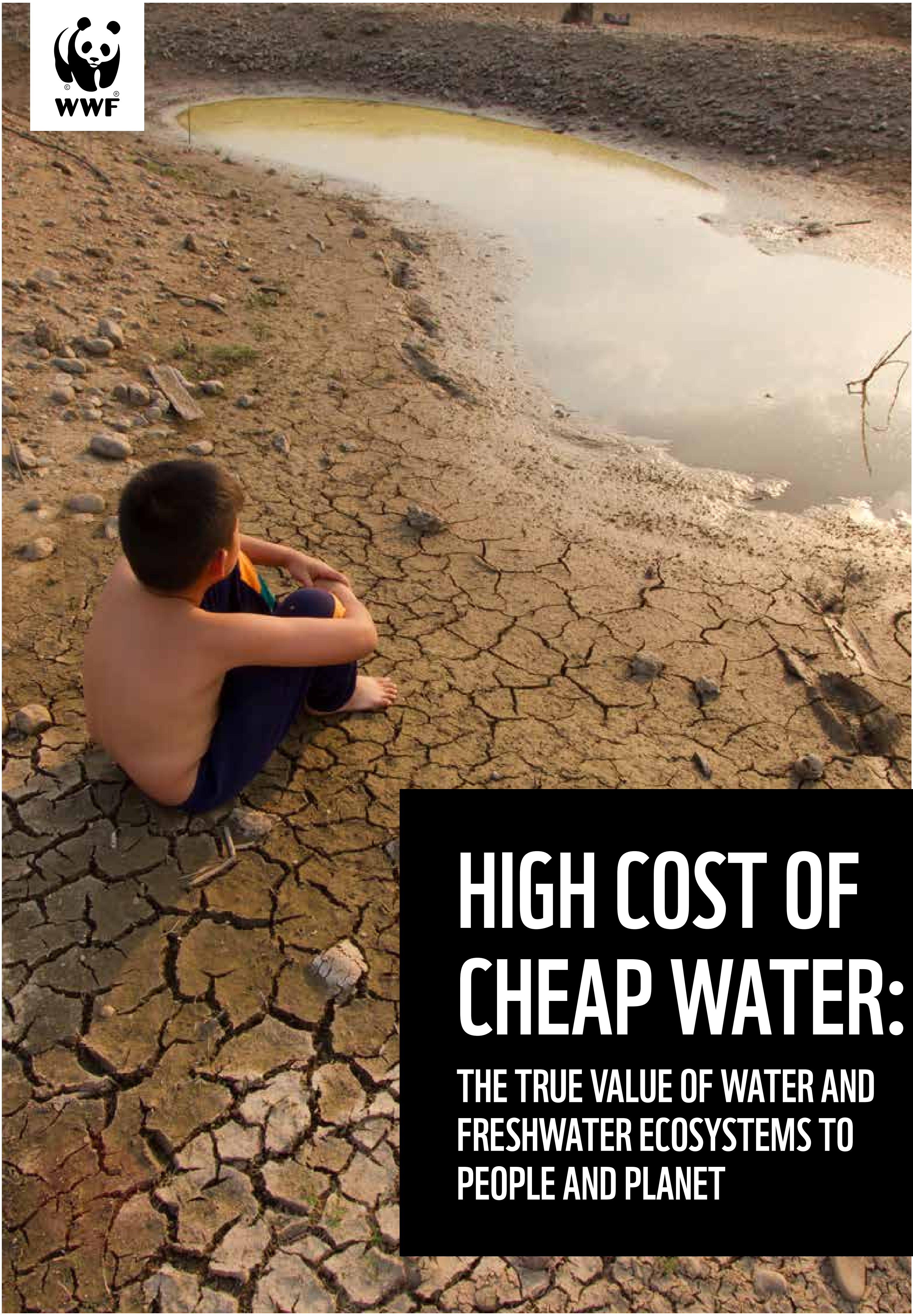

HIGH COST OF CHEAP WATER:

THE TRUE VALUE OF WATER AND FRESHWATER ECOSYSTEMS TO PEOPLE AND PLANET

Acknowledgements

The report was written by Dalberg Advisors, and the team comprised of Wijnand DeWit, Julia Lawson-Johns, Felina Lottner and Jean-Charles Guinchard.

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WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

Published in October 2023 by WWF – World Wide Fund For Nature (Formerly World Wildlife Fund), Gland, Switzerland.

Design: **Ender Ergün & Hakan Lokanoğlu**

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Cover photo: © Shutterstock

Contents page photo: © Adriano Gambarini / WWF-Brazil

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FOREWORD

BY KIRSTEN SCHUIJT,
WWF DIRECTOR GENERAL

We stand at a critical juncture that demands action. The escalating impacts of climate change and rapid nature loss are creating a defining moment for humanity. The stability of societies and economies hangs in the balance. Our report shows that amidst this crisis, a pressing opportunity emerges—an opportunity for global unity to directly confront these intertwined challenges. By addressing the overlooked but devastating freshwater crisis, we can shape a future defined by balance, resilience, and a world that embraces both nature-positive and net-zero goals.

Water, our planet's lifeblood, and the ecosystems that store and supply it — rivers, lakes, wetlands and aquifers — have been consistently undervalued. This oversight exacts a profound toll: a water crisis that corrodes human well-being and jeopardizes our planet's health. The realities are stark: hundreds of millions lack access to clean water, billions lack proper sanitation, and water-driven risks imperil food security and livelihoods. Nearly three quarters of recent disasters have been related to water.

This challenge will intensify as populations and economies expand, increasing the strain on water supplies. Water serves as the primary conduit through which societies and economies bear the impact of the climate crisis — more extreme floods, droughts, shifting rainfall patterns and associated insecurity in food supplies, fluctuating river flows, wildfires, and deteriorating water quality.

"We are draining humanity's lifeblood through vampiric overconsumption and unsustainable use, and evaporating it through global heating," said U.N. Secretary General Antonio Guterres. We urgently need to reverse these losses because healthy freshwater ecosystems are central to ensuring water, food, and energy security, as well as tackling the climate and nature crises. Rivers alone support a third of global food production and provide sediments that sustain mangroves and keep deltas above the rising seas. Furthermore, healthy floodplains and wetlands act as natural defenses for our cities and communities against floods, storms, and droughts.

At the core of this water crisis lies the dire decline of freshwater biodiversity and ongoing degradation of our ecosystems. Over five decades, one-third of wetlands have vanished, and freshwater species populations have plummeted by 83 percent on average. These staggering figures underscore the harm inflicted upon our rivers, lakes, wetlands and aquifers.

BY ADDRESSING THE OVERLOOKED BUT DEVASTATING FRESHWATER CRISIS, WE CAN SHAPE A FUTURE DEFINED BY BALANCE, RESILIENCE, AND A WORLD THAT EMBRACES BOTH NATURE-POSITIVE AND NET-ZERO GOALS.

Urgent action is imperative to reverse these losses. Yet, persistent neglect of the national and global significance of freshwater ecosystems perpetuates their degradation, despite their immense value. According to our report, freshwater's economic value reached US$58 trillion in 2021 — equivalent to 60 per cent of global GDP. Governments and businesses tend to focus on immediate gains, often disregarding broader benefits. Recognizing the importance of healthy freshwater ecosystems, including their cultural and spiritual significance, is crucial for informed decision-making. Overlooking the diverse values of these ecosystems lies at the core of the global water crisis.

Since 1961, WWF has steadfastly safeguarded healthy freshwater ecosystems, ranging from local restoration efforts to global stewardship. While challenges persist, a growing momentum for water-focused action is evident. The historic Global Biodiversity Framework and COP27 underscored the importance of water. And this year, the UN's first Water Conference in half a century launched the Freshwater Challenge with the aim of restoring 30 percent of degraded rivers and wetlands by 2030.

The world must take advantage of this unique opportunity to redefine water management and safeguard ecosystems. This report outlines essential steps to address the crisis and urges greater investment in Nature-based Solutions for restoring healthy water systems. WWF is dedicated to partnering with communities, governments and businesses and working across sectors, driving transformational efforts in freshwater ecosystems, and thereby enhancing our commitment to combating climate change and preventing biodiversity loss.

EXECUTIVE SUMMARY

Water is the world's most precious and exploited resource. Yet it has always been undervalued – along with the rivers, lakes, wetlands and aquifers that store and supply it. This water blindness – the lack of awareness and understanding of the importance of water resources – has come at an immense cost: the world is facing a pervasive and worsening water crisis that is undermining human and planetary health. Billions of people still lack access to safe water and sanitation, food insecurity is rising, water risks to agriculture and industry are escalating, and we are losing freshwater species and ecosystems at alarming rates. Growing populations, economies and urbanisation are putting additional pressure on water supplies and freshwater ecosystems – as climate change drastically disrupts the world's hydrological system. Combatting water blindness by understanding and valuing all the benefits that healthy freshwater ecosystems bring – including their role in food and water security, adaptation to a changing climate, biodiversity, and cultural and spiritual significance to communities across the globe – is critical to inform decision-making and sustainable water governance.

The infinite value that societies, economies and ecosystems obtain from rivers, lakes, wetlands and aquifers is chronically overlooked. More than one-third of the world's food production directly depends on rivers through their crucial role in sustaining freshwater fisheries, irrigated cropland, flood-recession agriculture, and highly fertile and nutrient-rich deltas. Beyond water and food security, achieving development objectives around health, gender equality and conflict prevention requires better water management, stewardship and protection. Water is also pivotal to the industrial production of goods, their transportation through inland waterways, and all forms of energy production. Most commonly overlooked is the immense value provided by intact freshwater ecosystems to people and nature. They offer critical regulatory ecosystem functions and sustain biodiversity, with their value extending to marine and terrestrial ecosystems. Water is the primary channel through which societies, economies and ecosystems experience the profound effects of the climate crisis in the 21st century, for example through severe droughts, catastrophic floods or water pollution. The immense value of freshwater ecosystems – including the ability of wetlands to filter pollution, floodplains to absorb the worst of flood events, and aquifers and springs to provide sufficient, good quality water to enhance resilience to droughts – often goes unnoticed.

This report estimates the total quantifiable economic use value of water in 2021 at approximately US$58 trillion, equivalent to 60 per cent of global GDP in 2021. Water has various direct use benefits (i.e., the direct consumption of goods and services provided by water) for households, agriculture and different industries that are valued at a minimum of US$7.5 trillion annually.

Despite generating an estimated 7 times more value than direct use activities (approximately US$50 trillion annually), the indirect benefits of freshwater are chronically undervalued. These ecosystem benefits – the natural processes that rivers, lakes, wetlands and aquifers provide to support human well-being – range from water purification and sediment delivery to biodiversity conservation, and the protection of communities from severe droughts and catastrophic flooding.

The degradation of rivers, lakes, wetlands and groundwater aquifers is putting this value at risk and threatening climate resilience in the 21st century. Governments and businesses have invariably focused on direct uses, treating rivers as just water pipes, wetlands as 'wastelands', and lakes and aquifers as water reserves to be pumped dry and polluted without consequence. The price of water, particularly for large users, has invariably been set too low – and has not factored in the value or health of freshwater ecosystems. Unsustainable withdrawals from surface and groundwater, human alterations to river flows, water pollution through agricultural run-off, industrial effluent and sewage, as well as climate change's impact on rainfall patterns and glacier melt, are threatening the health of our freshwater ecosystems. Two-thirds of the world's large rivers are no longer free-flowing,[1] and one third of wetlands have been lost since 1970.[2] Consequently, half of the world's population is currently exposed to water scarcity at least once per month,[3] while 55 million are affected by droughts annually.[4] By 2050, GDP may decline by up to 6 per cent in some areas of the world if societies do not change the way they manage water and protect freshwater ecosystems.[5] Erratic rainfall, water scarcity and flash flooding are all exacerbated by climate change and the worsening crisis is shining a light on society's failures to manage, restore and allocate freshwater resources responsibly.

The world urgently needs to accelerate action on water – increasing the current rate of progress sixfold to achieve water for all by 2030 (SDG6). This requires increased investment in sustainable water infrastructure. However, outdated 20th-century thinking cannot solve the water crisis because water does not come from a tap, it comes from nature. Relying solely on more built infrastructure cannot decouple us from our dependence on nature nor build long term resilience. We need to start treating rivers, lakes, wetlands and aquifers as the dynamic, life-providing systems they are, especially in the era of climate uncertainty.

The freshwater crisis is gaining awareness as people, governments and businesses increasingly understand water-related disasters as the result of poor water management and land use. In response to rising freshwater threats, political momentum is slowly building at national, regional, and international levels, with water and rivers mentioned for the first time in a United Nations Climate Change Conference (COP) cover text in Egypt in 2022. In accordance with high-level political initiatives, businesses are starting to change their behaviours as they experience water risks first-hand and acknowledge the importance of water risk management for their financial resilience. Financial institutions are also slowly waking up to the freshwater crisis and responding with new risk management mechanisms to limit negative impacts on freshwater ecosystems, as well as innovative financial instruments to bridge the water financing gap and encourage investments in water preservation. However, much more remains to be done to translate this momentum into implementable steps to value, protect and steward our freshwater resources.

Everyone has a role to play in tackling the world's freshwater crisis but real progress depends on urgent action by key stakeholders. Local, national and transboundary policymakers, business and finance leaders, and civil society organisations need to mobilise around fundamentally changing the way the world values and manages water and freshwater ecosystems.

We need to invest in nature by creating the right governance, stewardship, financing, and partnership structures to protect, restore and sustainably manage the world's rivers, lakes, wetlands and aquifers – and pave the way for a net-zero, nature-positive, equitable and resilient future.

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CALL TO ACTION

Everyone has a role to play in tackling the world's freshwater crisis but real progress depends on urgent action by key stakeholders. Local, national and transboundary policymakers, civil society organizations, and business and finance leaders need to wake up to water risks and mobilize around fundamentally changing the way the world values and invests in water and freshwater ecosystems. At the heart of the global response is the need to protect and restore healthy rivers, lakes, wetlands and aquifers – our freshwater life support systems, which have been undervalued and overlooked for far too long. Transforming our approach to managing water and freshwater ecosystems is the key to solving the world's water crisis as well as central to tackling the global nature and climate crises.

Governments and policymakers at the local, national and regional level, including transboundary river basin authorities, should:

- **Restore and protect vital freshwater ecosystems:** Commit to revitalizing 30 per cent of degraded rivers and wetlands worldwide by 2030 and conserve intact freshwater ecosystems through the Freshwater Challenge;
- **Develop ambitious freshwater targets**: Embed clear goals for freshwater ecosystems in planning, including national biodiversity and adaptation plans and accelerate actions towards delivering SDG6;
- **Integrate river and water resource management systems:** Increase collaboration and coordination across sectors and borders, and factor in the health, resilience and system-wide functionality of river basins and wetlands into all development and infrastructure decisions, as well as the diverse range of benefits and services they provide;
- **Implement adaptable water allocation:** Design flexible, locally tailored water allocation systems to ensure fair, sustainable distribution across sectors, while safeguarding ecosystem health;
- **Sustainably manage and protect groundwater resources:** Set sustainable extraction limits, enhance aquifer recharge through natural or managed replenishment, and reduce demand;
- **Invest in natural water storage through Nature-based Solutions:** Reduce the impact of extreme floods, and increase natural water retention and strengthen resilience to droughts by restoring wetlands, floodplains and watersheds, replenishing aquifers, and enhancing the health of soils; and
- **End harmful subsidies:** Eliminate counterproductive subsidies and foster incentives that promote sustainable water use, particularly in water-intensive sectors like agriculture and energy.

Industry and business should:

- **Develop transformative water stewardship strategies:** Create and implement water strategies, using guidance and systems from WWF, the Alliance for Water Stewardship and the CEO Water Mandate, including harnessing the new Science-based Targets for Nature on freshwater, to drive real change and build resilience;
- **Increase and disclose water risk assessments:** Evaluate and reveal water risks from scarcity, pollution, and floods within operations and supply chains using tools like the WWF Risk Filter Suite;
- **Invest in enhancing efficiency and reducing pollution while considering allocation:** Implement water-saving technologies and advanced treatment to minimize wastewater generation and maximize efficiency, especially in supply chains, but be mindful of where "savings" are going to avoid a net-zero gain for river basins;
- **Increase collective action for resilience:** Collaborate with peers, governments, and communities to enhance river basin resilience through investing and participating in collective action platforms and Nature-based Solutions in river basins where they operate; and
- **Advocate for action:** Companies should use their significant power and influence to call on governments to create the foundations for a new, sustainable approach to water and freshwater ecosystems – from better allocation and fair pricing to greater use of public funds to support freshwater ecosystem restoration.

Financial institutions should:

- **Dedicate 50 per cent of public climate finance to adaptation:** Investing in the "restoration economy" and Nature-based Solutions to enhance the health of freshwater ecosystems and build more climate resilient societies and economies;
- **Reduce water-related financial risks:** Enhance the resilience of freshwater ecosystems through avoiding investments in harmful infrastructure, divesting from high impact projects, creating new asset classes around Nature-based Solutions and adaptation, and investing in water technology and data;
- **Climate-proof Insurance:** Invest in Nature-based Solutions for climate adaptation, particularly restoring degraded freshwater ecosystems to reduce insurance risks;
- **Assess water-related financial risk to their portfolios** by requiring existing and potential client companies to assess and disclose the water risks in their operations and supply chains.

Civil society organizations should:

- **Raise awareness:** Shine a light on water blindness by stressing the central role of healthy freshwater ecosystems in enhancing water, food and energy security, improving human health, reducing conflicts and natural disasters, and tackling nature loss and climate change through campaigns, engaging Indigenous Peoples and local communities, women and youth, and leveraging the power of the climate movement; and
- **Advocate for action:** Pressure governments, corporations and financial institutions to tackle water challenges, implement and adhere to effective water regulations, and invest in the protection and restoration of freshwater ecosystems for people, nature and climate.

As individuals, we can take action by:

- **Educating others:** Raise awareness about worsening water scarcity, floods and pollution, and the importance of healthy freshwater ecosystems among family, friends, and communities;
- **Embracing mindful consumption:** Choose water-efficient products and reduce the overconsumption of animal-source products and increase the consumption of sustainably produced plant-based foods;
- **Supporting conservation:** Participate in local cleanup and restoration efforts around rivers, lakes, and wetlands – and campaign for their protection. Volunteer with environmental organizations;
- **Championing water stewardship at work:** Discuss your company's water strategy. If it is a water stewardship laggard, outline the case for action to reduce water risks; and
- **Advocating for change:** Petition for stronger water management policies, encourage adoption of freshwater ecosystem-based approaches to climate adaptation planning, advocate for investment in natural water infrastructure, and support sustainable practices.

Bringing people together is crucial as we unite stakeholders to form partnerships and coalitions on local, regional, and global scales. Through this shared effort, we can work collectively to overcome long-standing challenges, aiming to dispel water blindness and solve this global crisis for nature, people and our shared future.


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1. INTRODUCTION

Healthy freshwater ecosystems play a vital and under-appreciated role in human and planetary health

Protecting and restoring rivers, lakes, wetlands and aquifers is essential for the future sustainability of societies, economies and ecosystems.

Water is central to all life on Earth. It sustains all human societies and economies, and the globe's dazzling biodiversity. However, the world is facing a worsening water crisis, and the disastrous consequences of water blindness – undervaluing and overlooking the critical importance of water as well as the diverse benefits of healthy freshwater ecosystems – in policymaking are becoming more evident. Billions still lack access to safe water and sanitation, food insecurity is rising, businesses and financial institutions are facing increasing water risks, freshwater biodiversity is being lost faster than any other, and water is the primary channel through which societies, economies and ecosystems are experiencing the intensifying impacts of the climate crisis.

Healthy freshwater ecosystems – the world's rivers, lakes wetlands and aquifers – are central to tackling these 21st century challenges. In particular, resilient rivers have a key role to play in ensuring a sustainable future. Rivers connect the land and the sea, linking mountain glaciers and springs to highly productive floodplains, estuaries, and deltas. They have flowed through and sustained our cultures and civilizations since the dawn of history, and their health is intrinsically tied to our present and future.

- **Societies:** Beyond access to water, freshwater ecosystems underpin food security, physical and mental health, gender equality and conflict prevention, and are central to many cultures and traditions. From rural communities to sprawling megacities, healthy freshwater ecosystems are critical for well-being and sustainable development.
- **Economies:** Economic stability and prosperity – from local livelihoods to global corporations – depend on freshwater and the ecosystems that store and supply it due to their central role in agriculture, trade and transport, industry and energy production.
- **Ecosystems:** Healthy rivers, lakes, wetlands and aquifers provide invaluable ecosystem services that are often overlooked but directly underpin the prosperity of societies and economies. Freshwater ecosystems contribute to climate resilience by mitigating extreme floods and droughts, protecting against storms and erosion, regulating temperatures and micro-climates, and keeping deltas above the rising seas. The carbon sequestration capacity of wetlands, particularly peatlands, is also critical for climate mitigation. From a nature perspective, rivers, lakes, wetlands and aquifers are not only essential for freshwater biodiversity but also for the health of terrestrial and marine ecosystems through provisioning and regulating services, including water supplies, nutrient cycling and sediment transportation.

Human societies often pretend that we can immunise and decouple ourselves from nature by draining, dredging, damming and converting our rivers, lakes, wetlands and aquifers.[6] As a result, societies have been degrading freshwater ecosystems at alarming and increasing rates. Globally, only one third of large rivers are still free flowing[7] and the world has lost one third of its remaining wetlands since 1970.[8] In Europe, the extensive draining of wetlands began as early as the 18th century, with countries like Germany, the UK and Ireland losing more than 90 per cent of their wetlands since 1700.[9] Water quality is also worsening with agricultural run-off from fertilisers, pesticides and manure impacting surface and groundwater and 80 per cent of wastewater flowing untreated into nature, predominantly our rivers, lakes and wetlands.[10] The degradation of freshwater ecosystems is exacerbated by climate change and inappropriate land use and management, and is leading to intensifying water stress, including catastrophic water shortages and intense flooding.

The world's worsening water crisis and the intensifying impacts of climate change prove that modern engineering cannot decouple society from its dependence on nature. Traditional grey infrastructure is costly, requires ongoing maintenance and investment, and does not build long term resilience. To tackle our water crisis, we need to invest in the best overall solutions, including prioritizing Nature-based Solutions (NbS). We need to transform our relationship with water and treat rivers, lakes, wetlands and aquifers as the living, life-providing systems they are – systems that we need to value, protect and restore if we are to pave the way for a net-zero, nature-positive and resilient future.

This report estimates the economic value of water and the freshwater ecosystems that store and supply it to shine a light on water blindness in policy and advocacy and help ensure that efforts to protect, restore and sustainably manage freshwater ecosystems are commensurate with their true value. The remainder of Section 1 describes the different benefits that societies, economies and ecosystems obtain from healthy freshwater ecosystems and well-managed water resources, highlighting how many of these benefits are chronically undervalued. Section 2 estimates the economic value of freshwater from direct and indirect uses and emphasises the importance of adequately recognising this value to inform decision-making. Section 3 illustrates how momentum around sustainable freshwater management, protection and restoration has been building, although much more remains to be done to drive systemic and transformative action on freshwater. And section 4 concludes with an overview of emerging trends and innovations in freshwater and provides clear recommendations for different stakeholder groups to accelerate freshwater action.

SOCIETIES

Investments in healthy freshwater ecosystems and water infrastructure underpin progress on water and food security, health, education, gender equality and conflict prevention.

Access to safely managed water resources not only improves health outcomes but also generates wider societal benefits. However, as of 2020, approximately 26 per cent of the world's population still lacked access to safely managed[11] drinking water,[12] and attaining universal coverage by 2030 would necessitate a 6-fold increase in current rates of progress.[13] Meanwhile, over half the world's population faces water shortages at least one month per year and this figure could rise to 5 billion – or 2/3rds of the global population – by 2050. The Intergovernmental Panel on Climate Change (IPCC) also expects 50 per cent more people to live under water stress if the world temperature rises 2°C, compared to 1.5°C. Key barriers to access include limited availability of water in regions with high water scarcity, and increasing pollution of major water sources, such as rivers, lakes and aquifers, due to fertilisers, chemicals, heavy metals and untreated sewage. Consequently, water access varies significantly across regions, with coverage substantially higher in Europe and North America (96%) compared to Central and Southern Asia (62%) or Sub-Saharan Africa (30%).[14] Access to safe and affordable piped water is also not equitably distributed within countries, with service levels consistently higher in urban areas than in rural regions.[15] Almost 2 billion people source drinking water directly from rivers,[16] underpinning the importance of preventing overextraction and pollution.

Investments in the health of freshwater ecosystems and improvements to WASH infrastructure and governance have the potential to decrease the incidence of waterborne diseases like cholera, typhoid, and hepatitis, as well as vector-borne diseases such as malaria.[17] Half of the world's population still lacks access to safe drinking water, sanitation and hygiene (WASH), contributing to 1.4 million preventable deaths each year.[18] Access to clean water and handwashing facilities is also critical for pandemic preparedness and resilience, as the Covid-19 pandemic has shown. In addition to saving lives, the positive impact of healthy freshwater ecosystems and WASH infrastructure on health is strongly linked to improved educational outcomes, heightened productivity, poverty reduction, and gender equality. Globally, waterborne diseases are responsible for 443 million missed school days each year.[19] Improved access to clean freshwater also reduces the burden of water collection, leading to increased education outcomes and labour force participation. These impacts are especially felt amongst women and girls, who currently spend a total of 200 million hours each day collecting water.[20]

Freshwater access and availability and the health of freshwater ecosystems are central to food production – and directly linked to food security challenges. Global food production and food security are dependent on rainfall and irrigated water from surface and groundwater supplies. But the critical importance of freshwater for food security also extends to rivers – on which over one third of the world's food production is directly dependent.[21] Along with irrigated cropland, this also includes food from freshwater fisheries, flood recession agriculture and deltas.[22] For example, freshwater fishes provide food for 200 million people and generate livelihoods for 60 million people worldwide, particularly in low-income, rural settings across Asia and Africa.[23] Additionally, the combination of extensive water access and nutrient-rich sediment

AS OF 2020, APPROXIMATELY 26% OF THE WORLD'S POPULATION STILL LACKED ACCESS TO SAFELY MANAGED DRINKING WATER.

from rivers allows fertile deltas to contribute 4 per cent to global food production, despite covering just 0.5 per cent of the land surface area.[24] The Mekong Delta, for example, contributes half of Vietnam's rice production and 95 per cent of its rice exports, which feed other regions across the world.[25] However, the degradation of freshwater ecosystems – often linked to overextraction of water for agriculture – is increasing the pressure on irrigated agriculture in many areas. Critical freshwater fisheries are also at risk, while Asia's great deltas are sinking and shrinking. Meanwhile, rainfed agriculture is also facing growing challenges as rainfall patterns become more erratic under climate change. The UN Food and Agriculture Organization (FAO) found that 10 per cent of the world's rainfed cropland is subject to frequent drought along with 14 percent of the world's pastureland. In sub-Saharan Africa alone, FAO found that 50 million people live in regions where severe drought has catastrophic effects on cropland and pastureland once every three years.

Stable water access further improves human security through the reduction of conflict and forced displacement. Disputes over water access range from localised community confrontations over scarce resources to interstate conflicts over key watersheds. Confrontations over water have increased substantially over the past years: the Pacific Institute recorded 78 conflict incidents triggered by water in 2021 compared to 42 in 2017, constituting an increase of more than 85 per cent.[26] As water scarcity and competition increase, communities facing greater food insecurity, water stress, and disaster risks are increasingly forced to migrate to areas with better livelihood opportunities. Just and equitable approaches to the management of scarce water resources not only reduce the risk of conflict, but also address the underlying drivers of forced displacement. Increasing water scarcity also fuels human-wildlife conflicts.

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ECONOMIES

Freshwater contributes to economic prosperity by powering industrial manufacturing, mining, technology, trade, energy, and agricultural production.

For centuries, water has been an essential factor in both the industrial production of goods and their transportation through inland waterways. Manufacturing industries rely on water for cooling, cleaning and as a production component across various sectors. Almost every business and industry depends on water – from mining and manufacturing to the operation of enormous data centres that store, process, and distribute vast amounts of digital information.[27] In addition to quantity, good water quality is critical for various sectors, including beverage and food processing, car industries and textile production. As a result, water-related risks can severely disrupt production and trade: the 2021 droughts in Taipei slowed the water-intensive production of microchips used in computers, smartphones and cars, leading to substantial shortages in global supply chains.[28] And these water-related risks are growing. According to analysis by the WWF Water Risk Filter, 10 per cent of global GDP comes from regions of high water risk and this could rise to 46 per cent by 2050 due to climate and socio-economic change. Meanwhile, two-thirds of companies reporting to CDP say rising water risks could put US$225 billion at risk.

Rivers, canals, and other waterways also serve as vital connectors between major port cities, coastal regions, and inland areas, enabling the efficient transportation of goods. In China's Pearl River delta, where 24.8 per cent of China's total exports originate,[29] more than 1 billion tonnes of freight were transported on inland waterways in 2019.[30] In Europe, 524 million tonnes were transported in 2021[31] on 37,000 kilometres of navigable waterways connecting cities and industrial regions.[32] The value from inland waterway transport is predominantly concentrated in specific basins, such as the Rhine and Danube rivers.[33] However, governments in Europe continue to channel and dredge intact river stretches for inland navigation, even in instances where there is low commercial demand and substantial risk of harm to riverine ecosystems.[34] The drought of 2022 also resulted in record low levels in many European rivers, including the Rhine and the Po, impacting transportation and demonstrating the growing risks from climate change.

Water and freshwater ecosystems are central to energy security through their pivotal role in non-renewable and renewable energy production. The global energy system accounts for almost 10 per cent of global freshwater withdrawals.[35] Almost 90 per cent of global power production is water intensive, primarily involving the cooling of thermal and nuclear power plants,[36] as well as hydropower generation, which accounts for almost 15 per cent of global electricity production.[37] But water risks to energy security are growing. Droughts have severely reduced power generation from hydropower dams across the world – from Argentina to Zambia. In the US, falling water levels in two huge reservoirs on the Colorado river threaten future hydropower generation for millions of people. But drought also impacts non-renewable generation with some nuclear power plants being forced to reduce output in France in 2022 due to river flows being too low and too warm. Meanwhile, more extreme floods also pose a growing threat to the safety of aging and vulnerable hydropower dams.

Irrigated agriculture is facing increasing water risks. Nearly 70 per cent of global freshwater withdrawals from surface and groundwater can be attributed to agriculture, rising to over 90 per cent in many low- and middle-income countries.[38] While only 16 per cent of all cultivated land globally is irrigated, irrigated cropland contributes 44 per cent of food production worldwide.[39] More than one third of irrigation water is pumped from groundwater aquifers, while the remainder is drawn from surface water.[40] But more than 60 per cent of irrigated cropland is already highly water stressed with increasing numbers of rivers, lakes, wetlands and aquifers suffering from overextraction.

Unsustainable economic activities degrade freshwater ecosystems and contribute to worsening water risks to business, industry, energy and agriculture. Economic decision makers have long undervalued and overexploited freshwater ecosystems, resulting in severe impacts on the health of rivers, lakes, wetlands and aquifers. Overasbstraction threatens water supplies, while industrial pollution impacts water quality – contributing to the rising risks that companies face. Meanwhile, hydropower dams fragment rivers, disrupt sediment delivery, alter river flows, destroy habitats for biodiversity and can displace Indigenous Peoples and local communities. High impact hydropower can even contribute to the erosion of deltas, literally undermining the communities, cities, agriculture and economic supply chains that have developed on them.

SAND MINING AND DAM CONSTRUCTION IN THE MEKONG

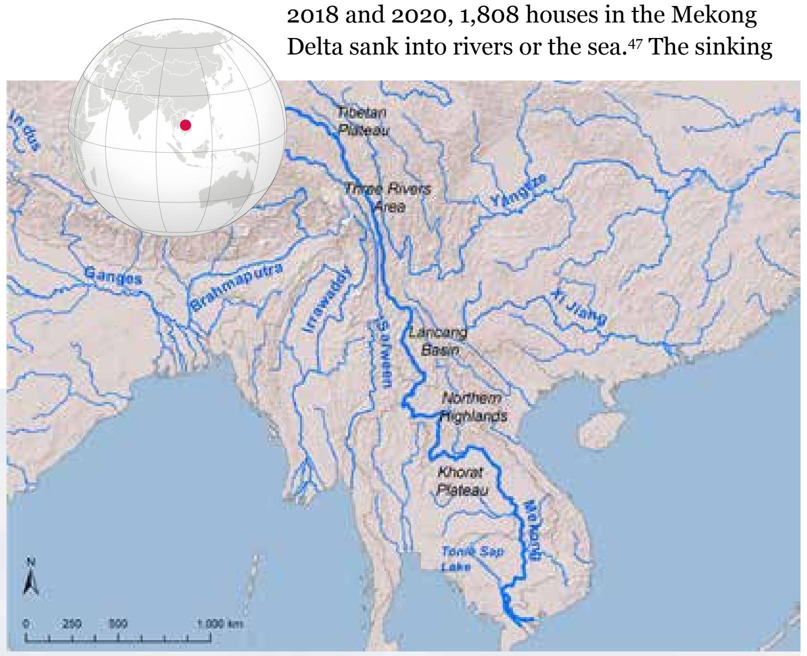
Sand mining and dam construction threaten the Mekong's sediment delivery processes, leading to the sinking and shrinking of the Mekong Delta. This has harmful impacts on the communities sustained by the Delta, global rice production and biodiversity.

The Mekong Delta in Southwestern Viet Nam and Cambodia is one of the world's largest and most fertile deltas. Covering an area of 41,000km², the region is home to 18 million people in Viet Nam alone and is critical for the region's economy and global production and trade.[41] Deposits of nutrient-rich sediment and regular river flooding have created ideal conditions for agriculture. As a result, the Mekong Delta produces almost 50 per cent of Viet Nam's rice crop and contributes 95 per cent of its rice exports.[42]

Additionally, almost one quarter of global freshwater fish catches are from the Mekong River,[43] which has the second highest fish biodiversity globally, after the Amazon river.[44]

However, this value is at risk as the Mekong Delta is facing critical threats due to sand mining and dam construction. National demand for sand, predominantly for use in the construction industry and for landfills, has grown to several hundred million tonnes per year. As a result, annual extraction volumes from river beds exceed the rates of natural sediment deposition, leading to altered river hydrology, reduced water quality and increasing river bank and coastal erosion.[45] This is exacerbated by dam construction: if the 11 mainstream dams currently being planned in the Mekong are constructed, they could prevent up to 94 per cent of river sediment from being deposited in the Delta.[46] These dams would also threaten biodiversity and fisheries in the Mekong, and are therefore putting immense value at risk.

As a result, the Mekong Delta has been sinking and shrinking, with devasting effects both for human livelihoods and wildlife. More than 600 hectares of riverside and coastal land are lost annually due to erosion, and between 2018 and 2020, 1,808 houses in the Mekong Delta sank into rivers or the sea.[47] The sinking of the delta also contributes to saltwater intrusion, which impacts ecological balances, freshwater supply, rice and other agricultural crop yields, and in turn, the livelihoods of millions of people. Many of these issues will only become more severe as climate change accelerates, leading to more erratic rainfall patterns, more frequent and intense storms, and greater sea level rise.



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Top three actions to prevent the sinking and shrinking of the Mekong Delta:

- **Register and manage sand as a strategic resource:** Sand plays a key role in economic prosperity and climate resilience in the Mekong Delta, and thus needs to be registered and managed as a strategic resource to incentivize.
- **Develop a delta-wide sand budget:** River sand is a shared resource among the countries along the Mekong River. To effectively manage its extraction and use, a comprehensive and basin-wide approach is necessary. Implementing a delta-wide sand budget would be a valuable tool in supporting policies and planning, but it must also be extended to cover the entire Mekong basin, with the active involvement and mandate of the Mekong River Commission.
- **Halt in-channel sand mining and shift to manufactured sand:** The current extraction rate of sand from the Mekong Delta is unsustainable, with the remaining exploitable sand stock estimated to last less than 10 years. Continued extraction at this rate will lead to devastating negative impacts for both people and nature. Additionally, the quality of the remaining stock is lower grade, often unsuitable for construction, and primarily limited to landfill use. Urgent action is needed to halt in-channel sand mining and transition to sustainable alternatives, such as manufactured sand.

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ECOSYSTEMS

Healthy freshwater ecosystems provide diverse values that are critical for people, and central to tackling global climate and nature crises

Healthy freshwater ecosystems play a key role in climate adaptation by mitigating extreme floods, building resilience to droughts, protecting against storms and erosion, regulating temperatures and micro-climates, and sustaining deltas. For example, resilient rivers, connected floodplains and healthy wetlands act as natural flood defences, spreading and slowing the flow of water and helping to mitigate downstream flooding and erosion. By absorbing excess water and slowly releasing it afterwards, floodplains and wetlands can also help to replenish aquifers and alleviate water scarcity during times of reduced water flows. Additionally, rivers and wetlands cool surrounding landscapes and provide micro-climate regulation, in both rural and urban areas.[48] But connected and flowing rivers provide many other overlooked benefits. Their natural dynamics and nutrient flows are essential for biodiversity, while their sediment flows are critical for preventing erosion, maintaining groundwater levels, sustaining most mangrove forests, and keeping densely populated and biodiverse deltas above sea level. (*See Mekong Delta spotlight on pg. 16*).

Freshwater wetlands also play a central role in climate mitigation. Peatlands store huge amounts of carbon – more than twice as much as the world's forests despite covering only 3-4 per cent of the global land surface.[49] (*see Congo peatlands spotlight on pg. 32*). However, drained, damaged, or burned peatlands release substantial amounts of CO_2, accounting for 4 per cent of annual anthropogenic greenhouse emissions in 2021.[50] Water, sediment and nutrient flows from rivers are also crucial to sustain most of the world's mangroves, which sequester on average 6-8 tonnes of CO_2 equivalents per hectare annually.[51] These rates are approximately 2-4 times higher than the average sequestration rates in mature tropical forests.[52]

Rivers, lakes and wetlands are biodiversity hotspots, home to almost 40 per cent of all known species.[53] Approximately one third of vertebrate species[54] – including more than half of all known fish species[55] – are supported by freshwater habitats. Rivers and floodplains serve as connecting corridors, breeding and feeding grounds for migrating fish, amphibians, turtles and river dolphins. Meanwhile wetlands, like the Doñana World Heritage Site in southern Spain (*see spotlight on pg. 28*) and all the diverse wetlands dotted along the world's great Flyways, play a critical role as stopover, breeding and feeding sites for millions of migratory birds each year.[56] But we have already lost a third of the world's remaining wetlands in the past 50 years[57], while freshwater species populations have collapsed by 83 per cent on average over the same time period. Freshwater ecosystems and biodiversity are still the most at risk – with around a third of freshwater species now threatened with extinction.

The health of freshwater ecosystems is also critical for the health of terrestrial and marine ecosystems and biodiversity. Rivers connect the land and the ocean, flowing through – and sustaining – diverse ecosystems from source to sea. Some forests, such as Mekong Flooded Forest, depend on periodic flooding and the deposition of nutrient-rich sediment for soil fertility. Additionally, fish species have been found to play a central role in dispersing forest seeds in ecosystems such as the Amazon forest and the Pantanal.[58] The health of our deltas, mangroves, coastal wetlands, and oceans is also closely connected to rivers as they supply essential freshwater, nutrients, and sediments to help sustain these ecosystems and their biodiversity, including nitrogen and phosphorus to feed the phytoplankton at the bottom of the food web. Lastly, freshwater sustains almost every terrestrial species, while connected rivers provide vital corridors for fish migrating between saltwater and freshwater ecosystems. Yet, the protection and restoration of freshwater ecosystems has always been neglected with conservation decisions focussing on land and sea.

Although the protection, restoration and sustainable management of freshwater ecosystems

WE HAVE ALREADY LOST 1/3RD OF THE WORLD'S REMAINING WETLANDS IN THE PAST 50 YEARS, WHILE FRESHWATER SPECIES POPULATIONS HAVE COLLAPSED BY

83%

ON AVERAGE OVER THE SAME TIME PERIOD.

are critical to boosting water, food and energy security, reducing water-related economic and financial risks, and tackling the climate and nature crises, freshwater resources are still consistently undervalued and under-prioritised.

Improving the management of freshwater resources is critical to achieving a net-zero, nature-positive and resilient future – and the world's Sustainable Development Goals (SDGs). Water is directly related to every SDG (see visual) as it is central to human and planetary health. While the global water focus is invariably on achieving water and sanitation for all (SDG6), water security and healthy freshwater ecosystems are also central to reducing hunger, poverty, inequality, and vulnerability to climate risks as well as sustaining terrestrial and aquatic biodiversity. However, the world is currently way off track on SDG6. Indeed, achieving all the targets under SDG6 by 2030 requires a 6-fold increase in current rates of progress,[59] underlining the urgent need for the world to accelerate action on water and drastically increase investment in healthy freshwater ecosystems. And not only to achieve SDG6 but also to ensure that countries fulfil their commitments under the Paris Climate Agreement, particularly on adaptation, and the Kunming-Montreal Global Biodiversity Framework, which calls for the protection of 30 per cent of freshwater ecosystems and the restoration of 30 per cent of degraded rivers and wetlands by 2030.

Despite their importance for human and planetary health, freshwater ecosystems have long been overlooked and are facing mounting threats from overextraction and poorly planned infrastructure to damming, draining, dredging and pollution. Rivers are dying, lakes are drying up, aquifers are being depleted and wetlands are being converted to concrete or drained for farming. Aside from further accelerating the already catastrophic loss of freshwater biodiversity, the degradation of our freshwater ecosystems because of short-sighted political and economic decisions – including poor pricing and subsidising the cost of water for major users – is undermining the diverse benefits they provide to people, increasing water risks to economies, and leaving half of the world's population already living in areas facing water scarcity.[60]

Water blindness – the lack of awareness or understanding of the diverse values of water and freshwater ecosystems to societies, economies, nature and climate – has long contributed to poor decision-making around water and freshwater ecosystems. The world urgently needs to wake up to water and start valuing freshwater ecosystems for all the benefits they provide to people and nature. They are our life support systems and the best buffer and insurance against the worsening climate impacts of the 21st century.

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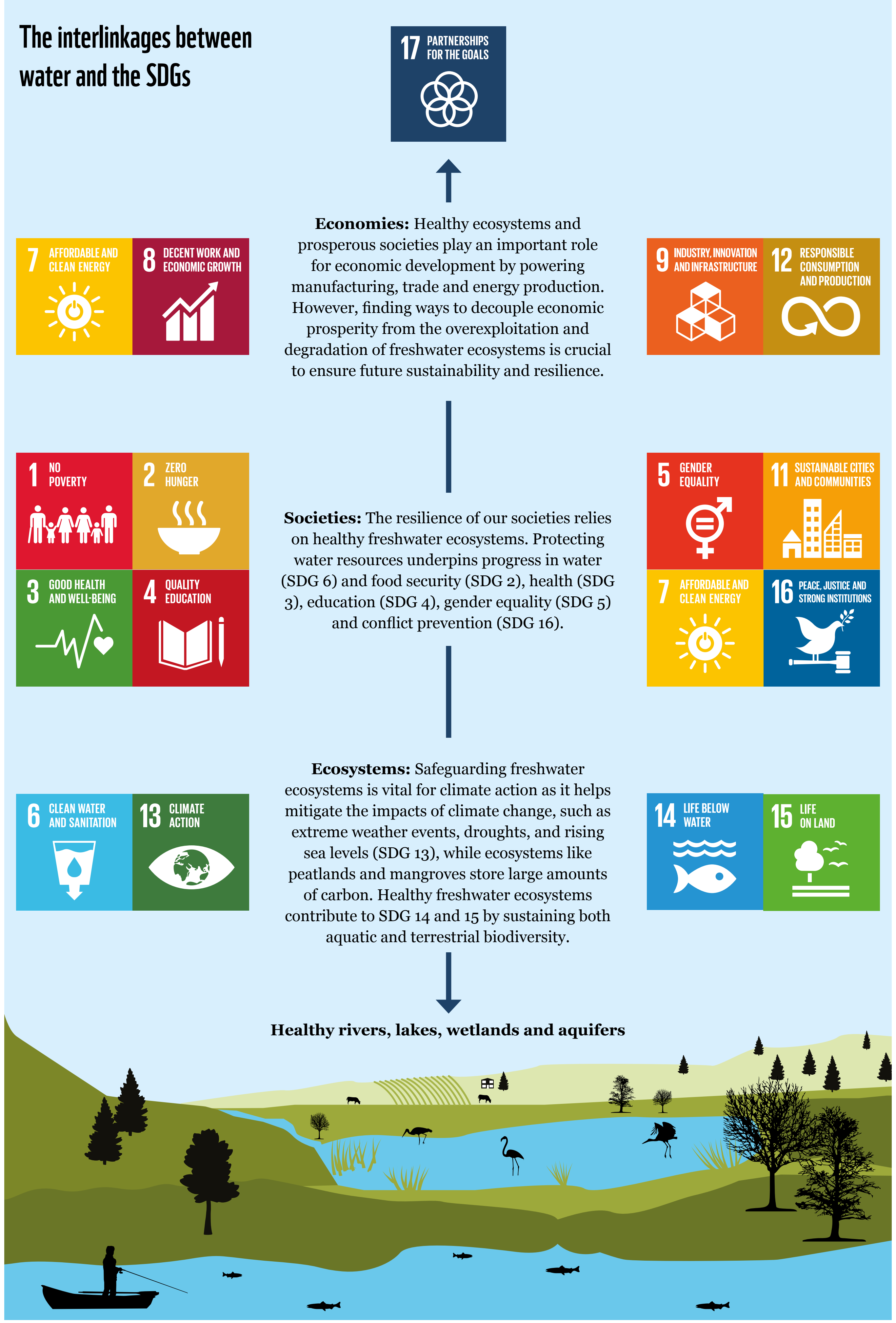

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2. THE STAKES

Water and freshwater ecosystems are chronically undervalued, contributing to poor management and degradation that are driving the water crisis

The value of water to societies, economies, and ecosystems is infinite. Water provides benefits to humans through its consumption, usage and very existence, while healthy freshwater ecosystems provide additional benefits for people, nature and climate. Total economic valuation frameworks categorise these benefits into three main value types:[61]

(1) Use value – Values derived from water through its direct or indirect use:

- **Direct use value:** Tangible benefits that humans derive from consuming or utilising water that is stored and supplied by freshwater ecosystems for different purposes (e.g., water supply for household, industrial and agricultural purposes, recreation, freshwater fishing, hydropower generation etc.).
- **Indirect use value:** Benefits that individuals and societies derive from using ecosystem services provided by rivers, lakes, wetlands and aquifers (e.g., water purification, flood regulation, carbon sequestration, biodiversity conservation, cultural and spiritual value etc).

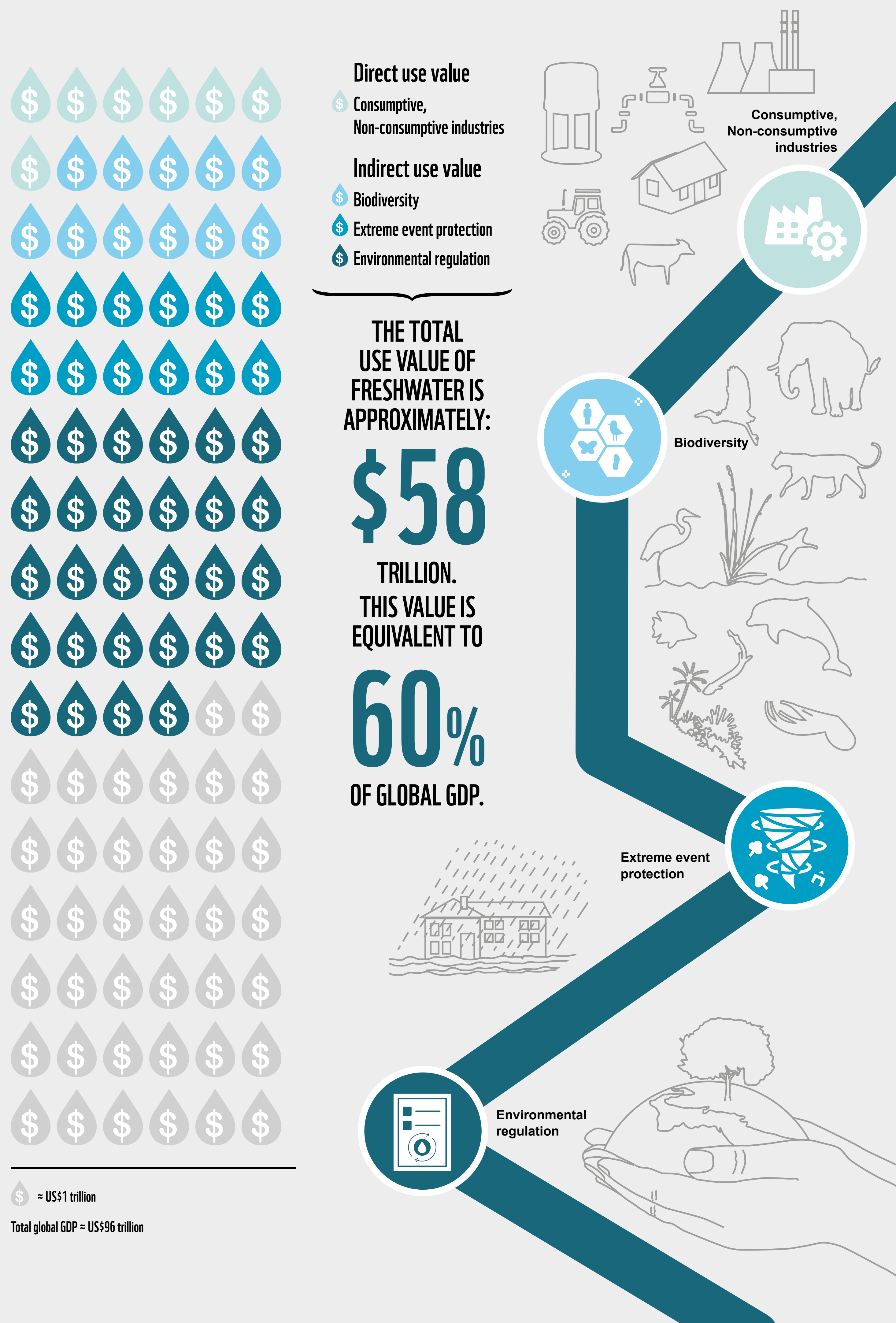
(2) Non-use value: Values derived from water and freshwater ecosystems without using them, including mental health benefits, bequest value (the satisfaction derived from passing resources on to future generations) or existence value (the utility or welfare derived from knowing of the existence of healthy lakes, rivers, wetlands and aquifers).

(3) Option value: Value of preserving or maintaining the potential future use of water, even if it is not currently being utilised, acknowledging that circumstances and needs may change.

While some of water's use values can be effectively priced and valued, others are impossible to put a price on. This includes the cultural and spiritual value of water (i.e., significance and symbolic meaning in traditions, rituals, and beliefs, particularly for Indigenous Peoples), non-use values, option values and ultimately, the importance of water for the existence of all life on earth.

Understanding the uses of water and the diverse values of freshwater ecosystems is essential to weighing up potential trade-offs and informing decision-making around the management of water and the protection, restoration and sustainable management of freshwater ecosystems. While it is impossible to put a dollar value on all benefits, accounting for the different uses of water is important for effective decision-making. This report aims to quantify the direct and indirect use values derived from freshwater globally to shed light on benefits that are chronically undervalued. Treating – and pricing – water exclusively as a commodity to be extracted, traded and consumed and ignoring the values of the rivers, lakes, wetlands and aquifers that store and supply it has contributed to the degradation of freshwater resources and the loss of some of the immense values derived from them.

The total use value derived from direct and indirect uses of freshwater in 2021 is estimated to be approximately US$58 trillion. This value is equivalent to 60 per cent of global GDP, and more than three times the value of China's GDP in 2021 (US$ 17.7 trillion).[62] This figure includes attempts to estimate the economic value of water across different components, including major ecosystem functions (e.g., extreme event protection, regulatory properties and biodiversity preservation) as well as estimates of its value in the production of agricultural outputs and industry. The estimate is computed using regional data where available (including country averages of water prices) and aggregated to global figures (*please see annex on pg 52. for a summary of the methodology and discussion of the limitations of the valuation technique*).



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DIRECT USE VALUE

Water has various direct use benefits for households, agriculture and industry that are valued at a minimum of US$7.5 trillion annually, amounting to 12 per cent of the total use value. This is equivalent to 7 per cent of global GDP, or equivalent to the GDP of Germany and France combined in 2021.[63] Agriculture stands out as the largest water user, accounting for almost 70 per cent of the water extracted globally as well as the rainfall that sustains most of the world's agricultural crops and pastureland.[64] In 2021, the estimated value of water in irrigated agriculture was US$380 billion, based on shadow price estimates for irrigation water[65] and water withdrawal data (from surface and groundwater). However, this figure underestimates the total water value since it does not account for rainfed or naturally flooded agriculture, much of which is subsistence farming. Beyond the market value captured by this metric, stable crop yields – particularly in vital agricultural regions such as the Mekong Delta – are critical for regional and global food security, and in turn are closely related to health and the prevention of conflict and forced migration.

AGRICULTURE STANDS OUT AS THE LARGEST WATER USER, ACCOUNTING FOR ALMOST

70%

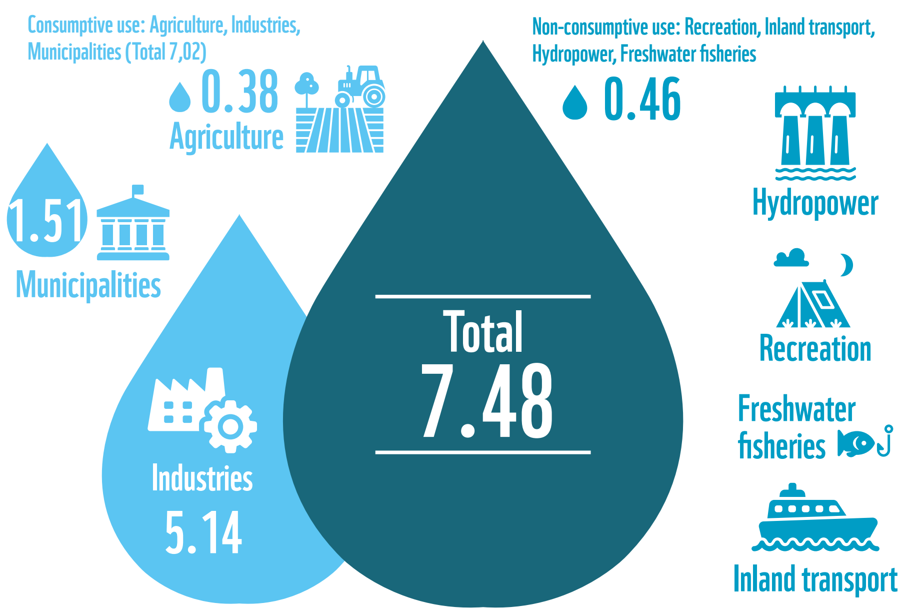
OF THE WATER EXTRACTED GLOBALLY.

Industries – ranging from manufacturing to mining – rely on 600 billion m³ of water each year[66] to run various industrial processes. Water is also a critical input for almost all forms of energy generation. Indeed, the energy sector is the largest consumer of water after agriculture. The industrial use of water generates US$5.1 trillion annually.[67] Along with direct consumptive use in everything from textiles to toiletries, various economic sectors generate value in predominantly non-consumptive ways, including hydropower generation[68] (US$220 billion),[69] freshwater fishing (US$18 billion),[70] recreation and tourism (US$205 billion) or inland transportation (US$19 billion),[71] contributing to llivelihoods, food and energy security, economic growth and international trade.

In addition to underpinning agricultural activity and driving industrial productivity, water is withdrawn by municipalities and households for drinking water and sanitation. Market prices paid by households and other entities connected to municipal grids (US$ ~500 billion) are supplemented by public water subsidies invested by governments (US$ ~1 trillion) to treat and provide water both as an essential good and human right, as well as a driver of productivity and economic activity. But progress towards universal access to safe water and sanitation (SDG6) remains way off target, due to poor governance, insufficient investment, and inequitable water allocation – as well as neglect of freshwater ecosystems. Poor wastewater management by utilities can also pollute these ecosystems, reducing water quality.

Unsustainable agricultural and industrial practices also contribute to the degradation of rivers, lakes, wetlands, and aquifers. Poorly planned agricultural expansion and the way water is currently valued through comparatively low market prices and extensive subsidies may lead to inefficient structural choices around crop mixes and agricultural practices. The comparatively low cost of water for agriculture in many countries is partially contributing to the overexploitation and extraction of water, as well as excess pollution. Growing food more sustainably, allocating water justly and capping water extraction are critical to protect agricultural output and the freshwater ecosystems on which it depends[72]. Similarly, despite deriving huge value from water, industries are simultaneously culpable for its overextraction and pollution – and devastating impacts on freshwater ecosystems. Subsidised prices and a lack of awareness of water risks and the importance of healthy freshwater ecosystems to economic resilience have contributed to poor water stewardship by companies across the globe, exacerbating the water crisis and creating additional social and ecological risks – and ultimately putting an immense share of these industries' value generation from their operations and supply chains under threat.

DIRECT USE VALUE GLOBAL VALUE (US$ TRILLION)



DROUGHTS AND AGRICULTURAL OVEREXTRACTION IN DOÑANA

Groundwater depletion and increasing droughts have negative effects on agriculture and ecosystems in the Doñana wetlands.

The Doñana wetlands are a system of marshes, dunes, Mediterranean temporary ponds, scrub woodland and forests at the mouth of the Guadalquivir Estuary,[73] stretching 130,000 hectares across Southwest Spain.[74] Doñana is a UNESCO World Heritage site, Ramsar site,[75] Biosphere reserve, Natura 2000 site and National Park, and home to more than 200 endemic[76] and endangered species.[77] The wetlands are also a hotspot for migratory bird species traveling between Northern Europe and Africa.[78]

However, Doñana is drying out due to the overextraction of aquifers and surface water for industrial agriculture and unsustainable tourism:[79] 8000 hectares across Doñana are legally allocated for strawberry and other red fruit production, while illegal groundwater withdrawal is also widespread. Agricultural withdrawals are putting water sources under severe stress, contributing to high levels of water pollution and in turn the loss of habitats and species. Droughts are a further stressor: since 2013, 59 per cent of Doñana's Mediterranean ponds have disappeared.[80] The largest permanent lagoon dried up for the third time in 50 years in 2022[81] and in 2023 it dried up even earlier. The impacts on wildlife are already materialising, as centennial cork oak trees are dying, aquatic plants, amphibians and dragonflies are disappearing, and the number of migratory birds observed has plummeted by 82 per cent from an average 500,000 to just 90,000 in the winter of 2022/23, marking the lowest recorded data in 40 years.[82] A failure to protect the Doñana wetlands poses risks to the immense indirect use values provided by the ecosystem, but also threatens the sustainability of agricultural productivity in the region in the long run.

Top three actions to prevent the drying out of the Doñana wetlands:

- **Slow down and reverse the expansion of irrigation:**[83] Bans on illegal groundwater withdrawals need to be enforced more stringently and quickly, and the expansion of legal irrigation across Doñana needs to be halted. Water use in Doñana has become a topic of intense political debate since 2022 when the Andalusian regional government moved forward with a plan to amnesty 1900 hectares of illegal irrigation around Doñana.[84] Political opponents, scientists and environmental conservation groups have been emphasising that this move could potentially signal the death knell for Doñana. WWF was at the forefront of a petition led by scientists and supported by the EU, UNESCO, large retailers and farmers, and more than 260,000 Europeans calling for a halt to the expansion of legalised irrigation.[85]
- **Expand sustainable agricultural practices:** Managing withdrawals sustainably is crucial for climate adaptation, regional water supply and long-term agricultural productivity. Sustainable agricultural practices (e.g., reducing irrigation losses, farming dryland crops with lower water needs) can reduce withdrawals substantially without major impacts on yields or quality.
- **Restore degraded landscapes in Doñana:** Investments in the protection and restoration of marshes, Mediterranean ponds and burned forests within Doñana are central to the preservation of biodiversity, and for the health of delicate ecosystems that are on the brink of collapse. The urgent restoration of the hydrological functionality of Doñana, encompassing both surface and groundwater, necessitates a holistic approach.

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DESPITE GENERATING 7 TIMES MORE VALUE THAN DIRECT WATER USE ACTIVITIES, THE INDIRECT BENEFITS OF FRESHWATER ECOSYSTEMS ARE CHRONICALLY UNDERVALUED AND OVERLOOKED. THE ECONOMIC VALUE DELIVERED BY THESE ECOSYSTEM SERVICES IS ESTIMATED AT $50 TRILLION ANNUALLY.

INDIRECT USE VALUE

Despite generating 7 times more value than direct water use activities, the indirect benefits of freshwater ecosystems are chronically undervalued and overlooked. The economic value delivered by these ecosystem services is estimated at US$50 trillion annually. Although the direct benefits of water for households or industries may appear more closely linked to GDP, the indirect use functions of water underpin economic and social development. For example, the various regulatory benefits of freshwater ecosystems, including nutrient deposition, natural water purification and maintenance of soil fertility, bring immense value that is either irreplaceable or extremely costly to artificially construct, and are valued at US$27 trillion annually.

Within these environmental regulation functions, wetlands, and particularly peatlands, have important carbon sequestration capacities valued at US$2 trillion annually. Globally, intact peatlands sequester around 0.37 gigatons of CO_2 equivalents per year,[86] but drained peatlands, which account for 15-20% of total peatland area, already emit more than 1.9 Gigatons annually.[87] Protecting existing peatlands and restoring degraded peatlands is therefore crucial to prevent the release of vast amounts of CO_2 into the atmosphere and limit global warming to 1.5 degrees. The Congo Basin peatlands, for example, store as much carbon as the entire Congo rainforest, despite covering only 5 per cent of its surface area,[88] and their degradation would have catastrophic impacts on global efforts to mitigate climate change.

By contributing to climate adaptation and disaster risk reduction, healthy freshwater ecosystems and well-managed water resources protect vast economic and social value. On an annual basis, the global value of extreme event moderation (climate adaptation and reduction of risks from extreme floods, droughts and other extreme events) through inland wetlands is estimated at US$ 12 trillion. Healthy rivers, lakes and wetlands are society's best insurance against the loss of lives, livelihoods and economic output due to increasing climate threats. Droughts already affect 55 million people annually and have contributed to approximately 650,000 deaths between 1970 and 2019.[89] These trends are predicted to intensify, and estimates show that water risks could create cumulative losses to GDP of US$ 5.6 trillion by 2050.[90]

Freshwater ecosystems also play an important role in preserving genetic diversity (US$9 trillion) and sustaining lifecycles of migratory species (US$2 trillion). The Amazon river basin, for example, contains more than 3,000 freshwater fish species – the largest number in the world – many of which are migratory and depend on connected rivers and floodplains.[91] Meanwhile the Doñana wetlands are home to a wide range of bird species, and host hundreds of thousands of migratory birds each year and more wintering waterfowl than any other place in Europe.[92]

Understanding the value of the diverse benefits we derive from water and freshwater ecosystems allows decision-makers to assess various scenarios and their consequences for effective water allocation, stewardship and management. Decision-making around water allocation and development necessarily involves trade-offs between different values and is ultimately related to how we manage land and freshwater ecosystems, plan for growing populations and urbanization, and regulate agriculture and industry. In the Mekong Delta, for example, disruption of natural river functions through dam construction and sand mining is contributing to the delta's sinking and shrinking, as well as saltwater intrusion (see spotlight on pg. 16). Along with threatening the future of the communities and cities on the delta, this is also putting at risk freshwater fisheries that feed tens of millions and globally important agricultural production: the 2015-2016 drought and associated saltwater intrusion threatened 30 per cent of winter and spring crops in the Mekong Delta region.[93] Furthermore, there are also trade-offs between extractive use and the indirect use values of natural ecosystem functions, including a dramatic loss of natural regulatory functions that have impacts on climatic and economic resilience. In the Amazon River basin, mercury pollution from gold mining not only has harmful effects on human health, but also on fisheries, wildlife and ecosystems (see spotlight on pg. 34), while draining the Congo peatlands for timber and palm oil production would disrupt carbon storage capacities and threaten their other ecosystem services and dazzling biodiversity (see spotlight on pg. 32).

Moving beyond a static understanding of water's value – and recognising the critical values of healthy freshwater ecosystems – is especially vital considering the dynamic and uncertain impacts of climate change. This estimate of the value of water and freshwater ecosystems is a global snapshot at a certain point in time and fails to depict that on a local level,

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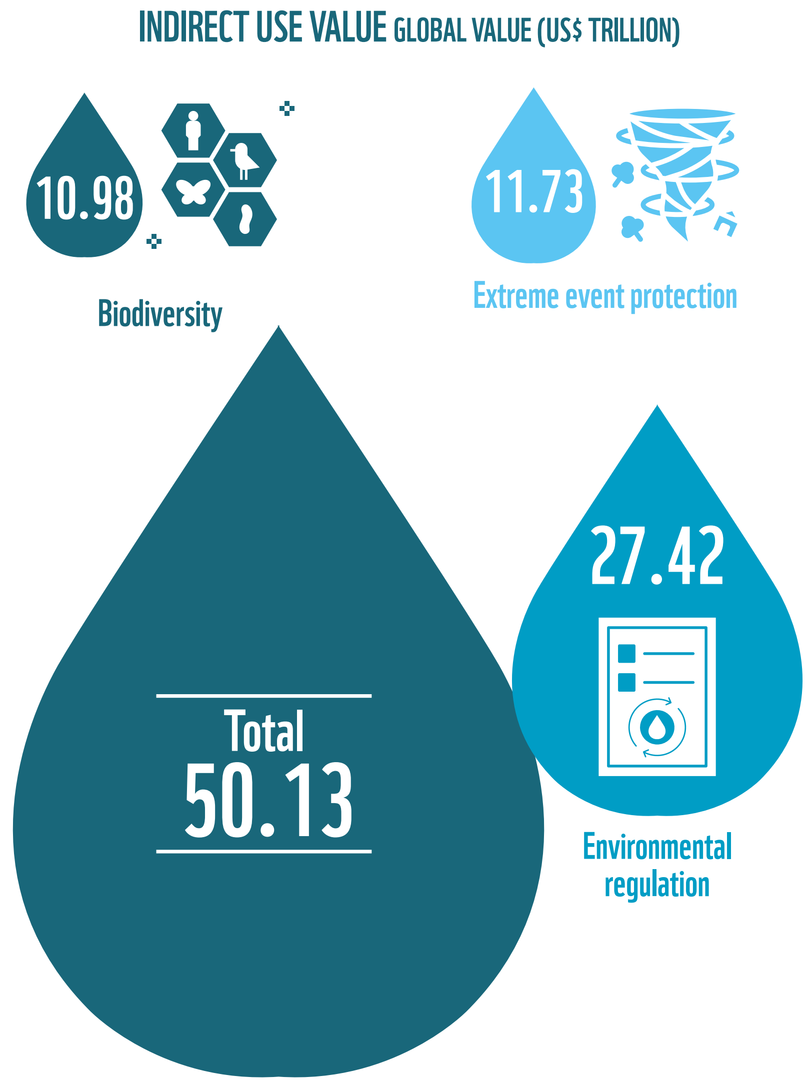
water availability and access may vary radically by season and from year to year. Erratic rainfall patterns, prolonged and more frequent droughts, extreme flooding and groundwater salinisation are expected to increase with climate change. By 2030, an estimated 700 million people in Africa will face the risk of being displaced due to droughts, and by 2050, droughts are likely to affect over 75 per cent of the global population.[94] If natural disasters occur at a similar rate as in past years, there could be more than 1.2 billion climate refugees by 2050.[95] Economic output and productivity are also closely linked to water: water insecurity already costs agricultural irrigators up to US$ 94 billion annually, and the probability of crop yield failures is projected to be up to 4.5 times higher by 2030.[96] In 2016, the World Bank estimated that in some regions of the world, GDP may decline by up to 6 per cent by 2050 due to water-related impacts on agriculture, health, productivity and incomes.[97] Most of these threats are highly interconnected, self-reinforcing and disproportionately impact vulnerable communities that already face higher risks of poverty, disease, food insecurity and conflict. As climate change intensifies, taking a systems perspective that accounts for deep uncertainty[98] and understands interactions in a way that is dynamic, holistic and does not reduce water to a commodity - and values freshwater ecosystems for all their diverse benefits to people and nature - is critical to improving water management and stewardship.



AGRICULTURAL AND INDUSTRIAL DEGRADATION OF THE CONGO PEATLANDS

Government concessions for agriculture and mining threaten the existence of the Congo Basin's peatlands and their value as one of the world's largest carbon stores.

The Congo Basin is home to the world's largest tropical peatlands, covering more than 145,000 km^2 of the Republic of Congo (RoC) and the Democratic Republic of the Congo (DRC).[99] Peatlands form over millennia when organic matter and vegetation partially decompose under waterlogged conditions to form rich peat soil. One of their most valuable characteristics, which often goes unrecognised, is the ability to store carbon. First mapped in 2017, the Congo Basin peatlands (also known as 'Cuvette Centrale') store almost 30 billion tons of carbon,[100] equivalent to almost three years of global greenhouse gas emissions.[101] Despite covering only 5 per cent of the Congo basin's surface, the peatlands store as much carbon as the entire Congo rainforest.[102]

Currently, the Congo peatlands are generally intact, and sustain both local communities who have used the wetlands' resources sustainably over centuries, and diverse wildlife, including forest elephants, chimpanzees and lowland gorillas.[103] However, these peatlands, often referred to as 'carbon time bombs', could release significant amounts of CO_2 if they degrade.[104] Two major threats contribute to this risk: (1) climate change, which leads to water scarcity and a resulting risk of wetlands drying up, and (2) government concessions for forest exploitation, logging, agriculture (especially palm oil)[105], mining for rare minerals (including cobalt, copper and lithium)[106] and oil and gas exploration. [107] Understanding the true value provided by intact peatlands is critical to inform policy-making and prevent degradation.

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Top three actions to prevent the degradation of the Congo peatlands:

- **Build data and map peatlands and wetlands:** Data and information on the carbon stored by peatlands is critical to inform environmental impact assessments for extractive projects in the Cuvette Central. The DRC's Ministry of the Environment developed a 2020-26 national peatland roadmap including the mapping of peatlands and their carbon stocks. WWF is supporting the development and implementation of this national strategy.
- **Develop and implement an effective governance framework for peatlands:** The DRC and ROC have signed agreements within the context of the Central African Forest Initiative focused on land use planning, land tenure, and sustainable forest management as well as mining and oil exploration. Effectively enforcing these regional, national and transnational agreements is critical to preserve the Congo peatlands and their carbon storage functions.
- **Support local communities:** Policymakers need to engage with and account for the needs of communities living within and in the vicinity of the peatlands. In the Lake Tumba and Lake Mai-Ndome landscape within the Cuvette Central, WWF is working closely with local communities to support community forestry and promote sustainable agriculture and fishing.

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MINING POLLUTION IN THE AMAZON

Mercury poisoning from gold mining in the Amazon River basin poses significant threats to the Amazon's rich biodiversity and ecosystem services provided to local communities.

The Amazon river basin boasts some of the world's most diverse ecosystems. However, biodiversity and livelihoods in the Amazon are facing a range of threats, including the proliferation of extractive industries, such as informal and illegal gold mining operations. Illegal gold-mining activity often uses highly toxic mercury to extract gold, which then enters waterways and accumulates in rivers, fish, plants and crops. In the Peruvian Amazon, 185 tons of mercury are released into rivers annually,[108] with 71 per cent of mercury emissions in the Amazon stemming from gold mining.[109]

Mercury accumulation has devastating impacts across Amazonian food webs, affecting river dolphins,[110] jaguars and humans. A study measuring mercury levels in fish sold across six states and 17 municipalities in the Brazilian Amazon showed that on average 21 per cent of fish sold had unsafe mercury levels. In the state of Roraima, the percentage was as high as 40 per cent.[111] Local communities that consume river fish are facing disastrous health effects, as unsafe levels of mercury have harmful and toxic effects on neurological systems, lungs and kidneys.[112] Indigenous Peoples in the Amazon are particularly affected, with mercury levels 7.5 times higher than background levels in the population.[113]

Top three actions to combat mercury pollution in the Amazon:

- **Increase data availability, transparency and accountability:** WWF Brazil and partners have developed the Gold Transparency Portal, a tool supporting government agencies to reduce illegality in the gold supply chain, and the Mercury Observatory, a georeferenced platform on mercury and mining data.
- **Enforce stringent regulations:** Governments and policymakers need to accelerate the implementation of the Minamata Convention[114] and strengthen their legal and regulatory frameworks to eliminate illegal gold mining and trade by 2030. This also entails strengthening transboundary collaboration in policy and regulation amongst Amazonian governments, introducing gold traceability standards and advancing anti-corruption agendas so, by 2030 illegal production of gold and the use of mercury are phased out.
- **Engage with actors across the value chain:** WWF offices are supporting small-scale miners to implement low-cost mercury-free technologies, encouraging responsible buying and are part of the Regional Alliance for the Reduction of the Impacts of Gold Mining in the Amazon.

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3. THE TURNING TIDE

Environmental and political momentum to protect and restore freshwater systems is growing

Around the world, there is a growing awareness of the urgent need for action to tackle the water crisis as communities, companies and countries face worsening water quantity and quality challenges as well as increasing water-related disasters due to climate change and ecosystem degradation. Decision-makers are finally waking up to water. But not nearly fast enough.

The failure to factor all the diverse values of healthy rivers, lakes, wetlands and aquifers into water allocation, infrastructure and development decisions has already caused widespread damage to freshwater ecosystems. More than one third of wetlands have been lost since 1970,[115] and only one third of long rivers are still free flowing.[116] Freshwater species populations have collapsed by 83 per cent on average over the same time, far more than terrestrial or marine species. And the persistence of water blindness in policymaking means that we are still damming, draining, dredging and destroying these ecosystems – despite the extensive value they provide.

Due to growing populations and economies, ecosystem degradation and accelerating climate change, water stress is intensifying everywhere – from increasing numbers of people facing water shortages and food insecurity to increasing losses incurred by businesses and stranded financial assets. The impacts of the freshwater crisis affect everyone.

The scientific community has persistently issued dire warnings about alarming rates of freshwater degradation.

Within the scientific community, there has long been a consensus that the current use of freshwater resources is unsustainable, with catastrophic consequences for human societies and nature. To maintain a safe 'Earth system boundary' for surface water, scientists argue that less than 20 per cent of the flow of rivers and streams should be blocked or altered in their flow in any catchment area, helping to protect biodiversity and ecosystem functioning.[117] However, this target is only met for 66 per cent of the world's land area and less than 50 per cent of the global population.[118] Scientists have detailed the damage being done to our freshwater ecosystems and biodiversity, highlighting how all the drivers of this destruction and degradation (*see spotlight*[119,120]) are harming human and planetary health – and outlining solutions to the crisis.

Poor water governance, unsustainable development, and the neglect and mismanagement of freshwater resources remain the key barriers to equitable and fair water allocation, and the conservation of healthy freshwater ecosystems. But people are finally starting to take the scientists'

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Key threats to freshwater resources

1. **Overexploitation:** Excessive use of freshwater resources (rivers, lakes, wetlands, aquifers) beyond their natural recharge capacity, particularly by agriculture, deteriorates water quality, creates shortages, and disrupts freshwater flows. Unsustainable sand mining contributes to erosion and flow alterations, while overfishing destabilises food chains and ecosystems.

2. **Climate change:** Changes in temperature and precipitation patterns disrupt hydrological cycles and reduce water availability, lowering the quality and quantity of freshwater ecosystems

3. **Water pollution:** Agricultural pesticides, fertilizers, industrial runoff, and human waste discharge lead to harmful algae blooms and create biological 'dead zones.' Acid rain and pollution can acidify freshwater bodies. Emerging threats like microplastics, engineered nanomaterials, light, and noise pollution are also increasing.

4. **Flow modification & fragmentation:** River diversions and infrastructure, such as dams and weirs for hydropower, irrigation and other uses, disrupt the natural flow and function of rivers, causing biodiversity loss and altered sediment flows. Loss of connectivity of freshwater systems impedes the movement of species to reproduction, feeding or resting areas and can cause species declines or extinctions.

5. **Destruction or degradation of habitat:** Loss of freshwater habitats and land-use changes around rivers, lakes, and wetlands contribute to biodiversity loss and decline in ecosystem services for water-dependent communities.

6. **Invasive species:** The spread of non-native species, which is being accelerated by trade of novel species, can destabilize aquatic food chains and lead to biodiversity loss.

7. **Saltwater intrusion:** The intrusion of saltwater into rivers, lakes, wetlands and aquifers increases drinking water salinity, harms wildlife and reduces crop yields

8. **Infectious diseases:** Pollution, invasive pathogens and the warming of water bodies contribute to the spread of infectious diseases, impacting wildlife populations and human health

As these threats interact and cumulate, the detrimental impacts on ecosystems and societies are further exacerbated.

warnings seriously, realising that solving the world's water crisis is about more than water security – it's about the future of our societies, economies, ecosystems and climate. Growing political, corporate and public awareness of this challenge means there is an opportunity window to fundamentally shift the dial on restoring and sustainably managing our rivers, lakes, wetlands and aquifers.

In response to rising freshwater threats, political momentum is slowly building at the national and international level. Globally, decision-making on socio-economic development, conservation and climate adaptation is increasingly incorporating freshwater. For the first time in Egypt in 2022, the cover decision at the UN Climate Change Conference (COP27) highlighted the importance of water and rivers to climate action, particularly adaptation. A few weeks later, 'inland waters' were explicitly included in the new Global Biodiversity Framework, raising freshwater for the first time to the same level as 'land and sea' and setting clear targets for the protection of 30 per cent of freshwater ecosystems and the restoration of 30 per cent of the world's degraded rivers, lakes and wetlands by 2030. The draft Nature Restoration Law under the EU Green Deal includes goals on peatlands and restoring 25,000 km of rivers. Finally, the UN Water Conference in March 2023 marked the first event of its kind focusing exclusively on water since 1977, building unprecedented momentum for action on water and freshwater ecosystems, although most of the more than 700 commitments would do little to accelerate progress.[121] However, some of the commitments could help to change the game, including the launch of the ambitious Freshwater Challenge by the governments of Colombia, the Democratic Republic of Congo, Ecuador, Gabon, Mexico and Zambia, supported by WWF and partners. This country-led initiative aims to restore 300,000 km of degraded rivers and 350 million hectares of degraded wetlands (equivalent to 30 per cent of degraded freshwater ecosystems) by 2030 (*see pg. 49 for more detail*) as well as conserve intact freshwater ecosystems. If the world can rise to the Freshwater Challenge, it will pave the way for real progress on global climate, nature and Sustainable Development Goals.

In tandem with high-level political initiatives, businesses are increasingly acknowledging water risks to their operations and supply chains and the threat they pose to future value and resilience. But too few are taking action. Water presents businesses with both opportunities and risks. On one hand, water is essential across operations and supply chains. On the other, water stress from scarcity, floods and pollution heightens uncertainty, disrupts operations, escalates costs and creates reputational risks. Water risks were reported to have a total potential financial impact of up to US$ 301 billion in 2020, according to CDP (2020). The cost of addressing these risks would amount to US$ 55 billion – less than 20 per cent of this total.[122]

Although water blindness among companies remains widespread, businesses are beginning to experience water risks in real time and some are awakening to the economic necessity of taking action to mitigate them, including investing in new technology and practices to reduce water use and wastewater within their own 'fence line' and in collective action to build resilient river basins. Organizations such as WWF and its partners in the water stewardship community have been supporting corporations with approaches and tools to help them assess current and future risks and chart effective pathways to address them. This includes tools such as the Water Risk Filter, the Alliance for Water Stewardship Standard and the new Science Based Targets for Nature on freshwater (*see spotlight on page 48*). However, most businesses have not yet woken up to water, focussing their sustainability efforts almost entirely on carbon. Transforming their approach to water and freshwater ecosystems is key to tackling the crisis.

Financial institutions are also waking up to the freshwater crisis and responding with new sets of risk management mechanisms and financial instruments. Financial institutions have historically overlooked the significance of nature, and water in particular, in their lending practices and investment decisions – even though 75 per cent of all bank loans in the euro area, for example, are to companies that are highly dependent on at least one ecosystem service (including surface and ground water supply, as well as flood mitigation).[123] Therefore, financial institutions are uniquely positioned with the potential to assist businesses in evaluating water-related opportunities and risks, divest from harmful projects, and bridge financing gaps for water investments. Banks such as the Dutch bank ING have started developing risk management approaches that model future climate and water risks. In 2018, Barclays and Standard Chartered announced that they would not finance any projects harmful to wetlands that are internationally protected under the Ramsar Convention.[124] Some institutional investors are

also recognising that there are profitable and impactful investment opportunities in the water sector, including the development of Nature-based Solutions for flood and drought mitigation. Nevertheless, progress remains slow and is still far from sufficient to deal with the magnitude of the freshwater crisis.

Public pressure to manage, protect and restore freshwater resources is contributing to the rise in political and corporate action. People are increasingly experiencing the impacts of the water crisis directly through worsening water shortages and food insecurity as well as historic droughts, catastrophic floods, and more frequent wildfires – all contributing to growing concerns around water issues and increasing calls for action. More than 80 per cent of Mexicans, Colombians and Brazilians were found to be concerned about freshwater shortages in 2022,[125] while river pollution has been high up the news and political agenda in the United Kingdom for the past few years. The Run Blue campaign saw activist and ultrarunner, Mina Guli, run 200 marathons in a year for water ahead of the UN Water Conference, building awareness and inspiring the largest ever global grassroots movement on water. But this growing global interest in the water crisis has not translated yet into significant action. Coordinating activities and messaging with youth and climate activists will be critical as will linking water and freshwater ecosystems more directly with food and energy security, and reducing disaster risks and conflict. In addition to people responding to the water crisis by demanding political change, trends towards community-led initiatives and the inclusion of marginalised voices, such as Indigenous Peoples and local communities, will be crucial to drive more inclusive freshwater action.

A lot more needs to be done to translate this momentum into urgent action that can transform our approach to freshwater management. Although there is growing momentum and evidence of progress, societies are still damming, draining, and destroying freshwater ecosystems at alarming rates. Incorporating freshwater ecosystems into global agreements is critical but only if governments start to set national targets and implement steps to achieve them. Similarly, action from corporates and financial institutions still falls short of what is required to reduce the risks to their operations and assets – and prevent ongoing, large-scale freshwater degradation. Companies are starting to increase water use efficiency, with 58 per cent of the 3,909 company respondents reporting through CDP's water security questionnaire stating that they were aiming to reduce or at least maintain water withdrawal levels in 2022.[126] However, progress on water pollution has been substantially slower, with only 12 per cent of companies setting pollution-related targets that are monitored at the corporate level.[127] Additionally, 4,568 companies did not disclose their water-related data to CDP.[128] Meanwhile, conservation, humanitarian and development organizations also need to do more to highlight the importance of freshwater ecosystems and call for action to ensure healthy rivers, lakes, wetlands and aquifers – because water does not come from a tap, it comes from nature.

Undoubtedly, a more fundamental shift is needed in the way society treats its invaluable freshwater resources. The convergence of environmental urgency, political momentum, corporate initiative and public awareness presents an unprecedented opportunity to mobilise around freshwater and drive more far-reaching action.

RIVER DIVERSIONS AND WATER DEPLETION IN THE RIO GRANDE/RIO BRAVO

The **Rio Grande/Rio Bravo is drying up due to extensive and heavily managed anthropogenic water withdrawals** that are exacerbated by climate change.

The Rio Grande/Rio Bravo (RGRB) would be the 5th longest river in North America if it still flowed freely from Colorado to the Gulf of Mexico. However, the river now dries up completely near El Paso, in what is known as the "Forgotten Reach." The RGRB supplies water for agricultural, industrial and municipal uses for more than 6 million people in the United States[129] and slightly over 10 million people in Mexico[130]. 85 per cent of withdrawn water is allocated for agricultural production, contributing to a billion-dollar agricultural sector.[131] The RGRB Basin is also home to various species, and provides habitats for migratory birds. The Rio Grande Silvery Minnow, for example, is an endangered fish species that is now only present in a 240-kilometre stretch along the river in New Mexico, equivalent to 7 per cent of its historical distribution.[132]

The RGRB is threatened by extensive dam construction, river diversion and aquifer depletion, with agricultural water use playing a disproportionate role in driving water overextraction. Drying up is intensified by a reduction in annual rainfall and snowmelt. Rising temperatures are accelerating evaporation from reservoirs and evapotranspiration from crops and vegetation. In July 2022, multiple kilometres of the RGRB dried out in Albuquerque, New Mexico, for the first time in 40 years,[133] with similar historical drying in the Big Bend region in the same summer. Scientists are predicting an increase of 3° Celsius (5.4° Fahrenheit) by 2050 and substantial changes in precipitation, which could lead to a 25 per cent loss of what is left of the river by 2050. [134]

Top three actions to protect the Rio Grande/Rio Bravo basin:

- **Restore degraded ecosystems and protect native species:** WWF has been working with partners across the US and Mexico for over 15 years in the northern Chihuahuan Desert to protect and bring back freshwater, riparian and grassland ecosystems.
- **Free up water for the river by:**
  - **Adapting agriculture to water availability:** By growing less water-intensive crops, investing in technologies that decrease irrigation water losses or fallowing some fields along the river, stress on groundwater aquifers and the RGRB can be reduced.
  - **Developing local adaptation plans to reduce water use:** Water scarcity and competing demands require governments and communities to adapt. Albuquerque has become a blueprint for city adaptation plans: it grew by 40 per cent during 2000-2020 but managed to reduce its total water use by 17 per cent,[135] mostly by replacing old plumbing and converting water-intensive landscaping with drought-tolerant native plants.
- **Re-operate dams to reshape the flow regime:** By re-operating key dams in more environmentally friendly ways, river flow patterns can be optimized and natural river processes restored. National government departments, e.g., the U.S. Bureau of Reclamation, have, for example, also helped address drought threats to biodiversity by releasing stored water into targeted areas inhabited by silvery minnows and other native species.[136]

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4. FRESHWATER FORWARD

Urgent action is needed to protect the diverse values of freshwater ecosystems and pave the way for a net-zero, nature-positive, equitable and resilient world

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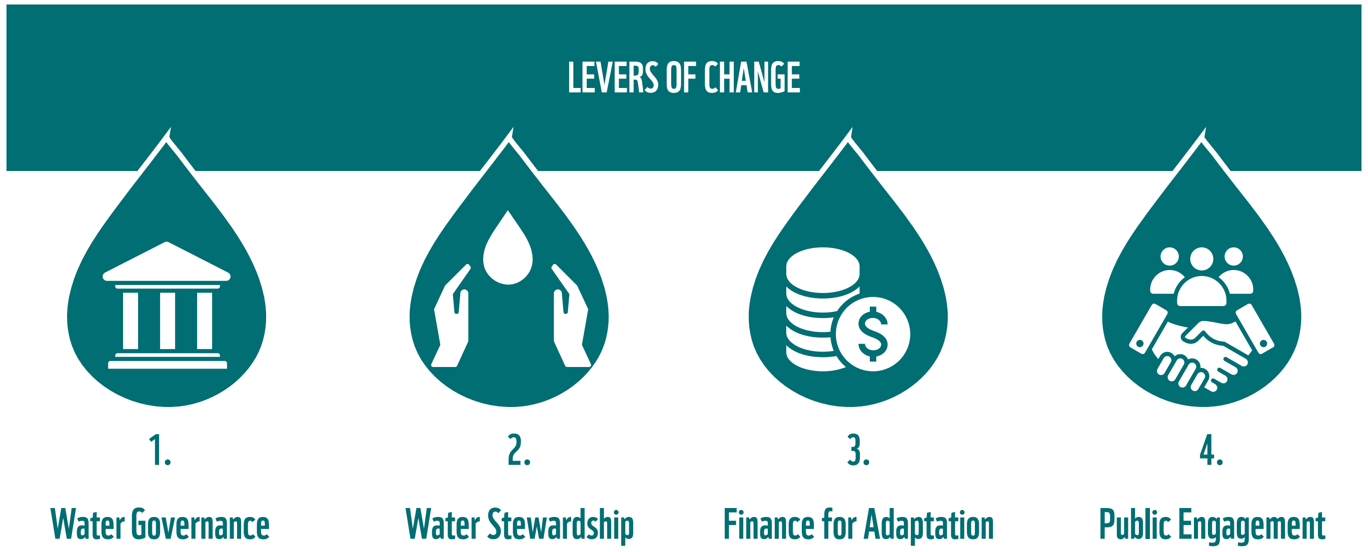
Local, national and transboundary decision makers, civil society, and leaders from business and finance need to wake up to the risks of freshwater degradation and mobilise around fundamentally changing the way the world values and invests in water and freshwater ecosystems. There is no silver bullet for the world's worsening water crisis: urgent action is needed on (1) water governance, (2) water stewardship, (3) finance for adaptation and (4) ending water blindness to drive transformative change and ensure the protection, restoration and sustainable management of our rivers, lakes, wetlands and aquifers. And solutions do exist, ranging from technological solutions around big data and water use efficiency systems in utilities to Nature-based Solutions, reconnecting rivers, corporate water stewardship, innovative financing structures and the ambitious, country-led Freshwater Challenge.

Effective water governance at the local, regional, national and transboundary levels is critical to equitably allocate water and simultaneously sustain the health of freshwater ecosystems. Decision makers should:

- **Restore and protect vital freshwater ecosystems by collectively rising to the Freshwater Challenge:** Championed by countries in the Global South, the Freshwater Challenge is the world's largest-ever river and wetland restoration initiative – aiming to restore 300,000km of degraded rivers and 350 million hectares of degraded wetlands by 2030 and protect intact freshwater ecosystems. Countries must set national targets, and multilateral and bilateral donors and funders must commit resources – not just from 'environmental' pots but from funds for climate adaptation, disaster-risk reduction, water security etc. – to help them achieve these ambitious targets.
- **Incorporate freshwater ecosystems specifically in national policy plans – and deliver those commitments:** Too often, widespread water blindness has kept freshwater side-lined from national policymaking and planning. Countries must seize the opportunity to embed clear goals for freshwater ecosystems into their National Adaptation Plans (NAPs), Nationally Determined Contributions (NDCs) and National Biodiversity Strategy and Action Plans (NBSAPs) and integrate these with their National Water Resource Plans and commitments under SDG6. This will ensure that targets for freshwater ecosystems feed into policy-making processes in all fields, including agriculture, energy, industry and transport, and that decision makers consciously weigh the trade-offs that are associated with the use and protection of rivers, lakes, wetlands and aquifers. Where clear commitments already exist – such as the EU Water Framework Directive – governments must fulfil their obligations. Freshwater ecosystems have long been overlooked in protected area planning and management. With the explicit inclusion of inland water targets in the Kunming-Montreal Global Biodiversity Framework, there is renewed momentum for ensuring that 30 per cent of inland waters are covered by, and managed well within, countries' protected and conserved areas.



- **Manage rivers and wetlands from a systems perspective in a changing climate:** The era of climate change necessitates a new approach to freshwater management when development decisions are no longer taken in isolation (separately assessing each proposed hydropower dam or navigation project) but are based on a systems approach, which factors in the health and resilience of river basins and wetlands – and all the diverse values provided by these dynamic natural systems. For example, we can now meet global renewable energy goals without sacrificing our remaining free-flowing rivers to high impact hydropower by investing in renewable alternatives that are low cost and low conflict with rivers and communities, and by assessing the siting of energy infrastructure from a basin level. Healthy rivers and wetlands are critical for climate mitigation and adaptation, and we must do a better job of managing these natural infrastructure assets to ensure human and natural resilience in a changing climate. Managing them from a systems perspective, including by increasing collaboration and coordination across sectors and borders, will ensure the best overall trade-offs between development priorities and ecosystem health.
- **Improve data collection and utilize enhanced data insight**: Effective water governance relies on the availability and use of high-quality data to inform decisions (*see spotlight)*, as well as the harmonisation of water, climate and land-use data. So, it is critically important to improve data collection and monitoring of freshwater biodiversity and ecosystems, and develop, legally codify and implement scientifically accepted frameworks, metrics, and definitions for ecosystem health and biodiversity.
- **Develop water allocation mechanisms that are adapted to local contexts:** The equitable and fair allocation of water is critical to provide water for all, ensure sufficient water for agriculture, energy and industry, and sustain the healthy functioning of freshwater ecosystems and the water cycle, including the replenishment of aquifers. Allocation mechanisms need to both distribute water resources effectively and sustainably across and within sectors, and be developed in close collaboration with different stakeholders, including local communities, who are impacted by decisions. There is no one-size-fits-all solution for water allocation, instead systems need to be adapted to specific places and local contexts and build on strengthened land and water tenure arrangements, as well as an understanding of alternative forms of ownership, including collective ownership.
- **Sustainably manage groundwater resources:** Our mismanagement of groundwater is jeopardising its future availability for human use, particularly agriculture, and its continued sustenance of freshwater ecosystems – including aquatic, riparian, wetland, estuarine, and subterranean habitats and the species they support. We need to monitor and manage our groundwater use so that aquifer levels and exchanges between groundwater and surface waters remain dynamically stable and resilient, especially in the face of climate change. This will involve setting sustainable extraction limits, enhancing aquifer recharge through natural or managed replenishment, and reducing demand.
- **Value and invest in natural water storage through Nature-based Solutions:** The world's water storage gap is increasing as freshwater ecosystems are degraded and aquifers depleted, and grey infrastructure

Global Water Watch – Democratising earth's data on water resources

Artificial intelligence (AI) and big data can be leveraged to inform water governance, management and decision-making.

Together with its partners Deltares and the World Resources Institute (WRI) as well as Google.org and the Water, Peace and Security Partnership, WWF has contributed to the development of the **Global Water Watch**. The Global Water Watch is a data platform of free, globally accessible, and near-real time information on water. It uses modern AI algorithms to map dams, producing information on the amount of water stored in more than 70,000 global reservoirs, as well as real-time data on water levels.

The tool can be leveraged for various purposes and applications, supporting different stakeholders in managing growing water risks and challenges. National and subnational governments can use the platform to govern water resources more equitably, equally and sustainably. Additionally, real-time and high spatial resolution data allows decision-makers to respond more swiftly to extreme events, such as floods and droughts. Given that the data is publicly available, the data also allows other stakeholders to hold the government accountable for the stewardship of water resources and shines a light on the conditions of water resources.

faces increasing constraints and risks. The world needs to pursue a systems approach to water storage – developing and implementing the best hybrid approaches by prioritizing large scale investment in green, Nature-based Solutions along with – when necessary – well-planned and designed, low impact grey infrastructure to enhance the water storage capacity of wetlands, floodplains, aquifers and other ecosystems. Not only will this improve the overall availability of water, but it will also reduce the impact of extreme floods, provide enhanced water supplies in times of drought, and enhance the health of soils.

- **End harmful subsidies and create incentive structures that promote sustainable water use, particularly in water-intensive sectors like agriculture:** Incentive structures play an important role in shaping the way agriculture, industries and municipalities manage water and land use. Subsidies need to be targeted more efficiently, taking into account their implications for entire social, economic and ecological systems. Harmful subsidies that encourage unsustainable land use, water withdrawals and pollution – for example in intensive water-use sectors like agriculture – need to be phased out and replaced with pricing mechanisms that encourage the adoption of water-efficient practices and the sustainable use of freshwater ecosystems. This includes farming crops that are appropriate for given levels of water availability or adopting agroecological water management and land-use practices, which also promote retention of water in the landscape. Through the Colorado River Deal, agreed in May 2023, the United States government is financially compensating irrigation districts, cities and Native American tribes in Arizona, California and Nevada with US$521 per acre-foot[137] of water that they do not use. Aiming to decrease water use by 13 per cent in the lower Colorado basin, this deal provides direct financial incentives for stakeholders to use water more responsibly.[138] These measures need to be accompanied by more stringent regulations around water pollution and water quality.

Science Based Targets Network (SBTN)- Supporting companies on their path to nature resilience

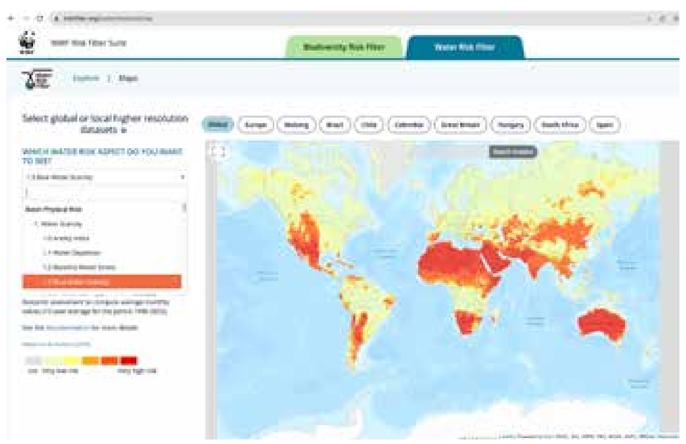
By setting Freshwater Science-Based Targets (SBTs) for nature, companies will take direct aim at the drivers and pressures fueling nature loss, offering a pathway to reduce their dependencies and impacts on the environment, including freshwater.

SBTN's Freshwater Hub is co-led by WWF and CDP in collaboration with The Nature Conservancy, World Resources Institute, and CEO Water Mandate and develops SBTN's freshwater technical guidance. The current guidance focuses on freshwater quantity (i.e., freshwater withdrawals from surface water and groundwater) and quality (i.e., nitrogen and phosphorus), is informed by the latest science, and is designed to help companies contribute to global sustainability goals, including the SDGs and Global Biodiversity Framework.

Transforming corporate water stewardship is critical to building more resilient businesses and economies - and tackling the water crisis.

Most corporations depend either directly or indirectly on water in their operations and supply chains, leaving them vulnerable to water risks now and increasingly in the future – as the water-related impacts of climate change intensify. But companies are also key drivers of the water crisis through overextraction and pollution. Companies are slowly waking up to water risks and opportunities but there is an urgent need to accelerate water stewardship across all sectors and drive collective, transformative corporate action in river basins to enhance ecosystem resilience and ensure a sustainable future for businesses, economies, people and nature. Corporate leaders should:

- **Develop transformative water stewardship strategies:** To reduce water risks and seize water opportunities, companies must develop and implement water strategies that will deliver real change and increased resilience – and are based around contextual, science-based targets using the guidance that is available from WWF, Alliance for Water Stewardship and CEO Water Mandate, including harnessing the new Science-based Targets for Nature on freshwater. This is particularly critical for companies in water-intensive sectors, such as food and beverage, water and electric utilities, apparel and textiles, mining, chemicals, pharmaceuticals, and ICT, and especially for those with operations and supply chains in river basins facing high water stress now or in the future.
- **Increase and disclose water risk assessments:** The critical first step for companies, particularly those that are highly dependent on water, is to assess their water risks – from scarcity, flooding, and pollution – now and in the future. There are no excuses for companies since tools are available, including the WWF Risk Filter Suite, which enables them to assess physical, reputational and regulatory water risks and includes climate and socio-economic scenarios for 2030 and 2050. But assessing water risk is just the first step. Companies must also disclose their risks. An increasing number are disclosing water risks to CDP each year, but the total still represents a fraction of the world's companies.
- **Invest in enhancing efficiency and reducing pollution while considering allocation:** Companies should implement water-saving technologies and advanced treatment to minimize wastewater generation and maximize efficiency, especially in supply chains, but be mindful of where "savings" are going to avoid a net-zero gain for river basins.
- **Increase collaboration to drive effective, collective action in priority river basins:** Companies must do more than simply focus on improving water efficiency and reducing wastewater: they must take the harder steps and work collectively with other companies, governments and communities to tackle water risks at the basin level and build resilience. Central to this will be participating and investing in recognised collective action platforms and funding Nature-based Solutions, which will often require a blended finance approach to deliver large scale, transformational NbS. But water stewardship organizations must also practice what they preach and work more collaboratively by identifying priority basins and agreeing on collective approaches to ensure maximum impact.
- **Advocate for better enabling conditions for action on water:** Companies should use their significant power and influence to call on governments to create the foundations for a new sustainable, approach to water and freshwater ecosystems – from better allocation and fair pricing to greater use of public funds to support freshwater ecosystem restoration, including publicly supporting implementation of the Freshwater Challenge.



Freshwater Challenge – Restoring 30% of degraded rivers and wetlands worldwide

Mobilising resources and financing for freshwater restoration and protection is critical for climate adaptation.

The Freshwater Challenge is a country-driven initiative to leverage the support needed to restore 300,000 km of degraded rivers and 350 million hectares of degraded wetlands by 2030 and protect intact freshwater ecosystems, given the importance of healthy freshwater ecosystems for climate adaptation and resilience. The Freshwater Challenge is championed by the governments of Colombia, Democratic Republic of Congo, Ecuador, Gabon, Zambia, Mexico and Ecuador, and supported by WWF and various partners.

Based on nationally identified priorities, governments will develop freshwater restoration targets and co-create solutions with Indigenous Peoples, local communities, and national and international partners. In addition to identifying priority areas for restoration and updating relevant national strategies and plans, the Freshwater Challenge also aims to mobilise resources and set up financial mechanisms to implement the targets set by governments. Commitments to shift public climate finance towards adaptation, increase investments in Nature-based Solutions and develop bankable projects that can draw in private sector financing is critical to achieve the goals of the Freshwater Challenge by 2030.

Drastically increasing finance for adaptation is crucial as societies and economies are increasingly exposed to climate-related water risks.

As the impacts of climate change will predominantly be felt through water, including changing rainfall patterns and river flows, and the increased prevalence of severe droughts, extreme floods and storms, climate adaptation and resilience are directly intertwined with the healthy functioning of freshwater ecosystems. However, the volume of funding and investments in water generally, and the protection and restoration of freshwater ecosystems in particular, still falls far short of what is required to drive action at the scale needed to adapt to climate change. UNEP estimates, for example, that the adaptation gap in the Global South is likely 5-10 times greater than current international finance flows and is predicted to widen even further.[139]

- **Dedicate 50 per cent of public climate finance to adaptation:** Governments and development finance institutions must commit to directing 50 per cent of public climate finance into adaptation initiatives. By drastically scaling up investment in the "restoration economy" and Nature-based Solutions, these funds will enhance the health of freshwater ecosystems and build more climate resilient societies and economies. Additionally, National Adaptation Plans can be a useful tool to integrate sector-specific and scenario-based medium- and long-term adaptation needs in relationship to water and freshwater ecosystems, and consequently allocate required financing accordingly.
- **Leverage private sector to close the financing gap:** There is a key role for the private sector in tackling the financing gap around freshwater and climate adaptation. Financial institution can identify promising and bankable investment opportunities that can bring financial returns and move the dial on freshwater and climate adaptation, such as investing in – and even creating new asset classes around – Nature-based Solutions. For example, the innovative Dutch Fund for Climate and Development (DFCD) used Dutch government funding to leverage hundreds of millions of euros into bankable projects to build climate resilience.
- **Investing in reducing water-related financial risks:** Financial institutions also have a critical role to play in reducing water risks and damage to freshwater ecosystems. By systematically integrating water and freshwater ecosystems into impact and monitoring frameworks, and committing to setting science-based targets that reduce negative impacts, financial institutions are better able to screen projects, such as infrastructure, that may have harmful impacts on rivers, wetlands and their biodiversity, and transparently disclose these risks to consumers.[140] Financial institutions can also divest from high impact projects, invest in water technology and data, and fund Nature-based Solutions to restore degraded freshwater ecosystems and reduce insurance risk. Finally, they can evaluate and respond to water-related financial risks to their portfolios by requiring existing and potential client companies to assess and disclose the water risks in their operations and supply chains.

C40 Coalition- Uniting cities across the world to confront climate change

Combining locally-rooted solutions with global momentum-building is vital to drive deep-reaching impact.

C40 is a global network of nearly 100 mayors of the world's leading cities that are united in action to confront the climate crisis. They are committed to using an inclusive, science-based and collaborative approach to cut their fair share of emissions in half by 2030, help the world limit global heating to 1.5°C, and build healthy, equitable and resilient communities. C40 works with local, national and international partners, including the private sector or youth climate leaders.

C40 recognises the role of water and freshwater management for climate adaptation, helps mayors to develop locally-adapted solutions to global water problems, and facilitates the sharing of knowledge and best practices. As such, a priority of C40's mission is the creation of specialised networks. For instance, the Urban Flooding Network supports city efforts to identify, plan and implement projects to increase resilience to urban flooding impact, for example by improving sustainable draining, retention and integration of water into urban ecosystems (blue-green infrastructure).

Inspiring and mobilising people and communities across the world is critical to ending water blindness and driving decision makers to take urgent action on water and freshwater ecosystems.

In recent years, the climate and conservation movements have really opened people's eyes to the climate and nature crises. It is time to do the same for water – to end the water blindness and blinkered decision making that are driving degradation and slowing solutions. While the water sector must break down its silos and collaborate better, other sectors need to join in as well because water is central to everything. Even within the climate and conservation communities, the role of freshwater has been chronically overlooked. They need to leverage their power to draw attention to the links between the freshwater crisis and the climate and nature crises. And so do the humanitarian and development sectors since healthy freshwater ecosystems are critical

to reducing poverty, hunger, disease, and the risk of natural disasters. Civil society organizations should:

- **Raise awareness:** Shining a light on water blindness by stressing the central role of healthy freshwater ecosystems in enhancing water, food and energy security, improving human health, reducing conflicts and natural disasters, and tackling nature loss and climate change through partnerships, campaigns, engaging youth, leveraging the power of the climate and conservation movements, and advocating for accelerated action on water and freshwater ecosystems; and
- **Advocate for action:** Pressuring governments, corporations and financial institutions to tackle water challenges, implement and adhere to effective water regulations, and invest in the protection and restoration of freshwater ecosystems for people, nature and climate.

But everyone has a role to play in tackling the water crisis. **So, individuals should also take steps to make a difference** because every bit counts, just like every drop of water counts. There are many opportunities for people to contribute to tackling the water crisis, including embracing mindful consumption, supporting freshwater conservation and restoration, educating family and friends, championing water stewardship at work, and advocating for change.

We need to create a global water movement. Bringing people together – including Indigenous Peoples and local communities, women and youth, scientists and activists as well as political, business and financial leaders – through partnerships and coalitions at local, national, regional, and global levels. Through this shared effort, we can work collectively to overcome long-standing challenges, aiming to dispel water blindness and solve the global water crisis for nature, people and our shared future.

The world needs to wake up to the freshwater crisis and acknowledge that the protection of our freshwater resources is critical to achieve global development objectives. Without adequately understanding the value of healthy rivers, lakes, wetlands and aquifers, societies will continue to degrade freshwater ecosystems with disastrous consequences for water, food and energy security, biodiversity, health, exposure to extreme events, economic prosperity and human well-being. By committing to the protection and restoration of freshwater ecosystems, streamlining freshwater considerations into decision-making, mobilising financial resources and leveraging new partnerships, stakeholders can combat water blindness and move the dial on freshwater. Ultimately, investments in healthy freshwater ecosystems are critical to ensure societies are insured against climate impacts and to pave the way towards a net-zero, nature-positive, equitable and resilient future.

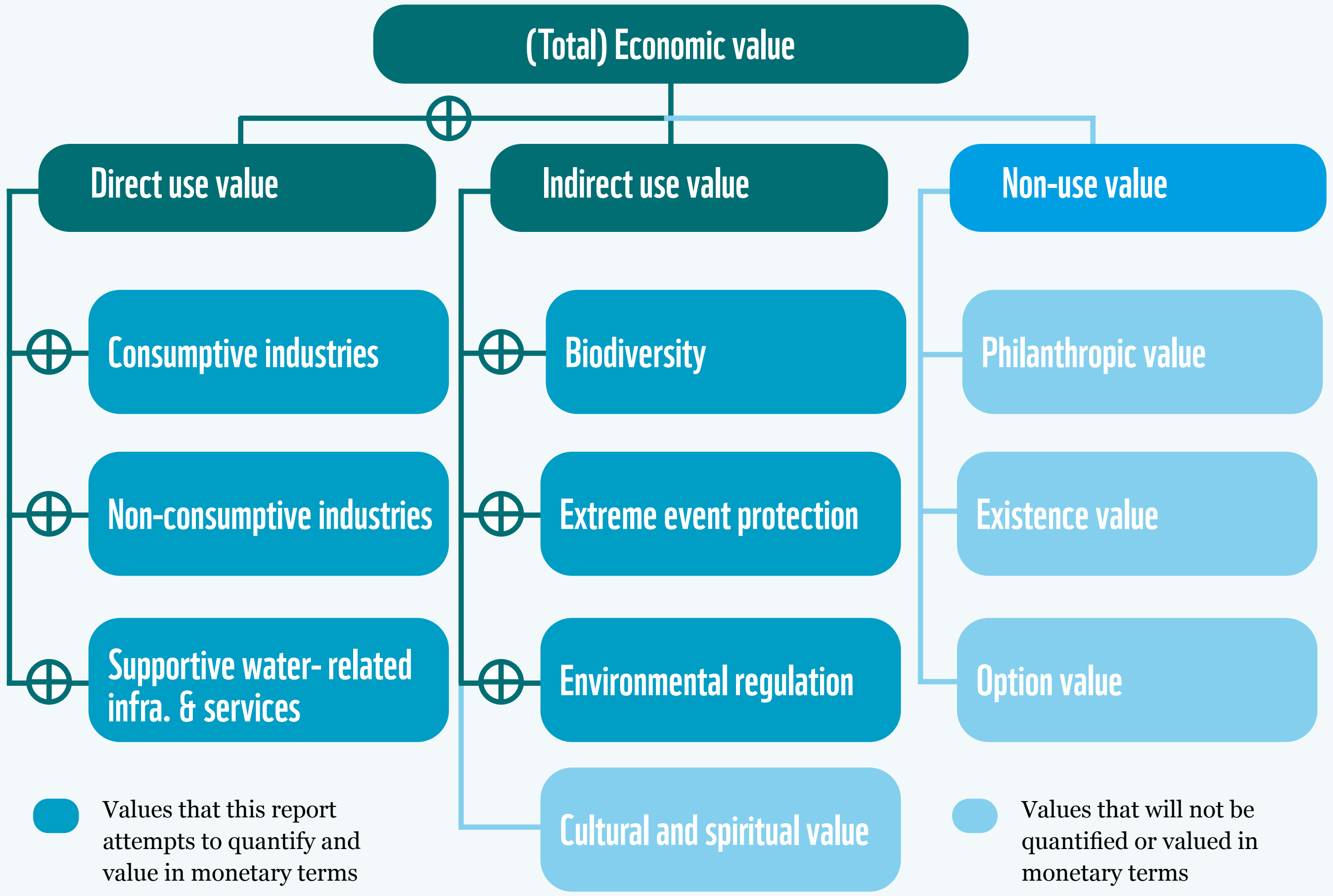
ANNEX

METHODOLOGY

This annex describes the methodology used by the authors to estimate the economic use value of water. As noted in the report, this model focuses on the direct and indirect use values of freshwater that are monetarily quantifiable. The results are therefore an underestimate of the infinite value that freshwater provides to human societies and economies from a use and non-use perspective. An overview of value types that are not quantified within the model has been provided throughout the report.

ESTIMATING THE ECONOMIC USE VALUE OF WATER

The objective of this analysis is to provide a more comprehensive view of the economic use value of freshwater resources. In particular, it computes an estimate for the economic use value of freshwater which is (1) global[141] (2) a snapshot of the 2021 annual value, (3) includes rivers, streams, lakes, reservoirs and inland wetlands (marshes, bogs, swamps, peatlands) and (4) measured in monetary terms (US$), using US$ 2021 constant pricing.[142] The analysis uses a total economic value (TEV) framework to compute values for multiple subcomponents, and are then aggregated to a total value. This includes (a) direct use values, including consumptive and non-consumptive use types, and (b) indirect use values, including biodiversity, extreme event protection and environmental regulation (*see figure*). The sources used to quantify estimates use either the best available data on different use values of freshwater, or provide estimates where data is limited or not available. Estimates are computed at the regional level (Asia and Middle East, Africa, Europe, North America, South America, Oceania).



LIMITATIONS

While this analysis provides insights into the various economic use values we derive from freshwater, there are multiple limitations and caveats of this approach to keep in mind.

- The report makes the value of water more relatable by demonstrating different uses, but cannot present a full quantitative picture of water's infinite value (including other values with immeasurable benefits, including mental health benefits, cultural value, existence value etc.)
- The estimates in this report are for advocacy purposes only and are designed to raise awareness of water blindness in policymaking. The published figures should not be used for decision-making, or policy-design purposes and the authors of this report would strongly advise the use of basin-level, geo-spatial analyses to produce economic valuation estimates for specific water bodies.
- While the report aims to put an economic value against ecosystem services, this does not imply that these assets should be monetised or commodified. On the contrary, the report emphasises that healthy ecosystems often provide benefits that far outstrip the economic value of extractive activities.
- The value of water has vastly different meanings across geographies, ecosystems and between individuals and communities. As a result, the extrapolation of estimates to a regional and global level is always associated with substantial limitations and very high levels of uncertainty, which could lead to under/overestimations of the value of freshwater in specific places.
- Economic valuation calculations for ecosystem services rely heavily on the Economics of Ecosystems and Biodiversity (TEEB) database to assign monetary values to freshwater biome types by surface area. While a weighting methodology has been applied to proxy for differences in the quality of water biomes and proximity of biomes to humans across geographies, this methodology has a high degree of uncertainty and cannot fully account for variation in quality and use value of different global watersheds.
- Freshwater systems are inextricably linked to estuarine and saline water biomes, including other immensely valuable ecosystems such as mangroves and corals, as well as non-marine landscapes. While this report strongly emphasises the ways in which the quality and quantity of water in rivers, lakes and wetlands affect the values of downstream ecosystems, it does not seek to quantify these values. Analysis is limited to the major direct and indirect use values of rivers, lakes and wetlands only.
- The estimates provided in the report are snapshots in time. They do not account for the fact that water is in many ways non-stationary and embedded in highly dynamic systems. Additionally, the numbers themselves do not describe interaction effects between using different benefits of water, e.g., how maximising water withdrawal for agriculture can have detrimental effects for the ecosystem services provided by rivers, lakes and wetlands in the future.
- These estimates rely on inputs from public data sources, and often require strong assumptions to cover data-scarce geographies and environments. The figures are therefore associated with high degrees of uncertainty.

MODEL CALCULATIONS

CATEGORY	INPUTS	CALCULATION
Consumptive use		
Households-municipalities	***a. Market payments*** • Tariff data (IBNET) for the years 2017-2023 (city-level data, filters: water, monthly, volumetric, 100m3) • Municipal water withdrawals by country (FAO, 2021)[143] ***b. Subsidies*** • Public water subsidies by country groups and regions as a percentage of regional GDP based on IMF paper[144] • GDP (current US$) for 2021 (2020 if not available)[145]	This component was computed as a sum of the total value of (a) municipal market payments for water and (b) government subsidies for the water sector. ***a. Market payments*** 1. Compute average water tariffs per country, where data is available 2. Compute regional average water tariff based on country estimates, and use this estimate for countries for which no data is available 3. Multiply municipal water withdrawals (includes surface and groundwater withdrawals) with average country tariff to obtain estimates of economic value of freshwater in terms of municipal market payments 4. Sum to regional and global levels ***b. Government subsidies*** 1. Match each country to the appropriate global region[146] as listed in Kochhar *et al.* and identify associated regional subsidy estimate as a percentage of GDP 2. Multiply country GDP with subsidy percentage to obtain approximated monetary value of subsidy per country 3. Aggregate to regional and global levels *Note: Market prices differ substantially by subregion within countries, and this methodology cannot fully account for this.*
Agriculture	• Agricultural water withdrawals by country (FAO, 2021)[147] • Median global value of irrigation water, estimated at **USD 0.13/m³**[148]	1. Multiply agricultural water withdrawals by global median irrigation water value 2. Aggregate to regional and global levels *Note: This estimate does not account for rainfed agriculture, which is particularly important for subsistence farmers. The method uses a single median global value of irrigation water, acknowledging that the true shadow price of irrigation water differs by region and by crop type.*
Industries	• Industrial water withdrawals by country (FAO, 2021)[149] • Average economic value of water in industry based on 6 academic papers, estimated at **USD 8.44/m³**[150]	1. Multiply industrial water withdrawals with average industrial economic value of water (calculated by taking the average figure from 6 academic papers) 2. Aggregate to regional and global levels *Note: In the absence of better data, this estimate is based on a small number of peer-reviewed academic papers which isolate the added value of water relative to other inputs.*

CATEGORY	INPUTS	CALCULATION
Non-consumptive use		
Recreation	• Value of tourism expenditure linked to wetlands, estimated at USD 925 billion[151] • Value of coastal tourism based on reef value of tourism (**USD 36 billion**) and the value of reefs in coastal tourism in coral reef countries (**9%**)[152]	1. Calculate value of coastal tourism by dividing 36 billion by share of value of reefs in coastal tourism in coral reef countries (*scaled down to 5% to account for the fact that not all coastal countries are coastal reef countries)* 2. Subtract value from total value of tourism expenditure linked to wetlands to obtain tourism expenditure from freshwater *Note: This is a market-based estimate of global touristic value of inland wetlands and relies on strong assumptions in the absence of better data. A market valuation technique likely underestimates the true recreational value of freshwater as it does not account for non-market benefits (e.g., the value of benefits / willingness to pay of individuals who walk alongside or live near lakes)*
Inland transport	• Value of the global inland water freight transport market (2021), estimated at **USD 18.66 billion**[153]	*Note: Given a lack of comparable global data for inland water transport on the country level, this value was not disaggregated by region. This method does not account for the economic knock-on effects generated through connectivity and the trade of goods and services.*
Hydropower	• Value of the global hydropower market (2021), estimated at USD 219.14 billion[154] • Hydropower production per country in TWh[155]	1. Use value of hydropower market as global estimate 2. Compute share of regional hydropower production (TWh) as a percentage of global hydropower production 3. Approximate regional value of hydropower market by multiplying percentage obtained in (1) with value of the global hydropower market *Note: Method assumes that value of hydropower production per TWh is approximately equal across countries. Method does not disaggregate value of hydropower market by different inputs.*
Freshwater fisheries	• Inland capture fisheries production (tonnes) by country (FAO, 2021)156 • Total value of inland and marine fisheries production (FAO, 2021), estimated at USD 141 billion[157] • Percentage of inland fishery in total fishery (inland + marine, FAO, 2021), estimated at **13%**[158]	1. Compute regional sum of inland capture fisheries production (tonnes) by summing country values 2. Compute total value of inland fisheries production by multiplying percentage of inland fishery in total fishery with the total value of global fisheries 3. Calculate regional values of inland fisheries by taking percentage of regional catch in total catch and multiplying with total value from freshwater fishing (global) *Note: Method assumes that value per tonne is equal across regions. Method does not explicitly account for subsistence fishing, implying that the true value of freshwater fishing is underestimated, and does not include aquaculture due to risk of double counting with municipal/agricultural water withdrawal.*

CATEGORY	INPUTS	CALCULATION
Biodiversity		
Genetic diversity **Lifecycle maintenance**	• Ecosystem service derived from TEEB/ESVD averages for genetic diversity and lifecycle maintenance based on De Groot et al. (2020) (Int. $/ha/year)[159] • Surface area of (a) rivers and lakes and (b) inland wetlands by continent* (see below) • Data on wetland exposure to human influence, based on Human Influence Index (HII)[1] by Reis et al.[160] • Data on % of wetlands under protection by continent[161]	1. For each region and for each ecosystem type (rivers + lakes, inland wetlands), multiply ecosystem surface area by monetary value of ecosystem service, and sum to regional level. 2. Apply weighting by proximity to humans: Divide regional HII by median HII to obtain regional weight. 3. Apply weighting by state of protection: Divide regional percentage of wetland under protection by median percentage under protection to obtain regional weight. 4. Create a normalised regional weight from both individual weights. 5. Multiply regional value obtained in (1) with weights computed in (4) and sum to global level. *Note on TEEB/ESVD estimates: The TEEB/ESVD estimates are based on averaging (local/regional) valuation studies, implying that there is a high degree of uncertainty associated with these estimates. Surface area of inland wetlands is a substantial determinant of total economic value by continent and may fail to acknowledge that the worth of freshwater ecosystems per hectare is particularly high in regions with higher levels of scarcity. The weighting measure attempts to partially adjust for this by increasing the weight of values of freshwater ecosystems that are in close proximity to humans.* *Note on weighting: This measure is imperfect given that it does not account for downstream users and high degrees of human influence can lead to more degradation, lower ecosystem benefits and therefore lower ecosystem values. This is in part accounted for by incorporating a measure on protection status (acknowledging that there are also confounding factors associated with awarding ecosystems conservation status). Lastly, the weighting measure is based on data for wetlands, but also used for rivers and lakes assuming that there are comparative levels of conservation status and human influence between these ecosystems per continent.*
Extreme event protection		
Moderation of extreme events (including floods, droughts and storms)	• Ecosystem service derived from TEEB/ESVD averages for soil extreme event protection based on De Groot et al. (2020) (Int. $/ha/year)[162] • Surface area of (a) rivers and lakes and (b) inland wetlands by continent* (see below)	1. For each region and for each ecosystem type (rivers + lakes, inland wetlands), multiply ecosystem surface area by monetary value of ecosystem service, and sum to regional and global level. *For limitations of estimation technique, see biodiversity (above)*

CATEGORY	INPUTS	CALCULATION
Environmental regulation		
Soil fertility **Water flow regulation** **Water purification**	• Ecosystem service derived from TEEB/ESVD averages for soil fertility/water flow regulation/water purification based on De Groot et al. (2020) (Int. $/ha/year)[163] • Surface area of (a) rivers and lakes and (b) inland wetlands by continent* (see below)	1. For each region and for each ecosystem type (rivers + lakes, inland wetlands), multiply ecosystem surface area by monetary value of ecosystem service, and sum to regional and global level. *For limitations of estimation technique, see biodiversity (above).*
Carbon storage	• Volume of carbon released annually by degraded peatlands, estimated at 1.9 gigatonnes CO_2e/year[164] • Surface area of degraded peatlands, estimated at 50 million hectares, and intact peatlands, estimated at 300 million hectares • Surface area of peatlands by continent** • Social cost of carbon, estimated at **190 USD/ton**[165]	1. Compute annual rate of carbon emitted if intact peatlands were degraded by dividing volume of carbon released annually by surface area of degraded peatlands and multiplying with area of intact peatlands. 2. Compute regional values based on regional peatlands share. 3. Multiply tonnes of carbon emitted on an annual basis by social cost of carbon to obtain monetary estimate of the value of peatlands' carbon storage on an annual basis. *Note: Assumes that carbon release rate is equal across all continents. There is no consensus on the social cost of carbon, this report uses an estimate from the US Environmental Protection Agency. The estimate only quantifies the value for peatlands given their immense carbon storage potential, while acknowledging that other freshwater ecosystems also have carbon storage and sequestration potential and are critical in sustaining forests and mangroves.*

1 Reis et al. calculate the Human Influence Index from nine global data layers covering human population pressure (population density), human land use and infrastructure (built-up areas, night-time lights, and land use or land cover), and human access (coastlines, roads, railroads and navigable rivers). This measure is imperfect given that it does account for downstream users and high degrees of human influence can lead to more degradation and lower ecosystem benefits. This is in parts accounted for by incorporating a measure on protection status.

Inputs for the surface area coverage (hectares) of lakes, rivers, wetlands and peatlands in the model

ECOSYSTEM	DATA SOURCE
***Lakes**	Surface area of lakes by continent according to Messager *et al* (2016)[166]
***Rivers**	Estimated based on surface area by continent and approximated river coverage by continent.[167] *Note: This approach is an imperfect estimate of the total surface area*
***Wetlands**	Surface area of inland wetland by continent according to Reis *et al.* (2017)[168]
****Peatlands**	Surface area of peatlands by continent according to Xu *et al.* (2018)[169]

Breakdown of estimates

COMPONENT	GLOBAL VALUE (TRIL. USD)	AFRICA	ASIA	EUROPE	NORTH AMERICA	SOUTH AMERICA	OCEANIA
Total value	**57.61**	**4.58**	**17.29**	**11.95**	**17.27**	**5.37**	**0.94**
Consumptive use	**7.02**	**0.22**	**3.18**	**1.01**	**2.29**	**0.27**	**0.05**
Municipalities	1.51	0.07	1.07	0.16	0.13	0.07	0.01
Agriculture	0.38	0.02	0.28	0.01	0.04	0.02	0.00
Industries	5.14	0.13	1.83	0.84	2.13	0.18	0.04
Non-consumptive use	**0.46**	**0.01**	**0.12**	**0.03**	**0.04**	**0.03**	**0.00**
Recreation	0.21						
Inland transport	0.02						
Hydropower	0.22	0.01	0.11	0.03	0.04	0.03	0.00
Freshwater fisheries	0.02	0.005	0.012	0.000	0.000	0.001	0.000
Biodiversity	**10.98**	**0.98**	**2.91**	**2.86**	**2.90**	**1.14**	**0.19**
Genetic diversity	9.05	0.81	2.13	2.57	2.46	0.92	0.15
Lifecycle maintenance	1.93	0.17	0.77	0.29	0.44	0.22	0.03
Extreme event protection	**11.73**	**1.03**	**5.22**	**1.38**	**2.55**	**1.35**	**0.20**
Moderation of extreme events	11.73	1.032	5.221	1.380	2.547	1.354	0.200
Environmental regulation	**27.42**	**2.33**	**5.86**	**6.67**	**9.49**	**2.57**	**0.50**
Soil fertility	2.08	0.19	0.27	0.76	0.62	0.20	0.04
Water flow regulation	4.62	0.41	1.61	0.90	1.12	0.50	0.08
Water purification	18.56	1.64	3.14	4.74	7.06	1.62	0.36
Carbon sequestration	2.17	0.095	0.832	0.271	0.684	0.249	0.035

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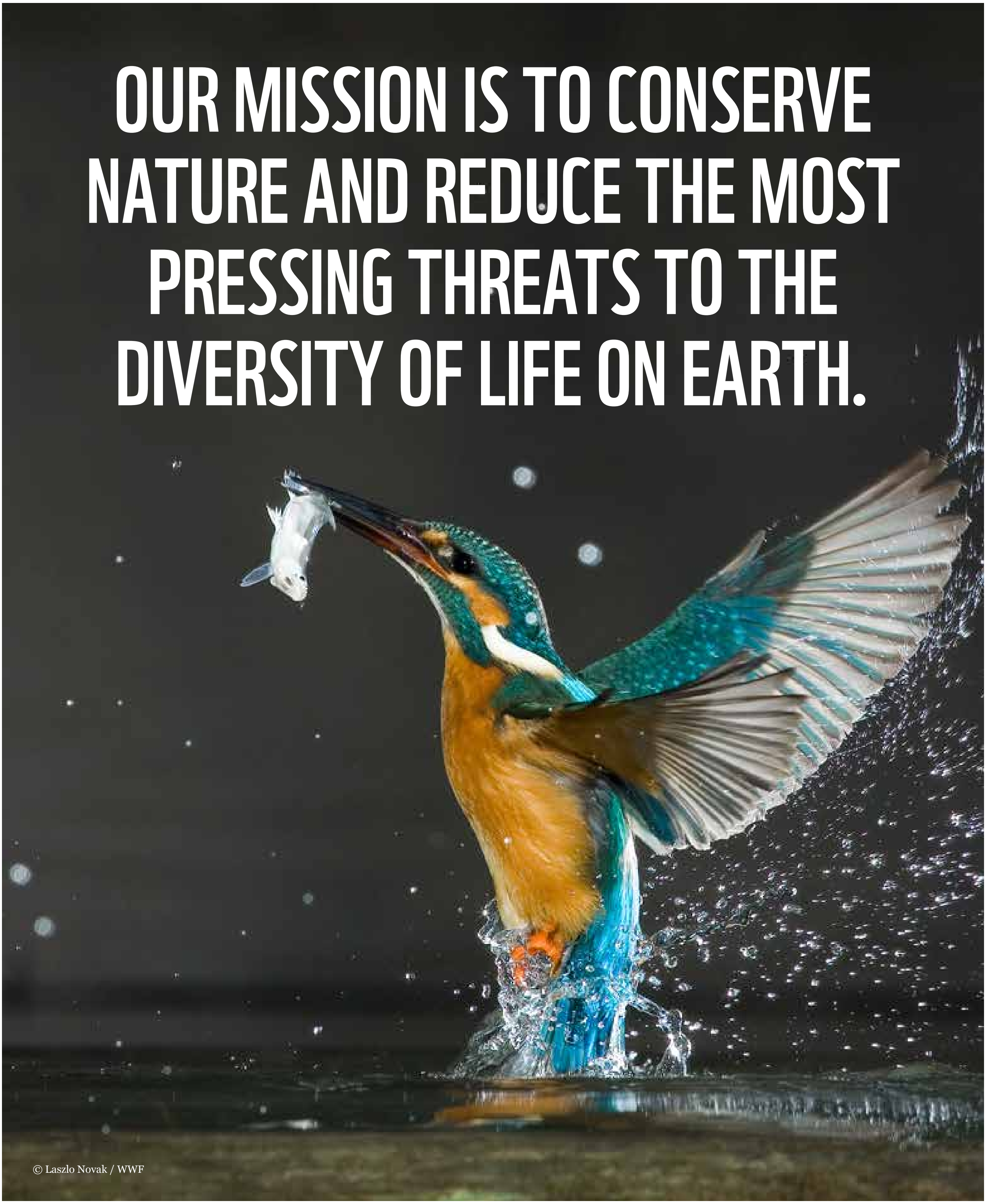

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