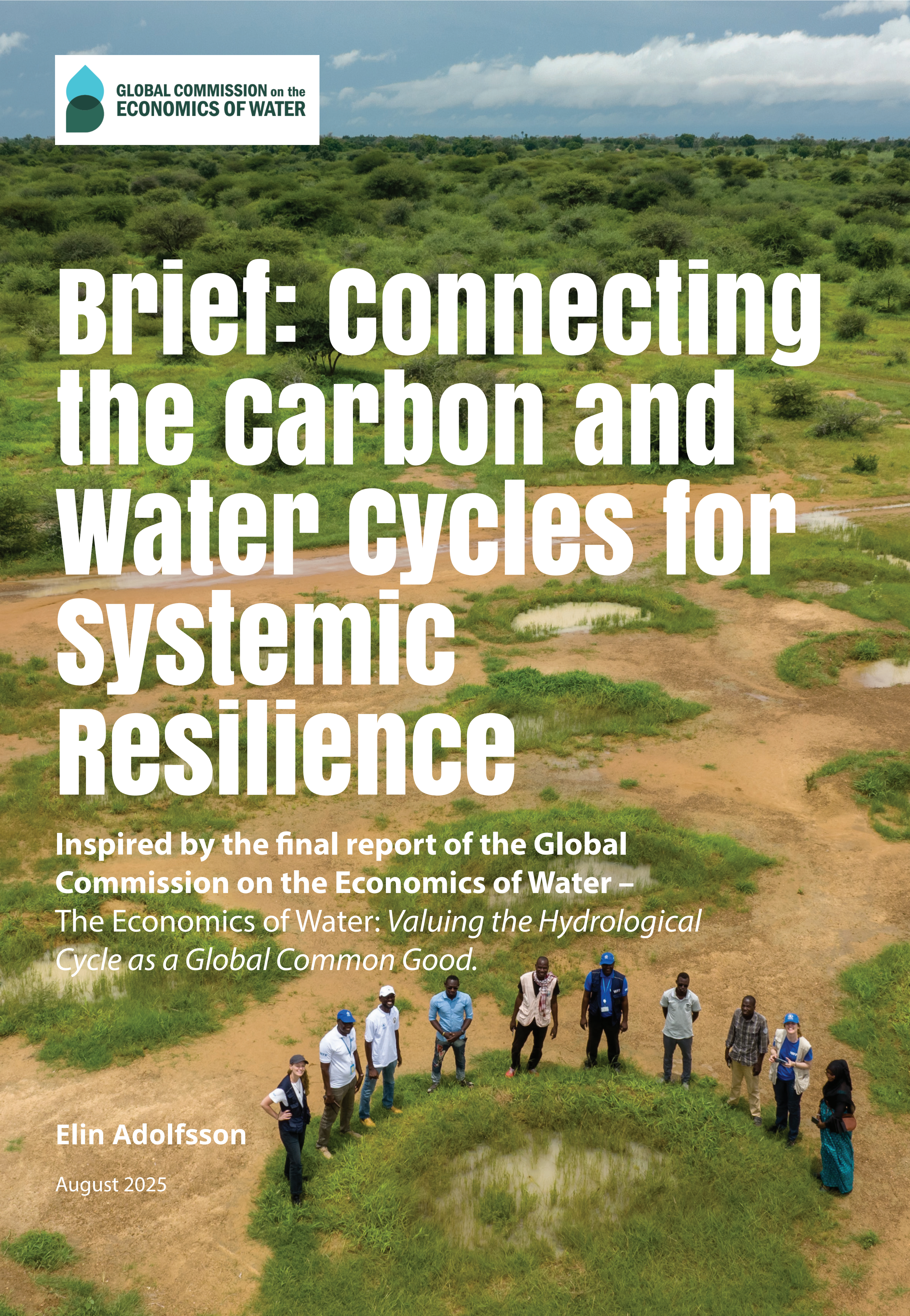

GLOBAL COMMISSION on the ECONOMICS OF WATER

Brief: Connecting the Carbon and Water Cycles for Systemic Resilience

Inspired by the final report of the Global Commission on the Economics of Water –
The Economics of Water: *Valuing the Hydrological Cycle as a Global Common Good.*

Elin Adolfsson

August 2025

The Global Commission's report sets out the shifts required to drive radical changes in how water is valued, managed, and used. The new economics of water begins by recognizing that the water cycle must now be governed as a global common good, that can only be fixed collectively, through concerted action in every country, collaboration across boundaries and cultures, and for benefits that will be felt everywhere.

This policy brief examines the implications of the Global Commission's findings for climate change mitigation and adaptation. Starting from the intricate relationship between the carbon and water cycles, it aims to guide policymakers in redefining the role of the resilience of the water cycle to deliver on the climate agenda, particularly in consideration of policies, programs, innovation, financing, and governance. Corresponding to each of the Global Commission's five missions, the scale and interconnectedness of the water and climate challenges demand systemic, economy-wide, and coordinated action to restore ecological balance, ensure hydrological resilience, and tackle the climate crisis.

Acknowledgments

The author extends her thanks to Lauren Seaby Anderson, Marie-Charlotte Buisson, Chiara Colombo, Anna Dupont, Bunyod Holmatov, Matthew McCartney, Henk Ovink, and Petra Schmitter for reviewing earlier versions of this brief.

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Key messages

- **Disruptions to the global hydrological cycle are deeply intertwined with climate change and biodiversity loss, reinforcing global risks and undermining resilience.** Land use change is not only a source of carbon emissions but also, together with climate change, a critical disruptor to the hydrological cycle. These disruptions intensify hydrological imbalances and shift rainfall patterns, exacerbating the climate crisis and its impacts, while threatening ecosystems. Furthermore, three billion people and over half of the world's food production are found in areas where green and blue water stores are projected to decline [1]. We must redefine the close relationship between water and climate, starting by recognizing the interconnected nature of the global hydrological cycle.

- **Integrating green and blue water into climate strategies can mitigate risks, unlock multiple co-benefits, and ensure long-term systemic resilience.**
  - For climate mitigation: this means acknowledging the link between climate change, land cover change, and precipitation while managing green water by conserving, restoring, and sustainably using ecosystems to promote soil moisture. It also requires improving blue water management by reducing greenhouse gas emissions from water supply, sanitation, and irrigation, and accounting for the water demand of emissions reduction technologies.
  - For climate adaptation: building resilience requires integrating both green and blue water management to address scarcity and abundance. Adaptation also depends on anticipating shifting rainfall patterns, reducing exposure to hydrological risks, and ensuring that communities, ecosystems, and economies can thrive under changing water conditions.
  - Adopting an integrated water cycle-carbon approach can help identify synergies and navigate trade-offs, particularly as increased water availability typically is a precondition for many adaptation and mitigation strategies.

- **The vast potential of an integrated approach to water and climate finance for enhanced impact remains untapped.** Restoring and conserving green and blue water support both climate mitigation and adaptation goals. Therefore, green and blue water-related investments, including nature-based approaches, must be systemically prioritized and leveraged within climate finance frameworks to optimize impact and promote resilience.

- **Valuing water as an organizing principle enables the strategic integration of climate, water, and biodiversity agendas. Water is both a local and global issue, and as such ensuring hydrological resilience is a collective and systemic challenge.** Redefining the relationship between climate and water governance in this light requires recognizing the value of green and blue water and the interlinkages with the carbon cycle and anchoring hydrological resilience as a central objective of the global climate agenda.

Context

The global hydrological cycle is the «bloodstream» of the biosphere, providing the basis for all life, regulating the climate, enabling carbon cycling through the production of biomass, and carrying nutrients, chemicals, and pollutants. Freshwater, often overlooked, is the silent currency sustaining our economies – powering every sector from agriculture to energy – and underpinning our livelihoods.

Disruptions to the water cycle jeopardize this very foundation. Furthermore, those disruptions are deeply intertwined with climate change and biodiversity loss, with each rebounding on the other. The increasing imbalance of the hydrological cycle obstructs our ability to act on the climate and biodiversity crises. A resilient hydrological cycle, in turn, requires both climate change mitigation and the protection of biodiverse ecosystems and lands and their hydrological functioning.

Taking the hydrological cycle as a starting point, this policy brief unpacks the interconnectedness of the water and climate crises and the imperative of integrated blue-green water governance. Approaching a resilient hydrological cycle as a global common good means we must redefine the relationship between water and climate, recognizing green and blue water as indispensable elements to tackle climate change [2], and ensure that hydrological resilience is centred and elevated as a collective policy priority.

Key challenges and implications

The water, climate, and biodiversity crises are intrinsically linked

Together, the water and carbon cycles regulate the Earth's climate. Green water – stored as soil moisture and in vegetation – supports photosynthesis and microbial activity, capturing carbon from the atmosphere in plants and soils. Soil ecosystems, in turn, are dual reservoirs of green water and carbon. Stable soil moisture keeps carbon stored in vegetation, soils, and wetlands, while soil organic carbon enhances soils' capacity to retain water. Blue water, found in rivers, lakes, and aquifers, stores and transports carbon across landscapes and to the oceans. Evapotranspiration, respiration, and outgassing return water and carbon back to the atmosphere. This symbiotic relationship means disruption to either cycle cascades into the other, often creating reinforcing feedback loops.

Water is the principal medium of climate change impacts on ecosystems, livelihoods, and economies, with the most significant costs borne by vulnerable communities and future generations. Climate change, as a result of anthropogenic carbon emissions, intensifies the water cycle. Dry becomes drier, wet wetter, extremes more extreme and frequent, and rainfall erratic, with compounding effects [3]. Unsustainable land and water use exacerbates these shifts with local to global impacts on the water cycle. At the same time, emissions from degradation of freshwater ecosystems, soil moisture loss, and blue water infrastructure and management position water as a driver of climate change and biodiversity loss.

While the impacts of hydrological disruptions are increasingly recognized in climate policy, gaps remain in acknowledging the scale and interconnectedness of the water and carbon cycles, and the ecosystems through which they move. A limited perspective risks missing water's multifaceted value and producing misaligned economic incentives, with implications for social equity, economic efficiency, environmental sustainability, and the development agenda.

Green water mismanagement obstructs climate change mitigation

While the water cycle–climate relationship, when acknowledged, has traditionally been framed through the lens of adaptation [4], the indispensable role of green water in mitigation has often received less attention. Land-based ecosystems absorb 25-30% of fossil-fuel carbon dioxide emissions [5], providing one of the most significant ecosystem services to the global economy. The availability of green water regulates carbon inputs and losses in soils, forests, and other ecosystems. It is also critical to maintain current levels of carbon stored in landscapes such as wetlands. Mismanagement of green water through deforestation, unsustainable land use, or wildfires reduces soil moisture and disrupts land-sourced precipitation patterns. When soils, forests, and landscapes dry out, they become more prone to wildfires, lose their capacity to store carbon, and can shift from sinks to carbon sources, aggravating climate change [6], [7]. The feedback between climate change, land cover change, and precipitation is therefore central to climate action.

Unsustainable blue water use impedes low-carbon transitions

Blue water dynamics play a key role in reducing carbon emissions. The use of blue water for industry, agriculture, energy, and households represents a significant source of carbon emissions. Water treatment and provision systems, dam reservoirs, and flooding regimes in rice cultivation make up 8% of global emissions, including considerable methane contributions [8]. Furthermore, energy to pump water for irrigation stands for 15% of agricultural emissions (see Box 1) [9].

Box 1: Cutting emissions through blue water efficiency

In Uzbekistan, energy inefficient irrigation consumes 20% of the country's power supply, and energy subsidies a significant portion of the government budget. Tackling the situation, the International Water Management Institute introduced irrigation planning in cotton and wheat cultivations in the Karshi Steppe as a tool to save blue water and energy, and consequent mitigation of carbon emissions. The work has shown that without compromising yields, optimizing irrigation schedules could reduce energy, blue water, and carbon emissions by a third. This demonstrates the potential of improving irrigation efficiency to reduce pumping needs and cut emissions. [10]

Blue water, from rivers, is a significant carbon conduit from land. Although a large share is emitted into the atmosphere, about one gigaton of carbon is transported to the oceans every year to make part of the ocean carbon sink, absorbing as much as 10% of global fossil fuel emissions [11].

Emissions reduction technologies like clean energy depend on blue water and often demonstrate substitutional blue water footprints throughout the life cycle, positioning blue water scarcity as a constraint in the transition to low-carbon economies. Actively managing the multiple roles of blue water in reducing emissions is therefore critical to reach water and climate objectives.

Siloed approaches to climate change adaptation and mitigation increase vulnerability

Adapting to a changing climate is chiefly about managing blue water to cope with hydrological imbalances and extremes. Too often, however, insufficient long-term, systemic efforts that overlook interactions between green and blue water, climate, ecosystems, and livelihoods risk maladaptation [12].

While many ecosystem-based adaptation strategies provide mitigation and water (green and blue) co-benefits, synergies are not automatic. Nature-based interventions like reforestation and green infrastructure strengthen resilience to droughts, floods, heat waves, and growing water variability. These measures depend on, and often enhance, green water, but sometimes reduce blue water flows in rivers and groundwater recharge. Neglecting green and blue water dynamics can strain water resources and heighten vulnerability to upwind land use change, altering precipitation [13]. Quantifying land and water resource requirements is therefore essential to avoid maladaptation.

In agriculture, rainfed systems are particularly vulnerable to green water variability. Regenerative practices that enhance soil health, increase soil carbon, and improve infiltration can mitigate drought impacts and enhance flood absorption, while sequestering carbon. Such practices can also alleviate pressure on blue water in irrigated agriculture. Conversely, irrigation, which may increase carbon emissions, will likely be needed to complement green water during prolonged dry spells. As climate change progresses, agricultural adaptation will demand more green water, alter rainfall patterns, and simultaneously increase blue water needs. Eventually, these limitations may force crop changes.

Photo by Detour

Policy Recommendations

Adopting an integrated lens on water and carbon

Green and blue water should play a much more prominent role in addressing global climate change. A stable supply of green water underpins carbon storage and sequestration in soils and vegetation, thereby supporting climate change mitigation, as well as ecosystem-based adaptation. Blue water is an essential input for mitigation and adaptation technologies, while different approaches to managing blue water are critical to mitigating carbon emissions and increasing resilience to water imbalances and extremes. Recognizing the intrinsic links between the water and carbon cycles, the boundaries between mitigation and adaptation, and blue and green water, are often blurred (see Figure 1). For example, plant-based proteins, which support mitigation efforts by carrying a smaller carbon footprint than animal-based alternatives, require green and blue (if irrigated) water for cultivation and blue water for production. Floodplain restoration demands green and blue water to restore ecosystem services and reduces the risk of flooding (blue water). Lastly, wetlands conservation and restoration cuts across all four dimensions since they depend on green and blue water to store and sequester carbon while regulating green and blue water flows to buffer imbalances and extremes.

Many of these connections are synergistic but, at times, might cause unintentional impacts. Furthermore, mitigation and adaptation require significant land and water (green and blue) resources, which must be balanced with other societal needs. Effective mitigation and adaptation, therefore, demand more coordinated and outcomes-oriented responses that embrace carbon and water in tandem from the outset.

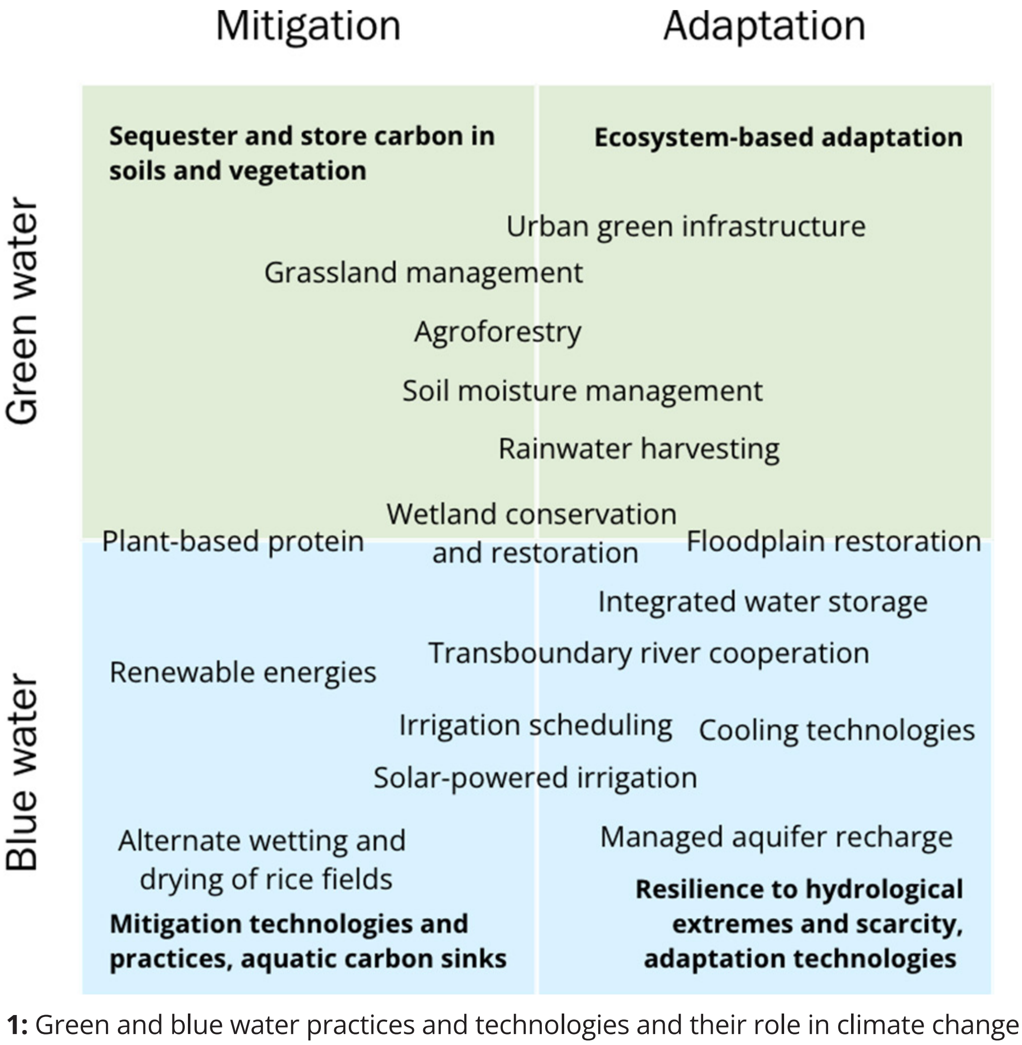

Figure 1: Green and blue water practices and technologies and their role in climate change mitigation and adaptation (non-exhaustive)

An integrated approach to water, carbon, and ecosystem health can harness synergies and manoeuvre trade-offs across the economy. Moving from silos to systemically integrating water-carbon management in mitigation and adaptation strategies across mandates and scales, as well as economy-wide transition strategies, can help bridge silos, ignite partnerships, and inform integrated policy and investment strategies that strengthen resilience of our economies, ecosystems, and livelihoods. The Freshwater Challenge, for instance, embodies this approach and illustrates that by recognizing water as integral to climate, biodiversity, and broader development objectives, investment can be mobilized to advance each of these objectives simultaneously.

The Global Commission on the Economics of Water's (GCEW) five missions to ensure hydrological resilience and foster just water futures echo this approach. The following examples illustrate how each mission offers synergies with both climate mitigation and adaptation agendas:

1. **Launch a new revolution in food systems:** Adopting regenerative practices such as cover-cropping, mulching, and agroforestry supports improved water infiltration and soil carbon. Maintaining and re storing natural and seminatural habitats in agricultural and forestry landscapes helps buffer against droughts and floods.
2. **Conserve and restore natural habitats critical to protect green water:** Investment in carefully designed integrated solutions based on nature restoration and conservation, especially of wetlands and forests, and healthy soils, contributes to restoring both water and carbon cycles and leverages synergies for mitigation, adaptation, and biodiversity objectives.
3. **Establish a circular water economy:** Scaling water reuse based on clean energy has the potential to alleviate pressure on blue water resources in regions facing dwindling water stores and reduce emissions associated with its extraction.
4. **Enable a clean-energy and AI-rich era with much lower water intensity:** Enhancing efficiency in water use and pollution management is imperative to avoid compromising water availability and quality while ensuring long-term viability of clean-energy generation, semiconductor manufacturing, and cooling of energy plants and data centres, and increasing the sustainability of mining critical minerals.
5. **Ensure that no child dies from unsafe water by 2030:** Accessible and climate-resilient water and san itation systems are critical to mitigate health hazards associated with climate shocks, e.g., sewage over flow [14]. Investment in the resilience of the water cycle increases water quality in ecosystems and for drinking water.

Leveraging climate and water financing

At the 29th Conference of the Parties (COP) in 2024, United Nations Framework Convention on Climate Change (UNFCCC) parties agreed on a new financing framework aiming to triple climate finance to developing countries and mobilize at least USD 1.3 trillion annually from all actors by 2035 [15]. Currently, water and wastewater receive a third of adaptation finance, but only 3% of total climate finance. Accounting agriculture, forestry, and other land use investments involving green and/or blue water adds up to two additional percentage points [16]. This gap highlights an opportunity to increase climate finance for water-related investments, including long-term finance, which is needed for nature-based interventions.

This brief argues that protecting green and blue water is foundational to mitigating and adapting to climate change, making the case for such projects to qualify for climate finance. Recent developments at the Global Climate Fund (GCF) reflect this perspective. In early 2025, the GCF approved financing for a large-scale programme in the Amazon Basin leveraging water for climate resilience (see Box 2). It offers a blueprint: large-scale, water-centred projects are key to climate action and eligible for climate finance. Furthermore, transboundary blue and green water flows are scales of collective action that can unlock funding. Looking ahead, there are opportunities to expand this ambition to mitigation efforts and explicitly target green water.

Box 2: Case study – Improving climate resilience by increasing water security in the Amazon Basin

The Amazon Basin is critical to global carbon and water cycles, acting as a climate buffer and significant source of land-sourced precipitation. Climate change threatens these ecosystems, with consequences for the water cycle, food, biodiversity, carbon storage, and livelihoods.

Recognizing the vital role of water and nature in climate resilience, the GCF approved a USD 390 million programme to strengthen water security in the Basin [17]. Led by Bolivia, Brazil, Colombia, Ecuador, Peru, and Surinam, with the Inter-American Development Bank, they are implementing integrated water management, mobilizing hydroclimatic data, wetlands and forest restoration (green water), climate-resilient water and sanitation (blue water), and cross-basin cooperation to improve decision-making, water management, and ecosystem functions. Although centred on adaptation, the approach also cuts nearly eight million tonnes of carbon dioxide equivalents.

By integrating climate, biodiversity, and green and blue water, the programme builds long-term resilience for livelihoods while delivering broader economic benefits across South America.

Financing institutions should work towards more integrated, outcome-based strategies that reflect the interdependencies between water, carbon, and nature to enhance efficiency and effectiveness. Systemically incorporating green and blue water into climate finance frameworks promotes resilience and reduces exposure to water-related risks or constraints. Co-benefits such as flood and drought regulation, climate stabilization, and ecosystem health and function should be explicitly measured and built into project design and reporting mechanisms. For instance, finance for nature-based solutions should measure the benefits of protecting and restoring green and blue water alongside climate and biodiversity values. This requires improving water data, particularly concerning green water, and more research to support the scaling of nature-based interventions.

Connecting the global climate and water agendas

The magnitude and interconnectedness of the water, climate, and biodiversity crises demand coordinated action to advance across development agendas. Unravelling this relationship requires that Multilateral Environment Agreements (MEAs), including the three Rio Conventions – the UNFCCC, the Convention on Biological Diversity (CBD), the Convention to Combat Desertification (UNCCD) – and the Ramsar Convention on wetlands, institutionalize hydrological resilience as foundational for achieving their mandates.

Water provides an organizing principle that these MEAs can capitalize on to connect and catalyze their mandates. Integrated governance frameworks also help inform, change, and link to financing mechanisms, strategically aligning financing partners around shared objectives. Water and carbon-cycle dynamics are at the core of these connections,

- **UNFCCC**: Green water regulates carbon storage and sequestration in biomass, supporting nature-based mitigation and adaptation, while effective blue water management (including as input for technologies) is critical for addressing climate impacts and mitigation, collectively underpinning the goals of the Paris Agreement.

- **CBD**: Water and carbon cycle through ecosystems, powering photosynthesis and sustaining biodiverse habitats, supporting the Global Biodiversity Framework.

- **UNCCD**: Managing green and blue water and carbon together is essential to sustain soil health, prevent desertification, and build resilience to drought, which are key conditions for achieving the goal of Land Degradation Neutrality.

- **Ramsar**: Green and blue water are essential for preserving wetlands and the critical carbon and biodiversity they hold. In turn, wetlands buffer climate extremes, recharge aquifers, purify water, and sustain atmospheric moisture cycles.

Multiple bodies and processes can be built upon to advance this objective. The Baku Dialogue on Water for Climate Action[1] represents a significant step toward integrating water and climate action. It provides a consistent forum for dialogue on the interlinkages between water, climate change, biodiversity loss, desertification, and pollution, with the water cycle-climate nexus anchored into the scope and ambitions of the process. Moving towards an operational platform, priorities focus on strengthening continuity and coherence, including across the Rio Conventions [18]. Looking ahead, the 2026 and 2028 UN Water Conferences, including through the six interactive dialogues, provide a key platform to advance the role of water as an organizing principle.

Pathways to operationalize water-carbon strategies for enhanced resilience

Managing water and carbon, as well as ecosystems, in ways that reflect their interconnectedness and acknowledge atmosphere-land-water feedbacks is essential to build long-term and systemic resilience for nature, livelihoods, and economies. Doing so requires advancing integrated approaches, including,

- **Explicitly integrating water cycle-carbon dynamics in Integrated Water Resources Management** can guide water decisions to support both climate adaptation and mitigation, by safeguarding ecosystems that act as carbon sinks, reducing energy-related emissions from water use, and aligning land and water management with national climate commitments.
- **Nature-based strategies for water-carbon management.** For example, preserving and restoring wetlands and forests, establishing riparian buffers, and enhancing soil organic carbon.
- **Water-sensitive carbon management in agriculture**. Managing water and nutrients in ways that limit carbon emissions, and adopting climate-smart agriculture, including solar-powered irrigation and water-saving technologies, alternate wetting and drying of rice paddies, and livestock feed innovation.
- **Circular and regenerative water-carbon systems**. Regenerative agriculture practices, such as cover cropping, agroforestry, and improved grazing, enhance soil organic carbon while increasing infiltration and water-holding capacity. Watershed restoration rebuilds natural hydrological cycles and boosts ecosystem resilience. Reusing and recycling water in a way that reduces freshwater withdrawal, lowers emissions, and increases the efficiency of carbon-rich byproducts.
- **Integrated metrics that capture dimensions of climate, water (green and blue), and biodiversity**. Advancing the use of such indicators, including ecological flow requirements, water quality in protected areas, and ecosystem service valuation, can enhance cross-sectoral coherence and improve decision-making and project design, while supporting progress monitoring.

To foster an enabling environment and ensure effective coordination, building institutional capacity at national and international levels is critical, including,

- **Strengthening technical expertise and data-sharing platforms** to monitor and model the hydrological cycle within government agencies. A global water data infrastructure can enable equitable access and sharing of interoperable data, facilitate capacity-building, and support development and dissemination of integrated metrics. The infrastructure could also facilitate valuation and evaluation of more complex, interlinked approaches, informing novel ways of governance and funding.
- **Leveraging integrated MEA forums and processes** to formalize dialogue and joint decision-making. Examples are the Baku Dialogue and the Bern process between biodiversity-related MEAs supporting the synergetic development and implementation of the Global Biodiversity Framework.
- **Establishing dedicated inter-agency coordination bodies**, with dedicated funding mechanisms and accountability structures, to bridge the MEAs' mandates and foster integrated planning that aligns targets, reporting, and implementation strategies related to hydrological resilience. At the multilateral level, this means creating a joint platform for enhanced coordination across scales and stakeholders, leveraging MEAs' institutional capacity. At the national level, politically anchored coordination mechanisms with relevant mandates can align water, climate, and biodiversity. Inspiration can be drawn from inter-ministerial committees and commissions on climate change [19].

[1] Launched at the 29th Conference of the Parties to UNFCCC in Baku by the Azerbaijan presidency with support from the UN Environment Programme (UNEP), UN Economic Commission for Europe, and the World Meteorological Organization, with contributions from other UN Water members. Its secretariat is hosted by UNEP.

Photo: Nirasha Perera/IWMI

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Photo: Tanmoy Bhaduri/IWMI

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Citation: Adolfsson, E. 2025. *Brief: connecting the carbon and water cycles for systemic resilience*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 16p. doi: https://doi.org/10.5337/2025.239

Front cover photograph: Land rehabilitation efforts in Mounrey, Niger (*photo*: WFP/Evelyn Fey).

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The International Water Management Institute (IWMI) is an international, research-for-development organization that works with governments, civil society, and the private sector to solve water problems in developing countries and scale up solutions. Through partnership, IWMI combines research on the sustainable use of water and land resources, knowledge services and products with capacity strengthening, dialogue, and policy analysis to support implementation of water management solutions for agriculture, ecosystems, climate change, and inclusive economic growth. Headquartered in Colombo, Sri Lanka, IWMI is a CGIAR Research Center with offices in 16 countries and a global network of scientists operating in more than 55 countries.

IWMI
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