economic constraints shape individuals’ capacity to adopt sustainable practices, suggesting that climate governance must integrate social justice considerations (Moreno-Llamas et al 2024; World Bank 2022).

Societal legitimacy and the social dimension of climate governance.

Environmental governance is not only a matter of institutional design, but also of social legitimacy. Climate and water policies often involve redistributive effects, affecting energy prices, mobility patterns, and land use, which can generate resistance if perceived as unfair or socially regressive (Moreno-Llamas et al 2024; Hahn & Stavins 1992). Without public trust and perceived fairness, even well-designed policies may fail to produce behavioral change (Hamilton & Keim 2009; Moldan et al 2012).

Recent studies (e.g., Huo et al 2025) emphasize that social inequalities significantly influence pro-environmental behaviour. Economic constraints and social status shape individuals’ capacity to adopt sustainable practices, suggesting that climate and water governance must integrate social justice considerations (Moreno-Llamas et al 2024; World Bank 2022). Sustainability indicators and transparent monitoring systems also play a key role in enhancing accountability and public confidence (Moldan et al 2012; European Parliament and the Council 2021).

Environmental impact assessment remains a central governance tool for integrating environmental considerations into decision-making, but its effectiveness depends on procedural quality and institutional transparency (Morgan 2012; Craig & de Búrca 2011). Where assessments are treated as formalities rather than substantive processes, their contribution to environmental protection and societal legitimacy is limited (Hahn & Stavins 1992).

Conclusions. Climate change represents one of the most complex governance challenges of the contemporary world. It is simultaneously an environmental, social, and security issue, requiring coordinated responses across institutional levels and policy sectors. In the EU, environmental governance has evolved into a dense legal and policy architecture that combines strategic programs, binding legislation, and cross-sector integration. However, persistent implementation gaps demonstrate that legal ambition alone is insufficient to ensure effective environmental outcomes. Institutional capacity, administrative coordination, public trust, and social legitimacy play a decisive role in shaping policy effectiveness. Climate governance must therefore be understood not merely as a technical or legal process, but as a deeply social and political one, embedded in broader structures of power, inequality, and collective responsibility. Ultimately, sustainable water governance and the protection of aquatic ecosystems emerge as key pillars of environmental security in the EU. Strengthening institutional coordination,

promoting adaptive management strategies, and integrating climate and water policies over the long term are essential for transforming climate ambition into tangible improvements in environmental quality, public health, and social resilience.

Conflict of interest. The authors declare that there is no conflict of interest.

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