CLIMATE CHANGE AND SUSTAINABILITY

Every Drop Counts—Pathways to Restore Germany's Water Balance

By Torsten Kurth, Benjamin Subei, Maximilian Meister, Sven Selbert, Ali Ziat, and Isabelle Roehler

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Have you ever thought about the amount of water available to us? Water seems abundant: it covers about two-thirds of the Earth's surface, and we tend to assume there is always enough of it. But only 2.5% of the planet's water is freshwater—and less than 1% of that is directly available for human use. What looks plentiful from afar is, in reality, a very limited resource that sustains all societies, economies, and ecosystems.

> *The entire share of usable freshwater available to all people on Earth would form a sphere small enough to fit over Luxembourg.*

Our research shows just how misleading the perception of abundance can be. Even in countries long considered water-rich, such as Germany, natural water storage has declined over the past two decades—roughly by the volume of Lake Constance. Shifting rainfall, depleted soils and forests, and rising runoff are weakening the small water cycles that once kept landscapes cool, moist, and resilient. As a result, droughts and local water shortages are becoming more common, and the economic cost of inaction could reach at least €20–25 billion annually by mid-century.

Managing water proactively is therefore both an ecological necessity and an economic imperative—and it requires coordinated action across sectors. In our study, we explore the drivers behind

Germany's emerging water shortages and outline the solutions that can expand water availability, rebuild resilience, and ultimately turn the tide.

Germany's biggest challenge is water quantity, and it comes at a cost

Germany faces water challenges across quantity, quality, and accessibility, yet the most urgent and consequential is water quantity. While wastewater discharge and intensive agricultural and industrial practices continue to degrade water quality—and aging infrastructure makes accessibility increasingly uneven—the clearest sign of systemic stress is the steady decline in water availability. Land use and land use changes, including a declining number of near-nature forests, soil sealing, and unsustainable land management practices have disrupted the small water cycles that once kept landscapes cool, moist, and fertile, turning water scarcity into a systemic land- and ecosystem challenge. At the same time, less predictable rainfall, drier summers, more frequent droughts and floods, groundwater depletion, higher evapotranspiration, rising agricultural water demand, and increasing runoff further intensify pressure on natural water availability. Together, these drivers have caused Germany to lose around 60 billion m^3 of stored water over the past two decades—about the volume of Lake Constance—as landscapes absorb and retain less rainfall than before. (See Figure 1.)

This long-term decline reflects a structural imbalance in Germany's hydrology: Germany is losing more water than its systems can naturally restore. If unaddressed, the consequences will be far-reaching. Visible costs—from more severe drought impacts, flood damage, and water-quality incidents that form self-reinforcing feedback loops—already amount to billions each year. Yet the chronic, less visible costs are even more significant: declining groundwater reserves, weakened small water cycles, shifting climatic and hydrological patterns, and growing competition between users quietly deepen water stress and accumulate substantial societal and economic burdens over time.

Taken together, these visible and hidden pressures result in a cost of inaction of at least €20–25 billion annually, or cumulatively at least €500–625 billion by 2050. Quantity is therefore not just the biggest challenge—it is the defining determinant of Germany's long-term water security. (See Figure 2.)

Controlling the controllables: managing water runoff via surface cover

While many parts of the water cycle—such as large-scale weather patterns or deep groundwater flows—lie beyond our influence, the surface and topsoil layers are fully controllable. They are shaped directly by land use, cover, and management, immediately determining what happens when rainfall meets the ground: whether water infiltrates, evaporates, or runs off. Because these layers govern both retention and recharge, they represent the largest actionable part of Germany's water balance—and therefore the strongest lever to counter declining water storage. (See Figure 3.)

When surfaces are permeable and biologically active, far more rainfall infiltrates instead of being lost as rapid runoff. Healthy soils draw water deeper into the ground, supporting groundwater and even deep-aquifer recharge. In forests, mixed and deciduous stands intercept less rainfall, especially during winter, than dense coniferous canopies, allowing more precipitation to reach the soil where it can soak in rather than evaporate or drain away. These mechanisms directly strengthen long-term water availability.

Regenerative agriculture, diversified forestry, and other nature-based practices unlock this potential at scale. They rebuild soil structure, increase vegetation cover, and enhance the landscape's natural hydraulic function. The result is a system that not only stores more water but releases it more slowly, buffers extreme weather, and reactivates the small water cycles—the process by which continental rainfall evaporates from land and vegetation, condenses in the atmosphere and is recycled back to local grounds as precipitation— that cool and stabilize local climates. By prioritizing the parts of the system we *can* control, Germany can meaningfully shift the trajectory of its water balance.

Nature-based water solutions offer the highest return

To understand how Germany can rebuild water resilience, we evaluated a broad set of nature-based, mixed, and technological solutions. Two complementary pathways emerge: Expansion and Optimization. Expansion increases the amount of water that landscapes can retain and make available through measures such as Regenerative Agriculture, Forest Management, Dynamic

Drainage (i.e., adaptive management of water at the landscape level to ensure reliable availability amid more unpredictable cycles of water excess and scarcity), Other Landscape-Level Methods, Sponge Cities, and Technical Supply Expansion (e.g., desalination or inter-basin transfer). Optimization focuses on using existing water more intelligently and more circularly—for example through Gray Water Reuse and Water Use Optimization across agriculture, industry, and households.

Our analysis shows that nature-based and mixed solutions—in particular Regenerative Agriculture, Forest Management, and Dynamic Drainage—have the highest combined impact, adding about 7–7.5 billion m^3 of water annually—enough to close Germany's water-storage gap over time. (See Figure 4.) Their effectiveness comes from how they reshape land systems: Regenerative Agriculture rebuilds soil organic matter and strengthens the soil carbon sponge; Forest Management focuses on diversifying forests that reduce canopy interception, slow runoff, and promote deeper infiltration; and Dynamic Drainage retains water longer in agricultural soils, shifting landscapes from drainage to retention.

Technological solutions such as desalination or reuse technologies can complement these measures, but they are typically more capital-intensive and less regenerative. Nature-based solutions, by contrast, deliver multiple benefits simultaneously—stabilizing microclimates, enhancing biodiversity, improving soil health, and reducing long-term infrastructure burdens. For Germany, these three interventions represent the most effective and scalable pathway to restore water availability nationwide.

Local measures to increase water resilience must be re-valued and properly financed

However, achieving this transformation requires a fundamental shift in how water resilience is financed, governed, and valued. Unlike energy or infrastructure, water has rarely been treated as an attractive investment area: Costs occur locally, and benefits are diffuse and often only come with a significant time gap in the longer term. This creates a structural funding dilemma—those best positioned to restore water availability, such as farmers and forest owners, often lack incentives and access to capital, while those most dependent on reliable water supply, including industry and utilities, have limited abilities to invest in measures on privately owned land to increase water retention and storage. As a result, public funding instruments and private initiatives

often operate in parallel rather than in a coordinated manner, limiting their effectiveness and preventing investments from being directed where water availability is influenced and water resilience is built. To overcome the current imbalance, two aspects are key: a clear understanding of where effective leverage lies and the ability to treat water as a strategic resource.

> *Water must be understood not as an isolated input or a private commodity but as a shared system of interdependence.*

The local aspect of water management and resilience is a big advantage for taking action. While much of the climate debate is driven by global drivers such as GHG emissions and CO_2 content in the world's atmosphere—where impact depends on collective international action as individual influence is vastly limited—this study shows that water resilience can be built decisively through local action. How we manage landscapes, soil, and vegetation directly shapes small water cycles, determining infiltration, retention, groundwater recharge, and ultimately water availability. These levers are firmly within our control—there are no excuses for not acting, now!

Recognizing this leverage demands financial and policy mechanisms that reflect water's true economic and ecological value and focus efforts on what can be influenced directly. Redirecting existing infrastructure funds toward water resilience, harmonizing pricing and incentive systems, and aligning public support schemes with private investment are essential to ensure that those who restore water availability and those who depend on it act in concert rather than in parallel. Building on this, innovative instruments—such as water or nature credits that reward measurable improvements in retention, recharge, and quality—can help share costs, pool capital and mobilize investment at a scale. Crucially, these mechanisms allow action and capital to flow to where water availability is shaped most directly: at the surface.

Ultimately, building a resilient water future requires a cross-sector implementation ecosystem. Public institutions must set clear frameworks and financing structures; businesses must integrate water stewardship into operations; farmers and foresters must restore the land's hydrological functions and small water cycles; and financial institutions must channel capital into the natural and hybrid systems that underpin long-term stability. Only through this shared responsibility can water security become the foundation of Germany's climate adaptation, ecological renewal, and economic resilience.

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Founded in 1899, NABU (Nature And Biodiversity Conservation Union) is one of the oldest and largest environmental associations in Germany. The association encompasses about 960,000 members and sponsors. NABU's most important tasks are the preservation of habitat and biodiversity, the sustainability of agriculture, forestry and water management, and last but not least, climate protection. The communication of nature experiences and the promotion of natural history knowledge are among NABU's central concerns. About 70,000 volunteers play an active role in practical nature conservation work, with great success: this is something that is unique to NABU. These active NABU members look after more than 110,000 hectares of valuable protected reserves in Germany. NABU also has volunteer groups working on an international level to conserve nature and combat poverty in Africa, Eurasia, and the Caucasus. This work is supported by professionals at our regional offices and at our national headquarters in Berlin, who take care of public relations, project development and management, and political lobbying. NABU is part of BirdLife International.

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Authors

Torsten Kurth

Managing Director & Senior Partner
Berlin

Maximilian Meister

NABU Policy Advisor for Regenerative Agriculture
Berlin

Isabelle Roehler

Consultant
Berlin

Benjamin Subei

Partner & Associate Director
Düsseldorf

Ali Ziat

Partner, Data Science
Casablanca

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