Navigating the Waters

Strategic Solutions for Water Resilience

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Navigating the Waters

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The world is facing a pervasive—and mounting—water crisis. Many people lack ready access to drinkable freshwater or are afflicted by severe flooding. Communities have too little water, or at times too much, or the water isn't clean. Already under pressure, the ecosystems and infrastructure that sustain water resources are now vulnerable to disruptions from climate change.

Readers might react skeptically. Hasn't access to freshwater steadily improved for decades? And didn't the recent United Nations Water Conference address this problem? Why should we worry about water when other challenges seem harder to solve? The reality, however, is both worse (because we are facing a global water crisis) and better (because new ideas and emerging technologies can help overcome the challenges) than many people imagine.

Part I: The Water Crisis

The Water Crisis: Myths to Clear Away

Many responses to the crisis echo common myths, so let's begin by addressing these misconceptions.

Myth 1: The Water Crisis Is Like the Carbon Crisis

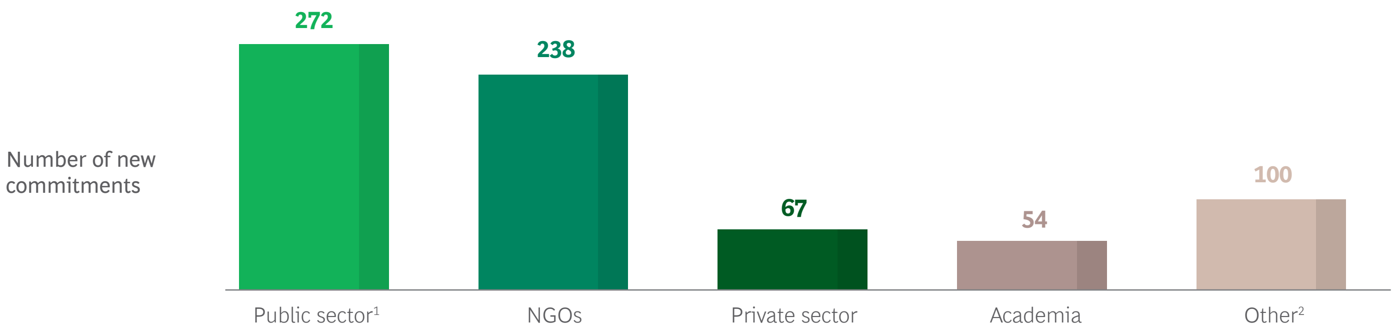
Unlike carbon emissions, water issues are hyperlocal. One region might face severe drought, while another a few hundred miles away has an abundant supply of water. Quality varies widely, too: the groundwater in one area might be undrinkable, while neighbors who benefit from a different geology can drink freely from their wells.

That hyperlocality complicates efforts to coordinate global action. It's much easier to set national limits on fungible emissions that flow freely into the atmosphere. Not surprisingly, we have a global framework for measuring and disclosing carbon emissions, but not for gauging and upholding water standards. Likewise, we can't create emissions markets with offsets for water.

These challenges help explain why the recent UN Water Conference—the first in almost 50 years—although groundbreaking in itself, yielded far fewer results than the several gatherings on carbon emissions. Instead of producing a "Paris moment" of accelerated solutions, the gathering in New York City in March 2023 served mainly as a forum for discussion, and it drew few (9% of the total) new commitments from companies.[1] (See Exhibit 1.) We need regular gatherings to share success stories, discuss ongoing challenges, and drive action. The water crisis demands creative thinking and action to address local challenges.

1. UN Department of Economic and Social Affairs, "Water Action Agenda" (April 7, 2023).

Exhibit 1 - The Recent UN Water Conference Led to Few New Commitments from the Private Sector



Sources: UN Department of Economic and Social affairs (April 7, 2023); BCG and WWF analysis.

[1]Includes national, regional, and local governments, as well as intergovernmental and multilateral bodies.

[2]Includes such entities as civil society, philanthropic organizations, and partnerships.

Of course, the water crisis and the climate change crisis are related, and water problems are often a visible manifestation of climate change resulting from high carbon emissions. But each crisis calls for its own separate solutions.

Myth 2: Governments Alone Are Responsible for Providing Resilient Water Supplies

Governments play a critical role in providing leadership and regulations to ensure the adequate, equitable, and sustainable management of water resources. Yet effective water management requires the involvement of diverse stakeholders, including the private sector, local communities, and civil society. Two-thirds of companies say that water problems could lead to substantive changes in their business, putting $225 billion at risk.[2] This is because the private sector depends on water supplies to transport goods over rivers, to serve as a key ingredient for beverages, or to act as an input for agriculture.

Crucial innovations must come from both for-profit and nonprofit organizations in those regions. Organizations can draw on advances from elsewhere, but they must adjust every new tool, technique, or process to the local context. Hence the need for competent governance to provide proper incentives to these nongovernmental actors.

For-profit companies need to seize the water opportunity, since the cost of inaction is likely five times as high as than the cost of action.[3]

Myth 3: Water Comes from Infrastructure

Many people assume that potable water is simply a financial or engineering challenge. As long as a community has the capital and expertise, it can build a water supply system to meet its needs. But water doesn't just "come from the tap." It depends on natural ecosystems.

Planners must factor interconnected freshwater environments into development in order to ensure water system resilience. Since 1970, one-third of the world's wetlands have disappeared, the number of long, free-flowing rivers has declined by two-thirds, and the populations of freshwater species have declined by four-fifths. Too many grand engineering projects have fallen short of expectations over time because they undermined those ecosystems.

Hydropower development, for example, can hamper food production, harm biodiversity, displace communities, and endanger public safety as dams age. It can also block migratory fish and prevent sediments needed to sustain deltas from flowing downstream. In some cases, the damage is so great—including to climate adaptation services—that it outweighs the climate mitigation value of the renewable electricity generated.

We therefore argue that future water management systems must work with nature, through nature-based solutions, to sustainably manage ecosystems. We see many promising innovations in the water sector, with numerous state-of-the-art solutions now in scalable and pilot phases. Yet these innovations can address the water crisis only in conjunction with freshwater ecosystems.

2. https://www.cdp.net/en/research/global-reports/high-and-dry-how-water-issues-are-stranding-assets.
3. https://www.cdp.net/en/research/global-reports/global-water-report-2020.

Myth 4: We've Already Largely Solved the Problem of Water Access

The percentage of people who lack clean water for drinking, cooking, and sanitation has been falling for decades. And today, proportionately fewer people are dying from preventable diseases linked to unsafe water and poor sanitation.[4]

Nevertheless, 1.4 million people die each year because they lack access to safe and affordable drinking water, adequate sanitation, and suitable hygiene facilities. Just under half of the world's 8 billion people still lack ready access to sanitation. And 2 billion people still struggle to obtain drinkable water. As population growth, rising economic output, and changing climate patterns increase pressure on freshwater supplies, the progress made in recent decades is under threat and could be reversed.

The UN's Sixth Sustainable Development Goal (SDG6) calls for universal access to clean water by 2030. Without such access, regions will struggle to achieve other development goals.

To meet this goal for SDG6, we need to boost the current pace of progress by six times. In 2030, at current rates of progress, one-fifth of the world will still live without safely managed drinking water, one-fifth without basic hygiene facilities, and one-third without safe sanitation.

Meanwhile, climate change is poised to disrupt ongoing efforts to improve water access in many places, making future advances more difficult. Both droughts and flooding are likely to become more common, and the higher rate of disruption will increase risks to water quality. The current slow rate of improvement under the status quo might even go negative. And as water risk grows, the challenge of reducing carbon emissions absorbs much of the world's attention and creativity.

Instead of doing more of the same, we need to adopt a new approach. This report will lay out ideas for accelerating the expansion of access to clean water while making water supplies resilient against climate change.

Myth 5: Water Should Be Free to Everyone

The UN recognizes access to adequate water and sanitation as a fundamental human right—one that is critical to health, dignity, and prosperity.[5] Water is the basis of all life on Earth, and freshwater is critical to many ecosystems. It is also vital to business operations in many industries.

This doesn't mean, however, that water should be free and access should be limitless. Water pricing calls for a complex balance between equity and efficiency. Given that water is a human right, it should be inexpensive, but people should also have an incentive to conserve it.

With careful pricing, governments can work with providers to promote both equity and efficiency. Market-based mechanisms, adaptive pricing, and other policies can promote conservation and stimulate sufficient financing while also meeting the needs of vulnerable populations.

Pricing was a key issue at the 2023 UN Water Conference, and must be a continuing focus of planning as regions around the world face freshwater shortages. We delve into pricing considerations in Part II of this report, along with other market-based mechanisms.

Myth 6: Investors Have the Information They Need to Make Sustainable Water Investments

This myth is simply false. Investors have far too little information about water efforts, often fail to recognize the magnitude of water-related risks, and lack understanding of the effects of climate change on the water supplies.

Investors need reliable information, but most companies provide few details about their water usage. The Carbon Disclosure Project (CDP), which collects data on carbon emissions, water use, and exposure to deforestation, recently surveyed about 8,500 companies and found that only 46% of them disclose water-related data.[6]

Many investors today pay no attention to water risks, either because they don't understand water's impact and dependencies or because they lack access to decision-useful data. Water is the key ecosystem dependency in most financial portfolios, yet fewer than half of those portfolios disclose their water-related risks. Jefferies, a US-based multinational investment bank, found that three of the five most material ecosystem service dependencies were water related.[7]

4. https://www.sdg6data.org/en/node/1.
5. https://www.unwater.org/water-facts/human-rights-water-and-sanitation.
6. https://www.cdp.net/en/research/global-reports/global-water-report-2020.
7. "Water is 'most critical' natural capital factor for investors," *Environmental Science* (February 9, 2023).

Reality: The World Is Facing Severe Water Problems in Many Regions

Overall, the world has not managed water sustainably and equitably—and today four drivers are raising the stakes.[8] (See Exhibit 2.)

Changing Climates Are Disrupting Freshwater Supplies

Climate change will exacerbate local risks of drought and flood, particularly in regions that already face water stress. According to the Global Commission on Adaptation, "The effects of climate change will most immediately and acutely be expressed through water."[9] The Intergovernmental Panel on Climate Change (IPCC) expects 50% more people to live under water stress if average global temperatures rise by 2°C, rather than by 1.5°C. As the climate changes, it becomes less stable. Droughts are likely to quadruple and their intensity to double, while floods will more than double and become 30% more intense.[10]

In many regions, climate change will probably reduce freshwater availability as a consequence of changes in precipitation and increased evapotranspiration. Higher temperatures and rising sea levels will likely intensify salinization (increased water-soluble salt concentration in soil), worsening water quality.

Demand Is Increasing Unsustainably

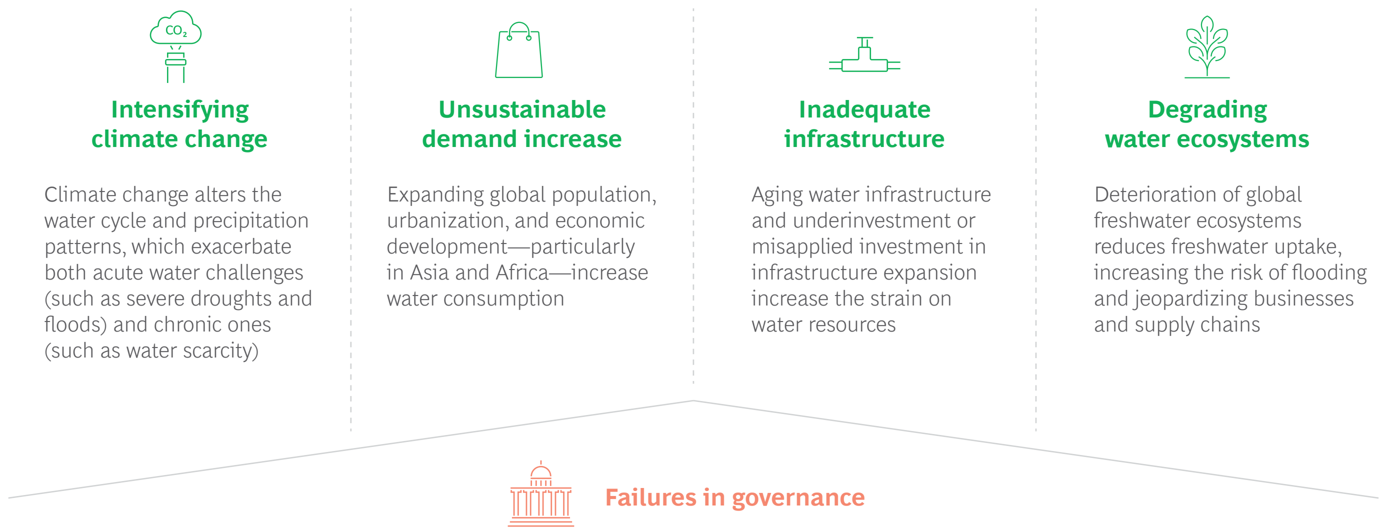
Even as water supplies come under threat, demand for freshwater continues to grow rapidly. That's especially true in BRICS countries (Brazil, Russia, India, China, and South Africa), where billions of consumers are joining the middle class and consuming much more water than they did when poor. They also eat more meat and consume a wide range of processed goods. Moreover, the UN expects the global population to exceed 9 billion people by 2050, with 60% to 70% of them living in urban areas.[11] These demographic changes will further stress water infrastructure and intensify local demand.

Water is not a simple commodity. It is critical to households but also essential for businesses and agriculture, which need to expand their output to meet increasing demand from consumers.

Infrastructure Is Not Keeping Up

Water infrastructure is critical for serving drought-prone areas, protecting communities from flooding, and providing public health services such as water treatment and sanitation. Yet water infrastructure is aging and often suffers from deferred maintenance. Three key points are relevant here.

Exhibit 2 - Four Drivers, Underpinned by Failures in Governance, Are Central to Global Water Challenges



Source: BCG and WWF analysis.

8. https://www.nature.com/articles/s41558-018-0257-z ; https://blogs.worldbank.org/climatechange/147-billion-people-face-flood-risk-worldwide-over-third-it-could-be-devastating.
9. "Adapt Now: A Global Call for Leadership on Climate Resilience," https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/.
10. IPCC AR6.
11. https://www.un.org/en/desa/world-population-projected-reach-98-billion-2050-and-112-billion-2100; https://www.un.org/uk/desa/68-world-population-projected-live-urban-areas-2050-says-un.

First, water infrastructure is prone to leakage, even in regions vulnerable to water stressors such as prolonged droughts. For example, demand in South Africa will likely outpace supply by 17% by 2030 even as one-third of the water that runs through existing infrastructure is lost to leaks.[12] This is a problem in the global north as well. For instance, Italy has a leakage rate of 42%.[13] In the US, a water main breaks every two minutes, resulting in the loss of 6 billion gallons of treated water daily. Globally, leakage costs water utilities $14 billion every year. Leaks and other water disruptions were responsible for $50 billion in losses by the 11 most water-reliant industries in 2019.

Second, aging infrastructure is a security risk. Most US levees and dams received grades of 'D' or 'F' for safety from the American Society of Civil Engineers.[14] Structural failure of any of these water containment barriers could devastate entire communities.

Third, in the absence of proper water treatment and distribution, consumers risk bacterial contamination and chemical pollution. In such situations, they must rely on questionable surface or groundwater, leaving them much more vulnerable to waterborne illnesses.

Freshwater Ecosystems Are Degrading

Supplies depend on broad ecosystems. For example, peatlands and wetlands perform crucial filtering and storage functions for downstream freshwater access. Yet a third of all wetlands have disappeared since 1970. Similarly, many rivers and lakes are being degraded, both qualitatively and quantitatively.

Even seemingly dry forests improve water quality and flow through filtration and retention, while also creating atmospheric conditions that led to rain elsewhere. Coastal mangroves provide natural flood protection. Yet many cities build over these nature-based resources. Even when many trees remain, disrupted flows can diminish vegetation and prevent forests from retaining water and recharging supplies. As cities and economies expand at the expense of these critical ecosystems, they weaken their own resilience to climate impacts. We need to explore models of development that work cooperatively with ecosystems to build resilience.

The Water Crisis Ultimately Stems from Failed Governance

Many regions lack the governmental capacity to manage freshwater resources effectively. They send out weak pricing signals, rely on outdated allocations, and in many cases do not consider the ecosystem's wider ecology and hydrology.

Effectively managing water use requires strong, impartial, and collaborative local governance. Governance structures often lack broad-based legitimacy, since many historical agreements have excluded stakeholders. Moreover, municipalities, water agencies, and other local governmental bodies struggle to enforce policies because they have inadequate technical capabilities and expertise in project management.

A deep understanding of the water crisis in all its complexity, and of how to meet the challenges, is critical to better governance. This report aims to provide that understanding. It offers guidance on strategic actions directed toward resilient ecosystems, economies, and societies.

A Framework for Understanding Water Impacts

To reduce the complexity, we can chart each region's degree of crisis according to a three-by-three matrix. (See Exhibit 3.) In 2020, BCG introduced the Water Impact Matrix, which enables policymakers, environmentalists, executives, financiers, and other stakeholders to consistently assess a local situation and propose appropriate solutions. It starts with three basic issues:

- **Too Little Water.** Demand for water exceeds available supply, water infrastructure is inadequate, or institutions fail to balance everyone's needs. Climate change is making dry areas drier and increasing the length and severity of droughts. Water scarcity hurts businesses as well as residents. This is the main problem in northern Africa and the Middle East, where rising demand is overwhelming local resources.

- **Too Much Water.** Some regions are at risk for floods due to developments such as paving floodplains, or to climate-driven shifts in precipitation patterns. More frequent episodes of excessive rain can overwhelm rivers or cause storm surges that batter coasts. Flooding can disrupt businesses at various points in their value chains—closing their main operations, shutting down suppliers, or raising transportation and capital costs. Coastal and riverine areas in places such as East Asia face the greatest impact from this threat.

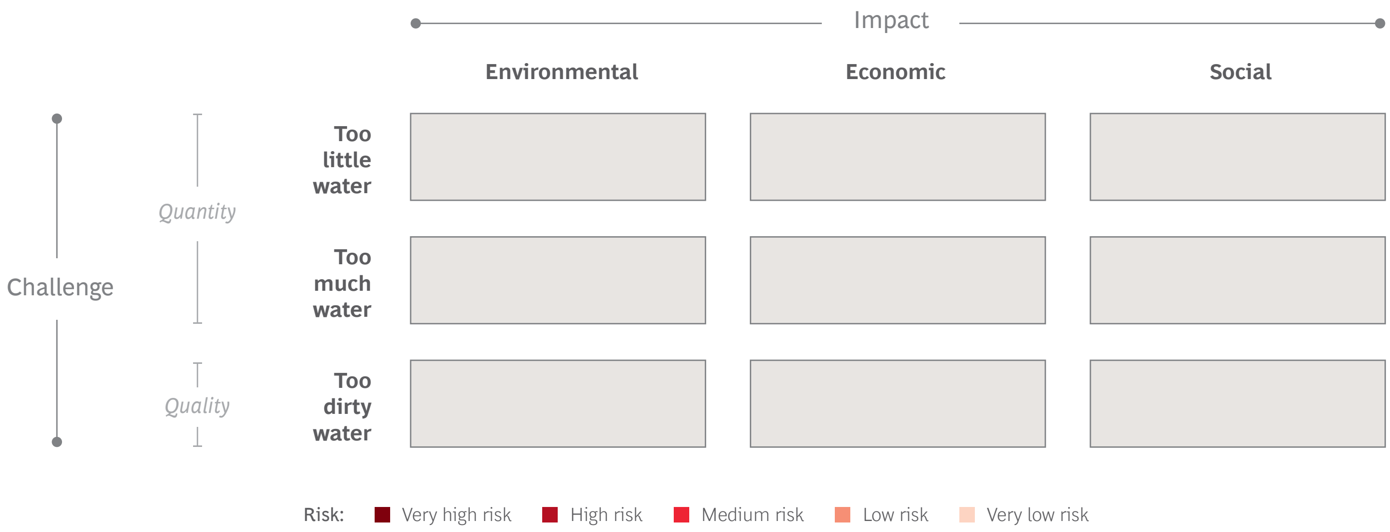
- **Too Dirty Water.** This issue covers not just polluted water, but also water that is too rich in nutrients, too salty, or too warm. In much of the world, poor water quality due to industrial activity poses the main challenge to water access.

12. http://awsassets.wwf.org.za/downloads/wwf009_waterfactsandfutures_report_web__lowres_.pdf.

13. https://www.reuters.com/business/environment/italys-water-crisis-exacerbated-by-leaky-pipes-data-shows-2023-03-21/.

14. https://yaleclimateconnections.org/2021/03/new-report-u-s-dams-levees-get-d-grades-need-115-billion-in-upgrades/.

Exhibit 3 - The BCG Water Impact Matrix Helps Reveal the Likely Impact of Various Water Challenges



Source: BCG and WWF analysis.

Note: The matrix shown here is a template version, with risk values not filled in. Water challenges can be acute (such as flash droughts) or chronic (such as long-term water scarcity). Both types are considered here.

The Water Impact Matrix then maps these issues against three dimensions:

- **Environmental.** Freshwater is crucial for virtually every ecosystem. When water is under threat—whether through scarcity, excess, or pollution—these ecosystems are, too.

- **Economic.** Clean water is a crucial business input in many industries, from agriculture to pharmaceuticals. It also plays a global role in maintaining reliable supply chains.

- **Social.** Water is a human right. All people deserve access to safe drinking water and dignified sanitation. This requirement is fundamental to the UN's Sustainable Development Goals and animates many water rights disputes around the world.

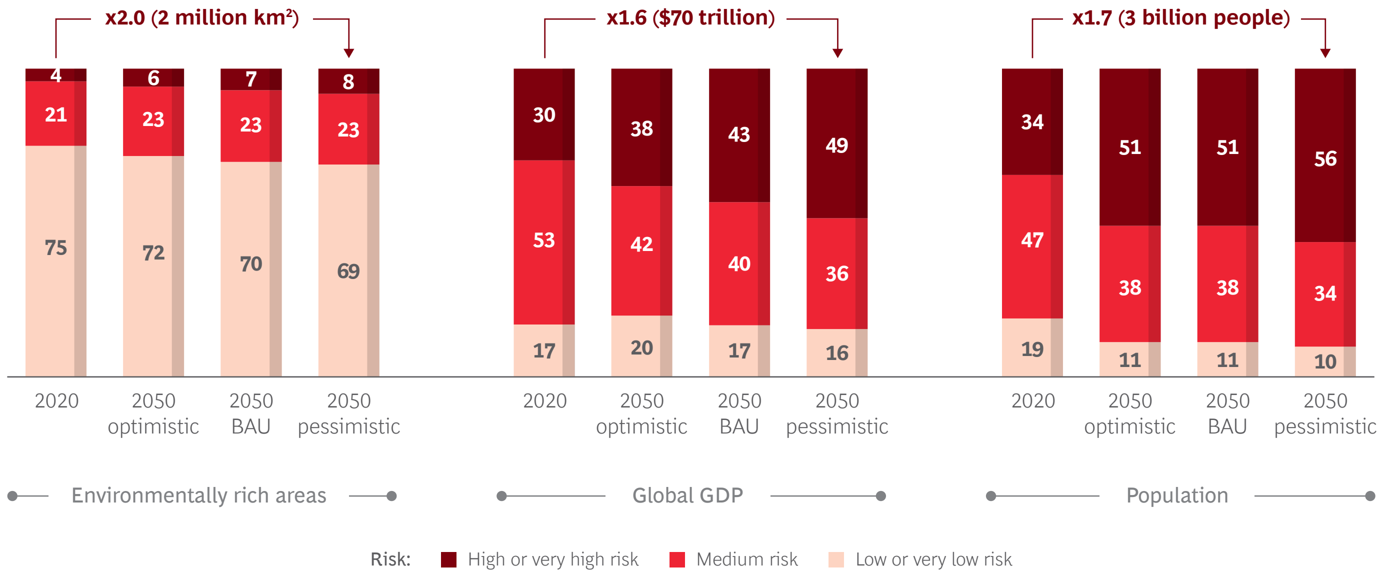
The Water Impact Matrix gathers these areas into a single view. Stakeholders can understand the likelihood and impact of each type of water challenge, and then identify a suitable path to action.

The matrix focuses on the primary impacts, while also permitting deep dives into specific topics such as reputational and regulatory risks. Take the textile industry, for example. As consumers become aware of environmental issues, they will push reputable companies to develop sustainable water practices. Government may adopt new regulations to address water pollution and water scarcity, which in turn may affect companies' operations and profitability.

To assess the extent of the water challenge, we combined the Water Impact Matrix with WWF's Water Risk Filter, a rigorous free tool that quantifies risks at high resolution with indicators from 32 external and peer-reviewed global data sets. We found that 4% of the world's environmentally rich areas, 30% of global GDP, and 34% of the world's population are in locations at high water risk. (See Exhibit 4.) By 2050, if we continue business as usual, 7% of environmentally rich areas, 43% of the global GDP, and 51% of the global population will be at high risk.

Exhibit 4 - Climate Change Will Put Much of the World at High Water Risk by 2050

Level of water risk for global environmentally rich areas, GDP, and population (%)



Sources: WWF Water Risk Filter; Wang and Su, "Global gridded GDP data set consistent with the shared socioeconomic pathways," *Sci. Data* (2022); Wang, Meng, and Long, "Projecting 1 km-grid population distributions from 2020 to 2100 globally under shared socioeconomic pathways," *Sci. Data* (2022); BCG and WWF analysis.

Note: GDP and population estimates include change—including climate scenarios—based on latest projections. GDP is measured as purchasing power parity, in 2005 international dollars. BAU = business as usual. Because of rounding not all bar segments add up to 100%.

The matrix reveals that poor water quality is a key issue. More than half of the current global population and GDP today are in Asian regions, including India, with high risks related to water quality—and that figure is likely to rise to 68% by 2050.

Flooding, too, has severe social and economic effects. Worldwide, 1.8 billion people face flood risks, and one-third of them have incomes of less than $2 per day. They have limited access to financing for flood protection or recovery, much less insurance, which leaves them vulnerable to property loss, dislocation, and economic disruption. In economic terms, river flooding is the world's most damaging form of disaster, at a cost of $115 billion per year.[15] Climate change will probably increase anomalous flooding, with $15 trillion in economic activity at risk of flooding by 2040.[16]

Regions and Sectors at Risk

Focusing on global statistics gives short shrift to the challenges faced by regions and sectors where water risks are acute. We can use the matrix and the risk filter tool to obtain more specific insights. (See Exhibit 5.)

Regions

The results show notable concentrations of water stress in northern India, northeastern China, the southwestern US, and the Mediterranean, among others. These regions must develop sustainable water management solutions to meet the needs of social and economic growth as part of their long-term sustainable development plans.

Northern India.[17] India is now the world's most populous country, and significant parts of its GDP and biodiversity are exposed to high water risks.

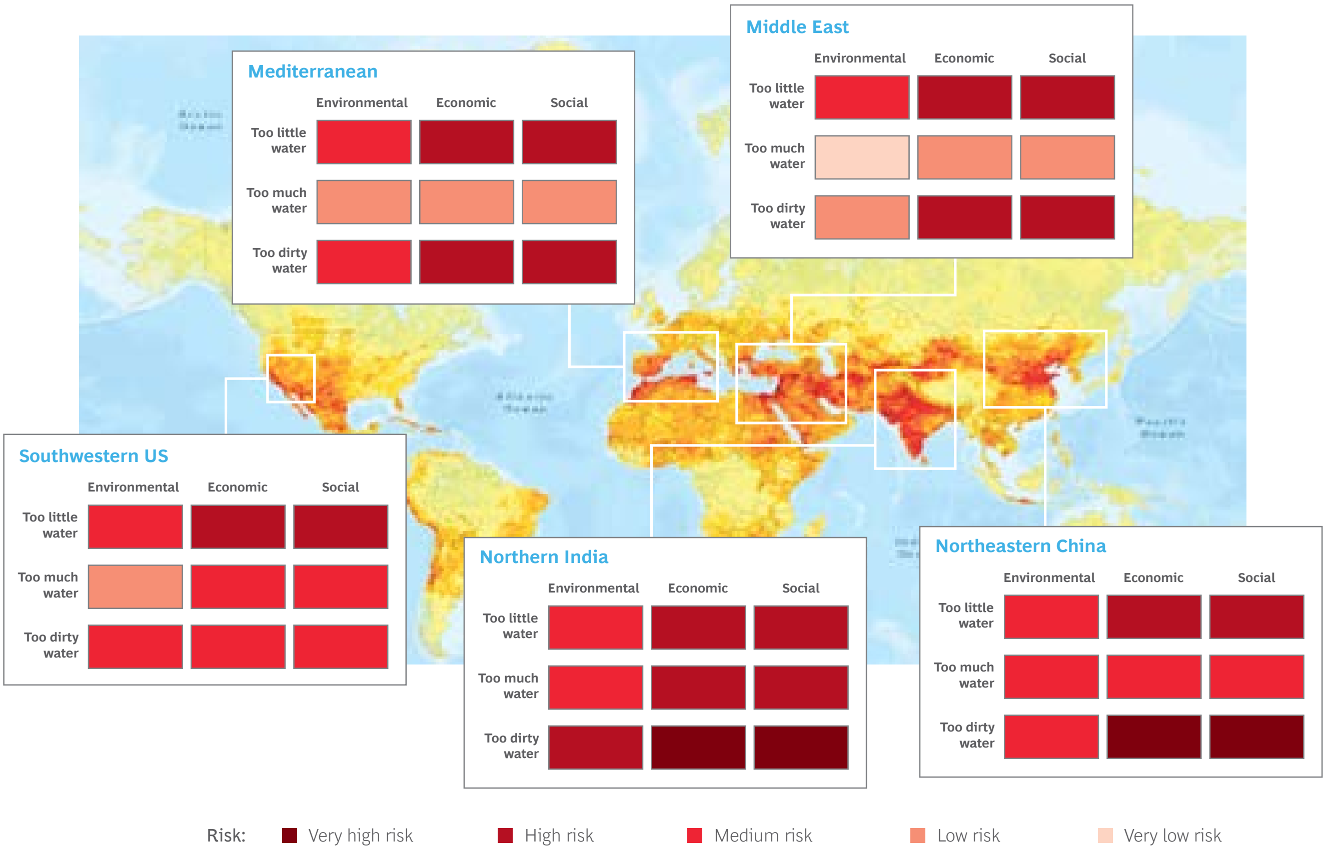
15. https://www.nature.com/articles/s41558-018-0257-z.

16. https://blogs.worldbank.org/climatechange/147-billion-people-face-flood-risk-worldwide-over-third-it-could-be-devastating.

17. https://www.wri.org/insights/3-maps-explain-indias-growing-water-risks.


Effects of climate change will most immediately and acutely be expressed through water

Exhibit 5 - BCG's Water Impact Matrix Identifies Hotspots



Sources: WWF Water Risk Filter; WWF and BCG analysis.

India's rapidly worsening water situation is due mostly to issues of water scarcity and poor water quality, but the country also faces substantial risks of flooding. It ranks among the world's most water-challenged nations, in part because of its high population density and inadequate water infrastructure. Groundwater levels are sinking as farmers, city residents, and industries overdraw from wells and aquifers; overall availability has fallen by half over the past seven years. For 16% of the land, the groundwater level is declining by an alarming 1 meter per year. Much of the water that is available is polluted.

India depends on its northern regions for supplies of rice and wheat, both of which are water-intensive crops. The availability of clean water is shrinking as a result of both climate change and unsustainable water use by local producers. The federal government subsidizes electric pumps and places no limits on groundwater extraction, worsening an already precarious situation. Fewer than 10% of India's groundwater districts provide water that is considered safe to drink.

Northeastern China.[18] A large portion of the China's GDP is generated in areas of high or extreme water risk. Like India, China faces the twin challenges of poor water quality and mounting water scarcity, driven by rapid population shifts, economic growth, heavy industry (steelmaking, smelting, and paper and chemical production), and electricity generation, along with climate change.

The northeastern part of China is an important agricultural producer, but that area holds just 4% of the country's freshwater. The region relies on ever-depleting and increasingly polluted groundwater for household use as well as for industry and agriculture.

China's electricity generation is water-intensive, comprising 12% of national water consumption. Much of it comes from coal-fired plants that require large volumes of water for cooling. Two-thirds of the country's coal plants are in northern provinces and other areas of high water stress.

18. https://www.lowyinstitute.org/the-interpreter/water-scarcity-challenges-china-s-development-model.

China's heavy industry is another major consumer of the country's freshwater, with a use-to-value-added ratio that far exceeds that of peer countries.

Southwestern US. The Colorado River Basin has been under stress for two decades, especially as a result of consumption in California, which is home to 39 million people and 15% of the US's GDP. The main challenge here involves water scarcity due to growing demand without a commensurate increase in supply, amplified by rising temperatures and worsening drought driven by climate change.[19] The river's flow has fallen by one-fifth since 2000, and a 2°C increase in average temperature (over pre-industrial levels) by 2050 could reduce it by 40%.

In response to the longstanding drought, the region's state governments recently agreed to substantially reduce their allocations. (See "Case Study: The Colorado River Basin.")

Mediterranean. The Mediterranean attracts tourists from around the globe, drawn by its fine weather and beautiful nature. The region also produces grapes, olives, and nuts—all water-intensive crops.

Yet the region has seen five consecutive years of drought, along with record-breaking high temperatures. This trend is likely to continue and worsen in coming years. In 2022 and 2023, temperatures sometimes rose to 4°C above average, due to long-lasting heatwaves.[20] The combination of drought, high water demand from agriculture and tourism, and record heat has reduced river flows. Spain is experiencing pervasive water shortages, particularly in Andalusia, where water reservoirs languish at one-quarter of capacity. Farm yields are falling, and forecasters expect even lower yields in the future.

Severe droughts and water scarcity are already having political repercussions. Drought-struck Andalusia, specifically the province Huelva, is the world's largest exporter of strawberries. The regional government wants to legalize farms and irrigation in the watershed that surrounds Doñana national park. Illegal operations already in place contributed to the park's losing more than half of its pond network from 1985 to 2018, and legalization would worsen the situation.[21] The potential damage is so great that German activists have called for boycotting Andalusian strawberries.

An extreme case of politics outside the Mediterranean involves the Horn of Africa, where years of conflict, localized violence, and refugee camps have combined with climate-related shocks to render 82 million people food-insecure. Aid agencies such as the World Food Program have worked with partners to ameliorate these conditions, but the region's worsening climate is likely to intensify future floods and droughts. The long-term solution is not expanded food aid, but investment in resilient food systems, which in turn depend on long-neglected water supplies. Engineering alone won't suffice—the region needs to adopt nature-based solutions and social innovations and build graywater infrastructure to create resilient water systems.

Sectors

Throughout the world, water is critical to the operation, profitability, and sustainability of agriculture, textiles, mining, and energy production. (See Exhibit 6.)

Agriculture. Because agriculture depends on water more than any sector does, it is especially vulnerable to water risks. At the same time, it heightens such risks through depletion and pollution. According to the World Resources Institute, agriculture accounts for two-thirds of global freshwater withdrawals, and 40% of the world's food comes from areas with high water stress.[22]

Agricultural production requires large quantities of water, even in regions where resources are limited. Aside from issues related to water scarcity, floods and water pollution can damage soil fertility and irrigation systems, leading to higher input costs or greater production losses and attendant food insecurity. These problems have knock-on effects in sectors such as food and beverage production and textiles. Another contributor to scarcity is the virtual water trade. (See "The Virtual Water Trade.")

Water pollution arises mainly from excessive agrochemical use and inadequate wastewater management. Agricultural runoff of pesticides, fertilizers, and animal waste can contaminate local water sources, making the water unfit to drink and hurting aquatic life.

19. https://www.nature.org/en-us/about-us/where-we-work/priority-landscapes/colorado-river/colorado-river-in-crisis/#:~:text=Temperatures%20in%20the%20Basin%20are,by%20another%2010%20to%2040%25.&text=In%20addition%20to%20causing%20soaring,threatens%20rivers%20and%20water%20supplies.

20. https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/severe-drought-western-mediterranean-faces-low-river-flows-and-crop-yields-earlier-ever-2023-06-13_en.

21. https://www.wwf.eu/?10136966/Donana-emergency-European-Commission-must-stop-destructive-law.

22. https://www.wri.org/news/release-one-third-all-irrigated-crops-face-extremely-high-water-stress.

Case Study: The Colorado River Basin

The Colorado River supplies drinking water to 40 million people in the southwestern US and Mexico. It supports $1.4 trillion in commerce, 16 million jobs, 15% of US farmland, and 30 tribal nations. Without the river, Arizona alone would lose 2 million jobs and see its gross state product fall by one-third, or $185 billion.[1] The high stakes involved in maintaining the Colorado River Basin's health have led stakeholders to adopt four of the six strategic moves described in Part II.

Seven state governments represented in the basin are balancing the water demands of municipal, commercial, cultural, and ecological end users, all competing for low-cost water. The largest user is agriculture, which takes up three-quarters of the supply, so stakeholders have been looking to farmers to reduce their usage without compromising the sector's economic viability. Metropolitan areas in the region have grown rapidly and are struggling to ensure the availability of supplies sufficient for continued growth. Often, they accomplish this by buying water rights from farms ("buy and dry"), a tactic that removes land from production and damages rural communities.

Allocations of Colorado River Basin water were set a century ago, with an incomplete understanding of climate variability and without the participation of stakeholders such as indigenous peoples and fisheries. The 1922 Colorado River Compact apportioned the water between Upper Basin and Lower Basin states, with the remaining flows going to Mexico. The compact created two groups: senior users such as California, and junior users such as Arizona. In times of scarcity, junior holders get cut first. Because 1922 was a time of anomalously high flows, compact participants had a false sense of the arrangement's sustainability. Since then, several droughts have strained relationships among basin users and forced some to question the compact. They point to such flaws as a "use it or lose it" provision that discourages conservation.

Today, junior rights holders are trying to renegotiate the compact's terms, but senior rights holders have little incentive to go along. The seven basin states recently agreed to a series of cuts in Colorado River water usage, and now the federal government is assessing whether those cuts are adequate in light of climate change.

Over the past two decades, the river's stream flows have fallen by one-fifth, and experts predict an additional drop of 9% per Celsius degree of higher temperature.[2] Water levels in the basin's reservoirs are dropping at an alarming rate, threatening not just water supplies but also hydroelectric power generation—a cornerstone of the region's energy. The current water allocation of 20.4 billion cubic meters per year exceeds the long-term average annual streamflow of 18 billion cubic meters by more than 10%.[3] From 2000 to 2022, the annual natural flow decreased to 15 billion cubic meters, which suggests a 30% deficit.

Three Critical Moves

Agencies and other stakeholders are working on various solutions to put the basin on a path to water resilience:

- Accelerating agricultural innovation, especially in the areas of precision irrigation, water-efficient crop selection, and regenerative agriculture
- Deploying market-based mechanisms to encourage basin users to share water temporarily by reducing transaction costs for water leasing and other measures
- New water-efficient technologies to intensify residential conservation, for both indoor and outdoor usage

These three moves could save about 2.3 billion cubic meters of water per year (See the exhibit.) Stakeholders could also seek equitable governance practices based on new legislation, new forms of block pricing, new partnerships, and new drought planning and disclosure mandates.

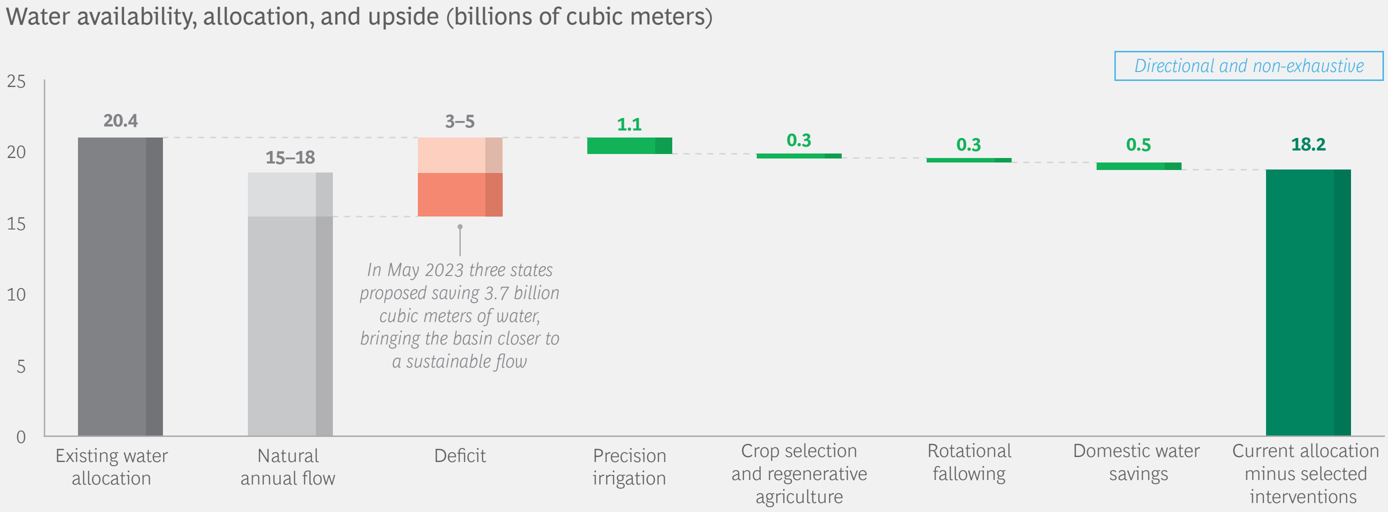
Let's delve into each of the three immediate moves available to stakeholders.

Accelerating Agricultural Innovation

Crops destined for cattle feed consume more river water than crops harvested for direct human consumption. Beef and dairy products are therefore the leading driver of water shortages (and fish imperilment) in the region.[4] But sales of these products are unlikely to fall in the near future. So stakeholders have focused on two innovations: precision irrigation and better soil management.

1. https://abcnews.go.com/US/happen-colorado-river-system-recover-historic-drought/story?id=98475953; https://feedingourselvesthirsty.ceres.org/regional-analysis/colorado-river.
2. https://pubmed.ncbi.nlm.nih.gov/32079679/.
3. https://sgp.fas.org/crs/misc/R45546.pdf.
4. https://www.nature.com/articles/s41893-020-0483-z.

Interventions to Overcome Deficits in the Colorado River Basin, Enabled by Equitable Governance



Sources: Congressional Research Services, "Management of the Colorado River: Water allocations, drought, and the federal role" (February 2023); Richter et al., "Water scarcity and fish imperilment driven by beef production," *Nature Sustainability* (2020); BCG analysis.

Farms are moving away from flood irrigation—although four-fifths of basin cropland still relies on it—and toward sprinkler and drop systems. Even better are drip irrigation and AI-driven sprinklers that optimize the timing and location of delivery, thereby minimizing evaporation from the soil surface.

To augment this precision application, farms are exploring regulated deficit irrigation (RDI), which limits deliveries of water when crops can tolerate water stress. The goal is to conserve water while minimizing adverse impacts on yield. According to the Pacific Institute, employing RDI can reduce annual irrigation in the region by 1.1 billion cubic meters.[5] The Pacific Institute also estimated that switching 10% of alfalfa plantings in the Colorado River Basin to cotton or wheat could save about 300 million cubic meters of water annually.

Related to RDI is conservation-oriented tillage and mulching, a method that limits evaporation to keep more water in the soil. Besides saving water, this approach can increase overall soil health.

Relying on Markets

Several agencies with stakes in the Colorado River Basin have established market-based mechanisms for water sharing. California hosts one of the world's largest water markets, with approximately 1.7 billion cubic meters traded annually.[6] Colorado is pioneering "alternative transfer mechanisms" that work in much the same way.

These mechanisms encourage voluntary water-sharing agreements among users and can handle permanent as well as temporary transfers to the optimal allocation. In exchange, users receive compensation and greater legal protection of their remaining water rights.

For example, farmers receive financial incentives for the voluntary, temporary, rotational fallowing of farmland. Estimates suggest that rotational fallowing of 20% of cattle-feed irrigated land from July through September would yield water savings of 300 million cubic meters per year.[7] Farmers can also enter into an interruptible water supply agreement with a municipal or industrial user. Under such an agreement, the user leases water from the farmers for three out of every ten years of drought-tightened supplies. In those years, the farmers curtail their water use by fallowing or engaging in deficit irrigation, in exchange for a fee.[8]

5. https://pacinst.org/wp-content/uploads/2013/05/pacinst-crb-ag.pdf.
6. https://www.scienceforconservation.org/assets/downloads/Market-Based_Mechanisms_for_Env_Water_TNC_2017.pdf.
7. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1064&context=wffdocs.
8. https://www.auroragov.org/residents/water/innovation; https://dnrweblink.state.co.us/CWCB/0/edoc/212963/ATM%20Status%20Report.pdf.

Scaling Household Savings

Total household water usage in Colorado River Basin states amounts to 3 billion to 4 billion cubic meters, with 55% outdoor and 45% indoor usage.[9] With "smart" applications such as WaterSense, engineers estimate that households can save up to 45% of indoor and 70% of outdoor usage. If we assume a 20% to 30% incremental adoption rate of these applications, the Basin could save up to 500 million cubic meters annually. That figure excludes urban growth trajectories, however, and the southwestern US's population is likely to increase in coming decades.

Much Depends on Governance

The region has made good progress in recent decades. Today, southern California uses less water than it did in the 1980s, despite having 50% more people. But to sustain these efficiencies over the long term, governance must improve. The goal following the unexpected flooding from heavy rains last year is to store currently abundant water for later use. Infrastructure changes—especially the ability to bank and transfer water—are essential. This should happen with a combination of greenwater and graywater solutions. For its part, the federal government is encouraging substantial investment in water infrastructure through the Inflation Reduction Act.

Governance must also promote deeper shifts in water allocations. Farmers (including agricultural companies) need incentives not just for temporary transfers, but also for permanent transfers that facilitate investments in water-efficient equipment and conservation. And of course, the region needs an updated compact governing water management on the basis of terms negotiated across all stakeholders, including recreational users, ecosystem-based sectors, and tribes. Those voices are at risk of being suppressed by large consumers—agriculture, municipalities, and industry.

Beyond big-picture changes, each municipality or locality must set up its own drought planning and demand management. Each must also develop a long-term supply portfolio strategy that plans for a warmer, drier, and ultimately uncertain water future.

9. https://www.flumedatalabs.com/water-index.

Exhibit 6 - The Agriculture, Fishing, Food and Beverage, Paper, Textiles, Mining, and Construction Sectors Are at Highest Risk of Water Challenges

Industry	Global GDP (%)[1]	Scarcity	Quality
Agriculture	4	Very high risk	Very high risk
Fishing and aquaculture	<1	Very high risk	Very high risk
Food and beverage production	2	Very high risk	High risk
Paper and forest production	<1	Very high risk	High risk
Textiles and luxury goods	<1	Very high risk	Low risk
Metals and mining	5	Very high risk	Low risk
Construction materials	6	Very high risk	Low risk
Energy production	6	High risk	High risk
Chemicals, pharma, and biotech	5	High risk	Medium risk
Hospitality	3	High risk	High risk
Manufacturing[2]	15	High risk	Very high risk
Oil and gas	5	High risk	Very high risk
Other[3]	48	Low risk	Low risk

Risk: Very high risk | High risk | Medium risk | Low risk | Very low risk

Source: WWF Biodiversity Risk Filter, 2023.

[1]World Bank Development Indicators, 2020.

[2]Includes automotive, electronic equipment, machinery, electronics and semiconductors, and general manufacturing. 3 Includes retail, professional services, transport services, telecommunications (including wireless).

Agriculture is particularly sensitive to climate impacts. Shifting climate trends can alter rainfall patterns, increase evaporation, and raise the frequency and intensity of extreme weather events such as droughts, heat waves and flash floods. The IPCC expects crop yields to fall substantially as a result of these weather changes, even as population continues to grow.

Deltas, which are among the most productive agricultural regions, are shrinking in response to several factors: sea level rise, groundwater pumping, and reduced sediment flow in rivers due to sand mining and trapping by upstream dams.[23]

Food insecurity may reverse its current downward trend and become a growing global problem, intensified by climate change and population growth. For agriculture generally, much of the world's five most popular crops—wheat, corn, rice, soybeans, and cotton—is grown in areas of high-water scarcity, and this is likely to increase substantially by 2050. (See Exhibit 7.)

In the case of wheat, which occupies the most hectares globally, farms in areas with a high risk of water scarcity will likely rise from 25% to 42%, a 68% increase. Other crops see similar trends. For example, corn will see an increase in high-water-risk plantings from 12% to 27%. The textile industry may be particularly hard hit: 44% of cotton production already occurs in heat-stressed areas, a proportion that is likely to increase to 70%.

23. https://weblog.wur.eu/fnh-ri/combined-insights-stimulate-sustainable-food-production-in-deltas-under-pressure/.

The Virtual Water Trade

Agriculture accounts for much of the world's virtual water trade—the buying and selling of water-intensive products. This trade can occur internationally or within a country. It becomes problematic when a water-scarce region exploits its water supplies unsustainably to support such products. A study conducted in 2019 found that 15% of global water consumption went to the international crop trade.[1]

In 2015, the US, India, Pakistan, Mexico, and Spain accounted for two-thirds of the international water-stressed crop trade. The US is the largest exporter, with 22% of unsustainable (business as usual) virtual water transfers, followed by India (19%), Pakistan (14%), Mexico (7%), and Spain (5%). China is the largest importer of these crops, followed by the US, Turkey, Mexico, and Japan. About 60% of this trade involves cotton, sugar cane, fruits, and vegetables.

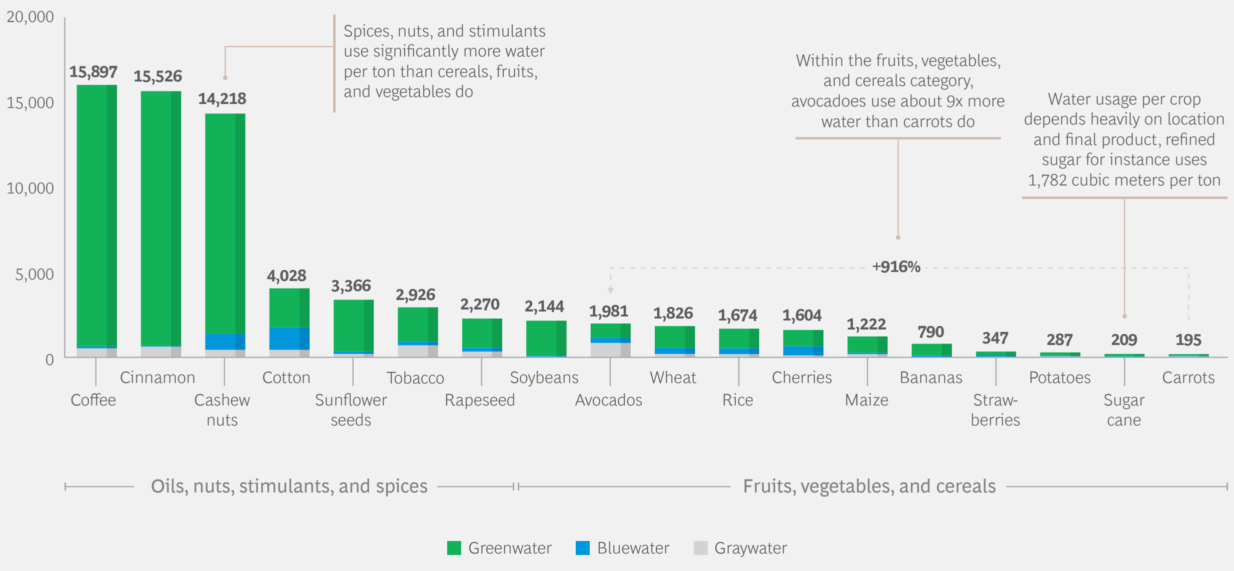
Virtual water trading also takes place inside many large countries, with electrical generation and chemical production contributing to the transfer totals. In China, from 2002 to 2012, the share of interregional trade to total water withdrawal doubled, from 20% to 40%.[2] Virtual water flows from agriculture, electricity, and chemicals accounted for 83% of the total. Paradoxically, much of the trade went from the water-scarce northwest and northeast to water-rich provinces in southern China.

Much of the virtual water trade is due to large variations in crop water intensity and to the inefficient distribution of these crops around the world. Nuts, spices, and stimulants use much more water than vegetables and fruits. (See the exhibit.) Water intensity varies within categories, too: avocados, for example, use nine times as much water as carrots. Location is another variable. If the region is water scarce, then Raising water-intensive crops in a water-scarce region has far more impact on the local water situation than raising them in a water-abundant region.

Animal products are the most water-intensive outputs of all. Beef uses 15,415 cubic meters of water per ton, while chicken uses 4,325 cubic meters.[3] The disproportionate water demands of animal products remain true even when gauged by caloric density: beef uses 10 liters of water per kilocalorie, compared to 0.5 liter per kilocalorie for cereals and 1.3 liters per kilocalorie for vegetables.

Water Intensity Varies Enormously by Crop

Global average water footprint of crops (cubic meters per ton)

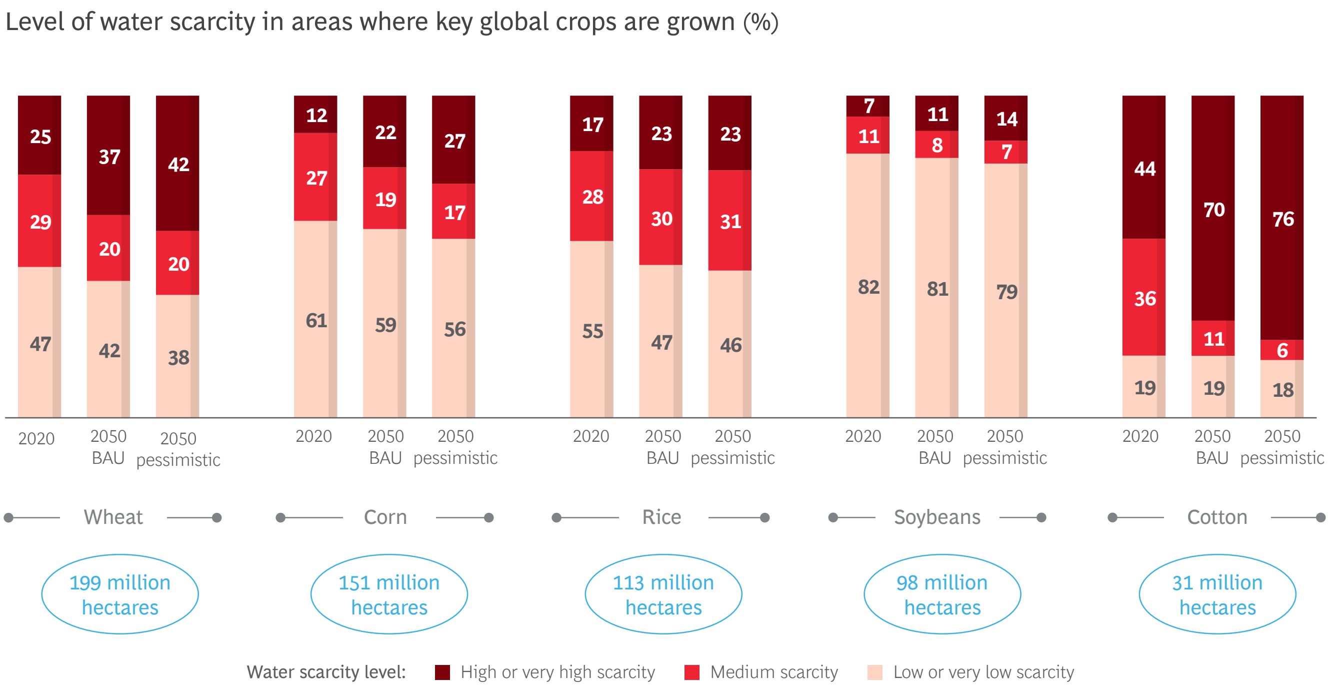


Source: Mekonnen and Hoekstra, The Green, Blue and Grey Water Footprint of Farm Animals and Animal Products, UNESCO-IHE (2010).

Note: As defined by the Water Footprint Network, "greenwater footprint" is water from precipitation, "bluewater footprint" is water that has been sourced from surface or groundwater resources, and "graywater footprint" is the amount of freshwater required to assimilate pollutants to meet specific water quality standards.

1. https://iopscience.iop.org/article/10.1088/1748-9326/ab4bfc/pdf.
2. https://pure.rug.nl/ws/portalfiles/portal/79507015/1_s2.0_S0959652618330919_main.pdf.
3. https://www.waterfootprint.org/resources/multimediahub/Mekonnen-Hoekstra-2012-WaterFootprintFarmAnimalProducts_4.pdf.

Exhibit 7 - More Agricultural Land Will Be at Risk of Water Challenges by 2050, with Wheat, Corn, Rice, and Cotton Particularly Vulnerable



Sources: WWF Biodiversity Risk Filter, 2023; International Food Policy Research Institute, 2019; BCG and WWF analysis.

Note: BAU = business as usual.

¹World Bank Development Indicators, 2020.

²Includes automotive, electronic equipment, machinery, electronics and semiconductors, and general manufacturing.

³Includes retail, professional services, transport services, telecommunications (including wireless).

Textiles. Of all industries, textiles has the highest water-related financial impact, as costs vary from 2% to 4% of revenues.[24] Manufacturing consumes large quantities of water for dyeing and finishing. WWF has found that it takes 2,700 liters of water to produce a single cotton t-shirt.[25]

Heightening the strain, much of the world's textile manufacturing takes place in water-stressed regions, such as southern Europe, India, and China. The industry is also a major contributor to water pollution because wastewater from textile manufacturing contains hazardous chemicals, dyes, and heavy metals. The resulting pollution harms aquatic ecosystems, damages human health, and reduces the supply of clean water. The UN estimates that one-fifth of global industrial water pollution comes from textiles.[26]

Energy. The energy sector faces risks related to both water quantity and water quality. Globally, power generation—particularly thermoelectric power—is among the largest consumers of freshwater. According to both the CDP Global Water Report 2020 and the International Energy Administration, the sector is second only to agriculture in water usage globally, accounting for 10% of withdrawals.[27]

Water use in energy production, such as to cool thermal plants or to extract and process fossil fuels, involves large quantities of water and contributes to water pollution. Wastewater from generation and processing may contain hazardous chemicals and heavy metals, and extraction and transportation can entail spills and leaks. The UN finds the sector responsible for 30% of global industrial water pollution.

24. https://www.cdp.net/en/research/global-reports/global-water-report-2020.

25. https://wwf.panda.org/?358216/Thirsty-for-fashion.

26. https://www.europarl.europa.eu/news/en/headlines/society/20201208STO93327/the-impact-of-textile-production-and-waste-on-the-environment-infographic.

27. https://www.iea.org/reports/water-for-energy-is-it-enough.


Regions can develop greater resilience to the water crisis by combining green and gray forms of infrastructure

The damage caused by this sector isn't limited to fossil-fueled power generation. Renewable energy technologies, such as hydropower and bioenergy, can stress water supplies as a result of poor siting of dams and broad changes in land use. Some dams reduce the risk of floods and improve water supplies, but incorrectly sited dams and those that fail to work with natural ecosystem can increase water risks. The proportion of hydropower dams located in basins with a high flood risk is likely to increase from 2% to 36% by 2050.[28] Meanwhile, many hydropower facilities are suffering from diminishing reservoirs in drought-stricken areas.

Mining. Another industry sector that ranks as a heavy water user and contributor to water pollution is mining. Drawing on vast amounts of water for mineral processing, dust suppression, and other activities, it is the most water-intensive of all industries. The 2020 CDP found mining to be the third largest user of water globally, accounting for 8% of water withdrawals.[29]

In some water-stressed countries that rely on mining, the industry accounts for a significant proportion of the country's water consumption. In South Africa, for instance, one-tenth of consumption goes to mining. And because mining discharges contain heavy metals, acids, and other pollutants, they can degrade water supplies. The UN ties mining to 10% of global industrial water pollution.

The mining sector has ample room for improvement simply by adopting existing solutions and technology. South Africa, for example, could address acid mine drainage (the outflow of acidic water from metal and coal mines) to make water flows drinkable. By accelerating investment in water treatment in the Witwatersrand gold region, the country could make 220 million cubic meters of additional water per year potable, according to the current masterplan.[30] (See "Water Risk in a Hydrogen Driven Future.")

Part II: Resilient Solutions for a Sustainable Future

Next-Generation Water Management

People have traditionally used, valued, and governed freshwater as an inexhaustible commodity. To boost access to water through adoption of climate-resilient systems, we need a long-term systems-level approach that includes natural processes for groundwater and aquifer recharge. (See Exhibit 8.) This approach will not only sustain primary access to freshwater, but also provide secondary services to economies and people. For example, rivers are crucial to many ecosystems, delivering sediment that makes deltas highly productive for agriculture and fishing. Often, however, stakeholders do not understand, recognize, and value these benefits appropriately.

We propose six strategic shifts in water management for the public and private sectors. (See Exhibit 9.)

- Foster and accelerate technological and social innovations.
- Anchor corporate strategy and decisions to the water crisis.
- Expand nature-based solutions to manage and restore ecosystems.
- Enhance valuation, pricing, and water allocation.
- Improve water financing frameworks.
- Develop a local foundation of governance and regulatory enforcement.

28. J. Opperman et al.: "Using the WWF Water Risk Filter to Screen Existing and Projected Hydropower Projects for Climate and Biodiversity Risks" (2022).

29. https://www.cdp.net/en/research/global-reports/global-water-report-2020.

30. https://www.gov.za/sites/default/files/gcis_document/201911/national-water-and-sanitation-master-plandf.pdf.

Water Risk in a Hydrogen-Driven Future

Partly in an effort to lessen their contribution to climate change, many countries are working to reduce their reliance on fossil fuels for energy production. One promising path is green hydrogen, which involves having factories use renewable energy to convert purified water into hydrogen fuel. The downside of this approach is that it could stress local water supplies.

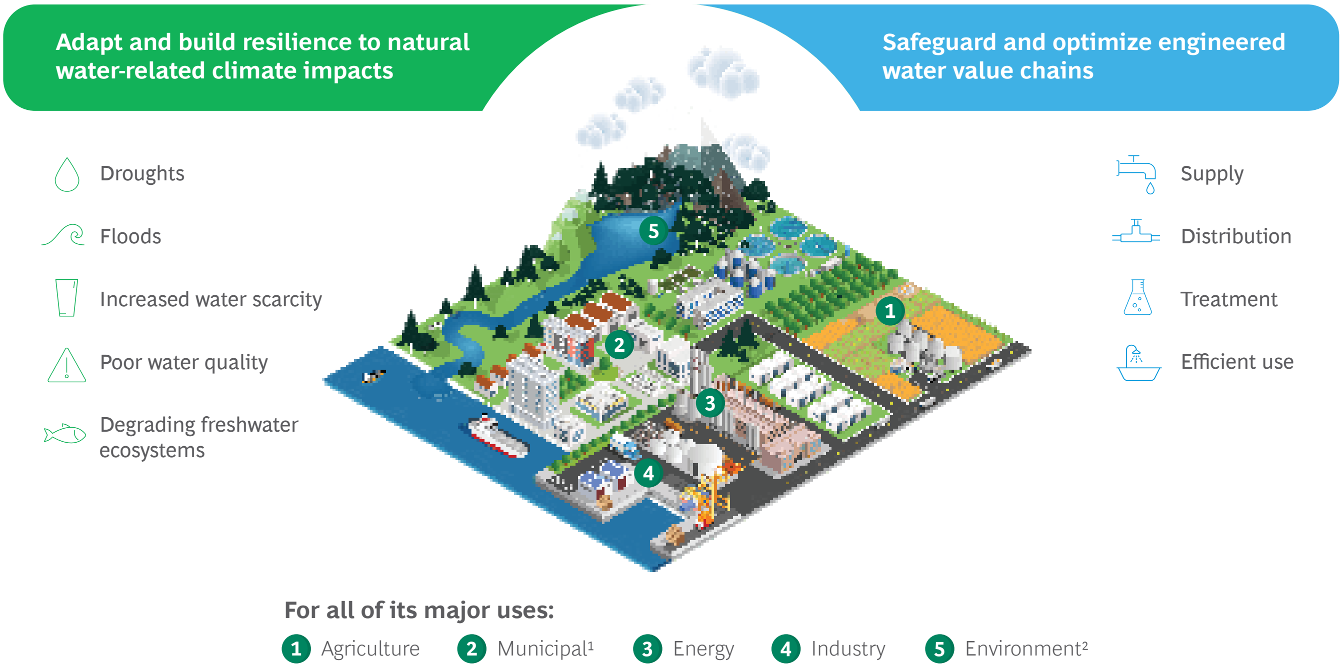
If the world were to transfer to a fully hydrogen-based economy, the additional freshwater consumed would amount to 2% to 3% of current withdrawals, or 10% of total industrial water usage.[1] Of course, the actual usage would vary by location. If Singapore relied entirely on locally made hydrogen for energy, it would use almost half of its available freshwater for that purpose, whereas the corresponding figure for Tajikistan would be only 1%. Typically, desert and island nations would have to draw the largest proportion of their local water supply to generate their own hydrogen fuel, so they would be more likely to import hydrogen instead. They would gain the bonus of a flow of clean freshwater, effectively imported from better-endowed regions—a beneficial water trade.

Green hydrogen's water footprint also depends on the source of energy used in its production. Solar and wind power have a minimal water footprint, while nuclear power requires eight times as much water as those sources.[2]

Abundant and inexpensive hydrogen could prompt the spread of desalinization plants, which are energy intensive and therefore too expensive for most countries. Hydrogen-powered desalinization could yield large quantities of freshwater. Although it is appealing for water-scarce regions, desalinization requires safeguards to avoid undesirable consequences such as those that can result from dumping high-saline water back into oceans.

1. https://www.weforum.org/agenda/2022/09/how-a-transition-to-a-hydrogen-economy-will-affect-water-security/.
2. https://itm-power-assets.s3.eu-west-2.amazonaws.com/Green_Hydrogen_Water_Use_56b96f577d.pdf.

Exhibit 8 - For a Water-Secure World, We Must Mitigate the Impacts of Water-Dependent Value Chains and Build Resilience to Water Hazards



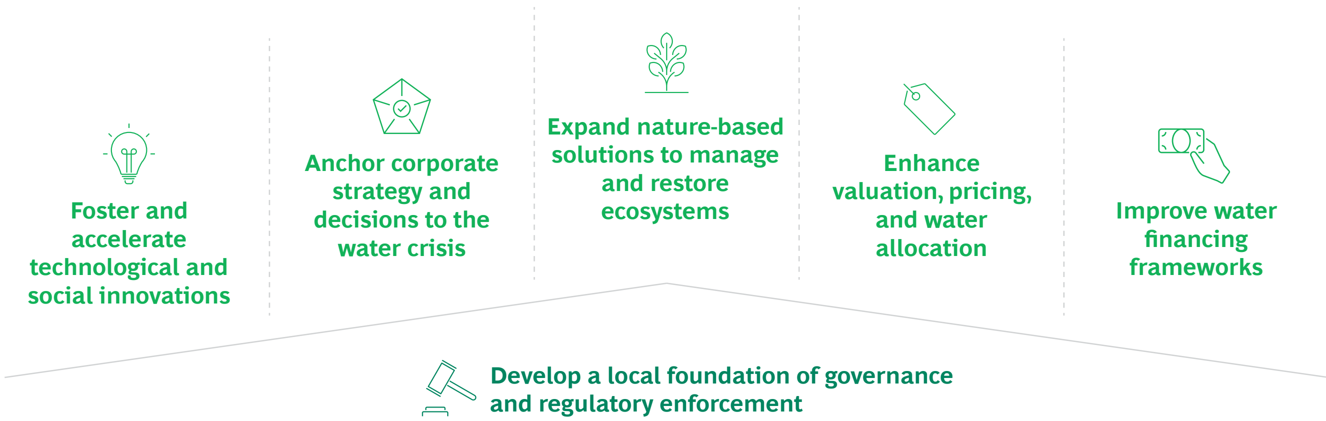
Source: BCG analysis.

Note: The following domains were not considered in this description: transboundary agreements on water, marine ecosystems, and the human right to water.

[1]Includes drinking water supply and provision of sanitation.

[2]Refers to environmental flows.

Exhibit 9 - Six Strategic Moves to Address the Water Crisis and Build Resilience



Source: BCG and WWF analysis.

Foster and Accelerate Technological and Social Innovations

Although technological gains garnered little attention at the recent UN Water Conference, they will provide the tools for a water-resilient future. They include improvements in collecting water, monitoring and forecasting flows, distributing water effectively, using water efficiently, lowering the cost of reusing water, and protecting against water-related hazards.

We've mapped these innovations along the water value chain in three buckets: digital innovation, infrastructure innovation, and other. (See Exhibit 10.) Our analysis identifies many promising developments. Some of these ideas will fail, but we expect that enough will succeed to accelerate gains in access and quality while reducing water-related hazards. The pressures of climate change make these improvements urgent, and they must come largely from the private sector—which makes the sector's meager representation at the UN Water Conference especially disappointing.

Exhibit 10 - Innovations Will Enable the Next Generation of Water Management

Non-exhaustive

Water sourcing → Water treatment and distribution → Water use → Wastewater collection and treatment → Disposal/reuse

Water resource management (Water sourcing; Water treatment and distribution)
- Water storage and **streamflow forecasting**
- Real-time **water quality** monitoring

Diversification of supply (Water sourcing)
- Cost-effective **desalination** operations
- Green and gray **storage capacities** and transmission
- Rainwater and graywater **collection** optimization
- **Harvesting water** from humid air

Infrastructure maintenance (Water treatment and distribution)
- Digital **leak detection** and monitoring
- **Infrastructure modeling** and simulation software

Optimization of efficiency (Water use)
- **Precision irrigation** and farming techniques

Smart water usage (Water use)
- **Connected meters** enabling insights on usage
- Residential and industrial **water saving** appliances

Resilient water systems (Water use)
- Real-time **monitoring and forecasting** of flooding
- Mobile **stormwater remediation** systems
- **Drought resistant seeds** to reduce water needs

Decentralized water access (Water use)
- Modular off-grid water **purification**
- **Point-of-use** filtration technology

Low consumption usage (Water use)
- Low **water-demand** agriculture
- **Waterless hygiene** products

Advanced water treatment (Wastewater collection and treatment)
- Cost-efficient (biological) **wastewater processing**
- **Micropollutant and biopollutant** filtration

Wastewater reuse (Disposal/reuse)
- **Wastewater reclamation** and re-use technology
- **Wastewater to energy** solutions

Market-based innovation
- **Market-based mechanisms** to enable trade of water
- **Bankable** water solutions
- **Blue bonds**

Sources: Expert interviews; company websites; StartUs, "Top 8 Water Management Trends & Innovations in 2023" (2023); Tracxn, "Water and Wastewater Management Tech" (2023); WEF Uplink, "UpLink at the UN Water Conference" (2023); RecyclingStartups, "Top 10 Water Saving Startups" (2023); BCG analysis.

In terms of social innovation, these initiatives make new technologies or collective action acceptable in the relevant cultural, economic, and political contexts. (See "Innovating Technologically and Socially.") In general, they prioritize improving society over generating return on capital. They come from startup enterprises, from teams within large organizations, and from collaborations across multiple bodies. (See Exhibit 11.)

Precision irrigation, for example, uses hardware (drip lines, sprinklers, timers, sensors, and satellites) and software (equipped with AI decision making) to apply water only where and when crops need it. Farmers and agricultural companies already have access to various digital tools to facilitate this approach. BCG's Center for Earth Intelligence (CEI) has extensive knowledge about how to maintain crop yields while minimizing the quantities of water and other inputs used.

For instance, to set suitable irrigation parameters, farmers must determine a crop's health with high granularity and accuracy. The CEI developed a tool to determine vegetation health down to areas of 3 square meters. From there, farmers can optimize their use of water and other inputs.

With water-efficient crop selection, farmers can move toward crops that better match future constraints. Crop shifting is especially appropriate for the Lower Colorado River Basin, which has a much greater diversity of crops grown, and where half of all agricultural water goes to feed cattle. By shifting from alfalfa to wheat and cotton, the region would save 300 million cubic meters of freshwater.[31]

Regenerative agriculture is an adaptive farming approach that applies proven, science-based practices to improve and maintain soil and crop health. Its goals include strengthening yield resilience, reducing carbon emissions, preserving water supplies, and enhancing biodiversity. A study in Germany suggested that scaling these practices would reduce water demands and nitrate pollution, with annual benefits totaling €500 million.[32]

Anchor Corporate Strategy and Decisions to the Water Crisis

Most corporations depend either directly or indirectly on water in their supply chain, leaving them vulnerable to risks today and increasingly so in the future. The water crisis can damage their bottom line and introduce reputational risk. To build resilient strategies for long-term growth, they must factor the water crisis into their decisions and investments. We offer a four-step approach. (See Exhibit 12.)

Exhibit 11 - Social Innovations Are Clustered Along Lines of Entrepreneurship, Intrapreneurship, and Extrapreneurship

	Approach to social change	Examples: South Africa
Social entrepreneurship The process of creating and growing a for-profit or nonprofit venture, where the entrepreneur's motivation is to address social challenges	Creates change by founding new organizations (to catalyze action)	**Clear Water**, a South African startup, is focusing on developing a closed-circuit system toilet to organically recycle toilet blackwater to render it suitable for use in flushing
Social intrapreneurship The process of addressing social challenges from inside established organizations	Creates change by leveraging the resources and capabilities of established organizations	**South African Breweries (SAB)**, a key water user in South Africa, is, tackling water scarcity challenges from within, working with communities on such projects as reducing alien plant species
Social extrapreneurship The process of interorganizational action that facilitates alternative combinations of ideas, people, places, and resources to address social challenges	Creates change through platforms that support collective effort within and between new and established organizations	**Strategic Water Partners Network,** a leader in South Africa in multi-stakeholder approaches to water resource management, offers the public and private sectors an engagement platform for shared learning and engagement

Sources: Paul Tracey and Neil Stott (2017) "Social innovation: A window on alternative ways of organizing and innovating," *Innovation* 19(1); company websites.

31. https://pacinst.org/wp-content/uploads/2013/05/pacinst-crb-ag.pdf.

32. https://www.bcg.com/publications/2023/regenerative-agriculture-benefits-germany-beyond.

Innovating Technologically and Socially

Parametric flood insurance and water-efficient sanitation are two examples of innovation that combine technological and social entrepreneurship.

Parametric Flood Insurance. This novel approach to insurance aims to reduce risks for home and business owners. Instead of reimbursing owners after documented losses, these policies give owners a fixed amount of cash that the insurer calculates on the basis of the overall severity of flooding in the area, using satellite data as well as local information. Because insurers have more information on weather patterns and better modeling, they can offer policies with payouts that avoid costly and contentious inspections. Owners get cash quickly so they can immediately rebuild or get on with their lives.

Because parametric flood insurance promises to lower premiums and boost access, it can change the industry. Most flood damage worldwide occurs on uninsured property. Both the economic activity onsite and the assets themselves are rarely covered—the rate of coverage is only 20% worldwide, and less in developing countries. Insurers have been reluctant to offer affordable policies in much of the world, but with parametric flood insurance's ability to predict likelihoods in specific areas, they can do more.

Insurers have long relied on flood prediction models, but these models tended to be thin on data and didn't account for aging water infrastructure or climate change. New technologies enable insurers to greatly improve their models.

Floodbase, for example, offers insurers a comprehensive data monitoring and modeling service.[1] Its real-time monitoring feature enables insurers to pay policyholders quickly in case of disaster. Besides supporting insurers and reinsurers, it works with governments and nongovernmental organizations, helping them move quickly with data-driven decisions.

In 2018, Floodbase provided insights for safely settling 11,000 refugees who had immigrated to the Republic of the Congo. It found that 7,000 of the refugees had settled in a high-risk area, so it recommended moving them to a safer spot. Ten months later, the old site was completely inundated in a flood.

Parametric flood insurance can also reduce upfront risk for business owners. In Latin America, farmers often take out loans to acquire seeds for seasonal products. By destroying their collateral, flooding can send farmers into bankruptcy because they can no longer obtain new loans. Floodbase has worked with lenders on a loan forgiveness program tied to flood risks.

Water-Efficient Sanitation. Popular household products that use lots of water, such as toilets, showers, and dishwashers, are not fit for purpose in water-stressed regions. For context, one-fourth of the domestic water consumption in the US goes to toilet flushing. Rapid development and deployment of water technology and social innovation is crucial in these regions to ensure that vulnerable populations have access to clean water and sanitation.

Take South Africa, one of the thirty driest nations in the world, where 11 million people (one-sixth of the population) lack access to good sanitation. Water-efficient or even waterless toilets exist, but inadequate financing makes them challenging to deploy at scale. A solution came from the national government's Water Research Commission. The agency developed the South African Sanitation Technology Enterprise Programme, bringing private companies, public agencies, and NGOs together to fast-track the adoption, commercialization, and industrialization of next-generation sanitation technologies. It is essential to pursue these steps locally because people often resist new sanitation equipment for cultural reasons.

Here are three examples of technological and social innovation for household water consumption:

- "Racing heart" is a low-maintenance, water-efficient toilet designed for tight spaces. The system can biodegrade the wastewater.
- "Clearwater" uses a closed-circuit system to organically recycle most of the blackwater (water with sewage) and make it suitable for flushing. Because it relies on solar panels for energy, the models can go anywhere off the electrical grid.
- "NEWgenerator" recycles 95% of blackwater. Because the toilets operate off the electrical and sewage grid, they can be fitted inside shipping containers, are easily installed, and generate nutrient fertilizer as well as graywater (nonpotable water cleared of sewage).

These and other improvements are enough to deliver dignified sanitation to everyone by 2030. The next step is to find the investment needed to produce them at scale, because most users can't afford the upfront cost at current prices.

1. Parametric (or index-based) solutions are a type of insurance that covers the probability of a predefined event happening instead of indemnifying actual loss incurred. It is an agreement to make a payment upon the occurrence of a triggering event, and as such is detached from an underlying physical asset or piece of infrastructure. For instance, an insurer would pay a certain amount for every millimeter of cumulative rainfall above a certain threshold in a specific area. (Swiss RE: "What is parametric insurance?" August 1, 2018.)

Exhibit 12 - A Four-Step Approach to Including Water Resilience in Strategy

Diagnose the baseline	Set ambitions	Create a plan	Implement pilots and scale up
• Quantify water footprint: including direct usage, usage throughout supply chain, and pollution • Identify risk hotspots: Determine specific regions/ locations within supply chain with high water risks • Define challenges and impacts: Use the Water Impact Matrix to identify location-specific impacts of water risk	Use three lenses to set ambitions and contextual science-based targets: • Reduce water footprint, focusing on the organization's own operations • Increase water resilience, reducing regulatory, physical, and reputational risks • Define water opportunities and contributions, such as technological innovations	• Align with overall strategy: Link water ambition to corporate and sustainability visions • Use fit-gap analysis and prioritization: Define new and existing actions, compare them to water ambition, and prioritize • Explore new water opportunities: Align them with water strategy, while managing water risks • Determine a roadmap: Define timelines and dependencies	• Define enablers: Determine critical enablers (tech, governance, monitoring) • Identify financing opportunities: Consider options such as blended finance • Explore partnerships and collective action: Find public/private partnerships, and join relevant action groups for coordinated initiatives • Explore the regulatory landscape: Take into account relevant subsidies and incentives

Sources: BCG and Quantis analysis.

Step 1: Diagnose the baseline. First, companies need to define and quantify their current water usage, dividing it into three components: direct (from sources owned or controlled); main indirect (all other usage in facilities); and other indirect (usage by suppliers or customers, which in many cases accounts for the bulk of total water usage). Second, since water is hyperlocal, executives must identify risk hotspots on the basis of where the facilities are located. Outside tools and data sources—such as WWF's Water Risk Filter and BCG's Water Risk Matrix—can be very helpful in this regard. Third, they must factor in the types of water challenges (flooding, scarcity, or poor quality) that are most likely to take place, and the ways in which these may affect the local economy, society, and environment.

Step 2: Set ambitions. From the baseline established in step 1, companies can identify contextual, science-based targets for water use. They can reduce their water usage and water pollution footprint, especially from direct sources, and increase their water resilience, usually through collaboration with suppliers (including shippers, as droughts and floods can impede transportation) and consumers. Besides taking into account the obvious physical and operational risks, they must consider reputational and regulatory risks, both of which are becoming increasingly important. But the water crisis also brings opportunities, so the goals need to factor in technological innovation and potential growth markets.

Step 3: Create a plan. Next, companies need to align their goals and targets with their overall strategy, especially on sustainability. They can integrate new targets into existing KPI frameworks. Then they should formulate initiatives to attain their water ambitions, assess gaps in them, and prioritize high-impact options and locations, both to reduce risks and to capture new opportunities. After that, they can align timelines and dependencies with running initiatives.

Step 4: Implement pilots and scale up. From there, companies should consider enlisting enablers to help achieve their goals—such as establishing a governance structure, monitoring for progress (aligned with frameworks such as the Taskforce on Nature-related Financial Disclosures), and building needed digital capabilities. Companies can leverage various funding opportunities within the public and private financing spaces to attain their ambitions. Partnerships and coordinated effort are essential here, so companies should explore collective action and existing public/private sector efforts before undertaking initiatives on their own. Finally, given how rapidly the regulatory landscape is changing, companies will benefit from scanning the relevant subsidies and regulations.

Expand Nature-Based Solutions to Manage and Restore Ecosystems

A sustainable water plan will likely include green infrastructure, including nature-based solutions (NbS), which use natural components (such as trees, wetlands, coastal mangroves, bioswales, and urban rooftop gardens) to protect, sustainably manage, and restore natural or modified ecosystems in order to address local challenges. The goal is to promote both human well-being and biodiversity. NbS complement the "gray infrastructure" that dominates most water systems, in which communities rely on concrete and other artificial engineering to collect and distribute water, often without considering systemic and long-term impacts. We need both types of investments if we are to meet SDG6 and improve climate resilience.

NbS can help build resilient river basins to address multiple water challenges: inland flooding (overall risk as well as stormwater and urban floods), coastal protection, droughts, and degraded water quality. NbS can moderate economic and social exposure to changing rainfall patterns and flooding by buffering river flows and boosting groundwater storage. In South Africa, for example, communities and businesses have used NbS to manage forests and limit development in order to protect plains and wetlands that hold floodwaters.[33]

As temperatures rise and microclimates shift, many forests are capturing less carbon than they once did, due to reduced groundwater. The severe 2022 drought in Europe caused an additional 200 megatons of CO_2 to enter the atmosphere, accounting for 5% of total EU emissions. Using NbS to increase the store of groundwater can therefore enlarge much-needed carbon sinks.[34]

Exhibit 13 categorizes seven types of NbS: catchment and river basin management, wetland restoration and protection, reconnection of floodplains, sustainable restoration and management of forests, expansion of riparian buffer zones, development of "sponge cities," and cultivation of coastal mangroves.

In promoting NbS, every organization has a role to play:

- **For-Profit Companies.** Besides working to develop water-resilient plans and disclose water-related impacts, companies can invest in relevant technologies, as outlined in Exhibit 10.
- **Financial Institutions.** In discussions with clients and investees, investors can integrate consideration of water-related risks and opportunities in their stewardship strategies. They can encourage disclosure of key water-related metrics, screen portfolios for water-related risks and opportunities, and establish investment funds that focus on promoting NbS. Banks can develop financial products that reward investment in NbS.
- **Nongovernmental Organizations.** NGOs can advise groups on the manifold values of water, identify and encourage local technology and social innovation, identify potential public-private partnerships to increase revenue streams for NbS, and help de-risk projects in consultation with stakeholders.
- **Public Sector.** Governments can accord greater value to water, enable investments with public-private partnerships, encourage adaptive (not just conventional gray) infrastructure, and offer blended financing. They should also consider NbS in public procurement processes.

With these actions, and combining green and gray forms of infrastructure, regions can develop greater resilience in responding to the water crisis.

Enhance Valuation, Pricing, and Water Allocation

Water is simultaneously the most precious resource on Earth and the most undervalued one. Pricing water is difficult because it entails a precarious balancing act: prices need to be low enough to ensure access for low-income, vulnerable communities, but high enough to minimize profligate use and inadvertent freshwater contamination.[35]

Real-world pricing of water is complex, but it rarely covers the full spectrum of values and costs involved. To balance social, economic, and environmental needs, governments often subsidize water, pricing it below its marginal cost. Large commercial water users in agriculture and industry often pay almost nothing for water while consumers pay much more—and yet consumers still pay less than the actual cost.

33. https://www.dffe.gov.za/projectsprogrammes/wfw.

34. https://www.nrc.nl/nieuws/2023/04/27/veel-bossen-trekken-het-s-zomers-niet-meer-dan-nemen-ze-geen-co2-meer-op-a4163062.

35. https://www.wearewater.org/en/what-is-the-value-of-water-and-its-price_349991; http://d2ouvy59p0dg6k.cloudfront.net/downloads/the_value_of_water_discussion_draft_final_august_2015.pdf.

Exhibit 13 - Nature-Based Solutions for Water Resilience

Societal problem addressed: Coastal protection	Inland flooding	Water scarcity	Poor water quality	Type of nature-based solution	Examples
	✓	✓	✓	**Catchment and river basin management** Improving the free-flowing capacity of a river, including managing sediments and sand flows, while preserving critical aquatic wildlife habitat	• Vietnam: Mekong River
		✓	✓	**Wetland and peatland restoration and protection** Protecting wetlands, which restore water quality by reducing runoff of pollutants (e.g., nitrates)—for instance, near agricultural areas	• Peru: Datem del Marañón • UK: Ingoldisthorpe • Turkey: Büyük Menderes
	✓			**Reconnection of floodplains** Enlarging floodplains by moving dikes back, giving rivers more room to flow, reducing pressure on dikes, and providing wildlife habitat	• Netherlands: Room for the River
		✓	✓	**Sustainable restoration and management of forests** Removing invasive alien plant species and enabling forests to naturally regulate flows of water, filter water, and supply downstream water	• Kenya: Mau Forest Complex • Indonesia: Central Kalimantan • South Africa: Working for Water
	✓		✓	**Expansion of riparian buffer zones** Establishing a vegetated buffer area near streams and rivers to help protect the stream from land use, enhance water quality, and reduce flooding	
	✓	✓		**Development of "sponge cities"** Absorbing water naturally, by channeling away rainwater through terraces, wetlands, green roofs, and permeable pavements	• China: Yanweizhou Park • Rwanda: Kigali
✓				**Cultivation of coastal mangroves** Restoring, sustaining, and expanding coastal mangrove forest to improve coastal protection against flooding related to sea-level rise	• Jamaica: Coastal defense • Kenya: Coastal protection

Sources: WWF, "Waterways to Resilience" (2021); WWF, "Bankable Nature Solutions" (2020); BCG and WWF analysis.

There is no one-size-fits-all model for water pricing. Decision makers must consider efficiency and equity in the local context.[36] Water is critical for agriculture and other economic sectors, and low prices can stimulate economic investment. Yet keeping prices lower for companies than for consumers may not be socially responsible. To address questions of equity and efficiency, policymakers might develop variable pricing according to type of user and volume of use. This form of variable pricing with metering can increase revenue and expand the public water network for consumers.

Governments must also encourage conservation. Water is not a simple commodity, and aquatic ecosystems are not mere conduits for storing and moving water; both have multiple economic, societal, and ecological values.[37] Pricing must take into account such nonmarket values as climate regulation, ecosystem functionality, and cultural services. For example, rivers reduce flood risks, sustain freshwater fisheries, and deliver sediment.

36. https://academic.oup.com/oxrep/article/36/1/86/5696684.

37. http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf.

Effectively managing water use requires strong, impartial, and collaborative local governance

These types of service deserve maximum protection. Policymakers should consider future water use and a changing climate. Since water use today can deplete aquifers and limit water availability for future use, policymakers need to plan responsibly for long-term provisioning of water. In doing so, they must use models that incorporate forecasted droughts and changing precipitation due to climate change, rather than rely on outdated historical patterns. By combining continual monitoring of flows and demand with agile policies, they can develop effective incentives to preserve and increase supplies for use in times of scarcity.

Somehow, water prices must cover the costs of water to keep the system from degrading over time, without denying vulnerable communities access to the resource. A number of approaches to variable pricing are possible. (See Exhibit 14.) Three are popular:

- **Variable Tariffs.** Uniform tariffs require all users to pay the same rate across sectors and locations, while variable tariffs differentiate. The latter adds a burden to administration, but it also enables communities to set incentives for water-scarce regions or specific users.

- **Tiered Pricing Based on Volume Used.** A flat price charges the same rate regardless of the volume of water used. In contrast, tiered pricing encourages conservation by charging a higher rate for larger-volume usage. The latter approach requires additional capital expenses to install meters.

- **Combination.** Many communities use both tiered pricing and a variable tariff, in one of two ways. Either everyone pays a standard yearly fixed usage fee, combined with a volume charge, or everyone pays a tiered volume charge that is cheap at low usage but climbs substantially as consumption rises. The goal in this case is to give companies and households a low basic rate, to ensure access, while discouraging heavy use.

In setting prices, policymakers must take into account all stakeholders—not just paying customers, but also indigenous peoples and communities that rely on ecosystem services, from fishing communities to residents of flood-prone areas. Different institutions inevitably have conflicting goals. Water utilities seek a return on investment, for instance, while policymakers seek reelection. But the fundamental balancing act is between providing water as a human right and encouraging efficiency and conservation.

Exhibit 14 - Water Pricing Options

	Uniform	Variable
Tiered	• Medium transactional costs • Incentivizes reduced water usage • No differentiation between user types	*Mostly developed economies* • Highest transactional costs • Incentivizes reduced water usage • Differentiates between user types
Flat	*Mostly emerging economies* • Lowest transactional costs • Does not incentivize reduced water usage • No differentiation between user types	• Low transactional costs • Does not incentivize reduced water usage • Differentiates between user types

Sources: Grafton, Chu, and Wyrwoll, "The paradox of water pricing: dichotomies, dilemmas, and decisions," *Oxford Review of Economic Policy* (2020); BCG analysis.

Besides adopting variable pricing, policymakers can promote the use of market-based mechanisms to share water. (See Exhibit 15.) Well-regulated markets can help solve the water allocation puzzle efficiently, while safeguarding social and ecological uses of water. By increasing supplies to higher-paying users, utilities can use the enlarged revenue stream to invest in supplies and infrastructure that lower prices for everyone else. The goal is to establish ways for users to trade allocated water permanently or temporarily.[38]

Dozens of countries in water-scarce regions have begun to establish these markets. First, governments issue water rights, and then they permit reallocation of these rights through trade.[39] Sensible government policies can ensure that urban and high-value agricultural users that pay top-dollar don't squeeze environmental and equity interests and undermine water resilience. Left unchecked, water markets could descend into time/space water arbitrage, and thus into speculating on water—a practice that many Western countries view as unethical.

In establishing these markets, policymakers must consider the specific water-related problem or problems within the region. Deciding whether to encourage long- or short-term trades depends on whether water scarcity is chronic or episodic. Should the markets be open to everyone from farmers to municipalities, or should it be limited to, say, farmers only? Is the main goal to reallocate water efficiently, or is it to decrease demand for water and encourage new supplies?

Today, three main barriers limit market-based mechanisms: high transaction costs due to limited data on assets and pricing; equity concerns in situations where maximizing revenue squeezes environmental or social goals; and inadequate monitoring of availability and consumption (especially in developing countries). Policymakers must overcome these barriers before encouraging widespread adoption of market-based mechanisms. Better data collection and information sharing platforms can help, but governance and political concerns must be addressed as well.[40]

Exhibit 15 - Market-Based Mechanisms to Address Water Scarcity

	Temporary solutions to solve episodic scarcity	Permanent solutions to solve chronic scarcity
Increase supply	Groundwater banking to store water for later use	Forest thinning to restore health and increase water supply
	Off-stream storage ponds and tanks to align supply and demand	
Decrease demand	Rotational fallowing of agricultural land for compensation	Groundwater cap and trade to allocate rights and allow purchases
	Inclining block rate pricing to incentivize water conservation	Pump tax to increase cost of pumping and encourage reduction
		Irrigation efficiency to fund irrigation upgrades to secure water
		All-in auction to permit bidding for water rights and compensation for rights
		Groundwater mitigation to offset impacts of new pumping
Redistribute supply	Leasing of existing land or water rights	Permanent acquisition of existing land or water rights
		Water neutrality, offsetting (corporate) water use

Sources: The Nature Conservancy, "Market-based mechanisms for securing environmental water in California" (2017); Richter et al., "Water scarcity and fish imperilment driven by beef production," *Nature Sustainability* (2020); The Nature Conservancy, "Water share: Using water markets and impact investment to drive sustainability" (2016).

38. https://www.scienceforconservation.org/assets/downloads/Market-Based_Mechanisms_for_Env_Water_TNC_2017.pdf.
39. https://www.nature.org/content/dam/tnc/nature/en/documents/WaterShareReport.pdf.
40. https://iopscience.iop.org/article/10.1088/1748-9326/acb227/pdf.

Improve Water Financing Frameworks

In the private sector, business as usual creates an underestimated portfolio risk for investors and an underestimated operational risk for economies—all the more so with the advent of climate change. As the investment bank Jefferies noted, "The greatest number of corporate product-making activities depend on surface water, in addition to other water-related ecosystem services." Freshwater access is "irreplaceable."[41]

In a recent open letter, major investors urged governments to "commit to ambitious, domestic short-term water targets" and to implement "mandatory water disclosure requirements."[42] Very few companies currently disclose their water-related risks. Only about half offer any water-related data through CDP, though that represents a 16% increase from 2021, suggesting increased corporate interest in water-related risks.[43] The CDP says that the EU and the UK are the only two G20 members that have proposed comprehensive water disclosure regimes.[44]

Several investment funds target water projects, but many funds lack the data necessary to track improvements in availability, quality, and efficiency. As one journalist pointed out, "From a sustainable point of view, it remains dubious whether many water funds really address the UN goal of clean water and sanitation for all. At best, they are tamely addressing it for the developed world, by buying utilities with stable returns."[45]

After responding to the immediate risks that business as usual poses to water supplies, communities must adapt to future climate change. More than half of the $330 billion in projected 2030 adaptation financing is water-related.[46] That adds up to $200 billion, driven by the agriculture and disaster management sectors. Yet we currently see only $46 billion in climate adaptation finance flows.[47]

How can we fill the gap? To increase water-related investments, banks, companies, and investors must incorporate water into investment decisions. We propose that companies and governments take the following actions:

- Improve the transparency and quality of reporting for water-related risks and opportunities. Financial institutions can learn from carbon emissions reporting, which took years to develop.

- Set up a strong disclosure framework on the basis of common taxonomies and reporting mandates. Models include the EU Corporate Sustainability Reporting Directive (CSRD)/EU Taxonomy, Science Based Targets for Nature (SBTN), and the Taskforce on Nature-related Financial Disclosures (TNFD).

- Trace water-related financing needs, flows, and outcomes, and intervene structurally as needed with tax incentives, subsidies, and other tools. Investors should disclose the results of their efforts so that others can assess remaining gaps and engage with companies on pressing water-related topics. To map risks granularly at the company level, they can draw on tools and capabilities such as the WWF Water Risk Filter, the WRI Aqueduct, and Climate Central.

As banks, companies, and investment funds set objectives and refine their selection criteria, they can help conserve freshwater, reduce dirty water discharge, increase access to potable water, maximize water efficiency, and minimize the impacts of floods. They can go beyond traditional boundaries by collaborating with social investors and development banks to de-risk investments. Such action is especially important in developing countries, where macroeconomic, political, and project-specific pressures increase investment risk, but where investment is even more critical than in the developed world. Blended or social financing can reduce the initial risk on these investments.

41. Environmental science: Water is 'most critical' natural capital factor for investors (February 9, 2023).
42. https://cdn.cdp.net/cdp-production/comfy/cms/files/files/000/007/160/original/Water_Investor_Letter_March_23.pdf.
43. https://cdn.cdp.net/cdp-production/cms/reports/documents/000/006/925/original/CDP_Water_Global_Report_2022_Web.pdf?1679328280.
44. https://cdn.cdp.net/cdp-production/comfy/cms/files/files/000/007/716/original/Water_Infographic_2023.pdf.
45. FT: "Water funds dilute the environmental message" (February 17, 2023).
46. https://www.rockefellerfoundation.org/wp-content/uploads/2022/11/Climate-Finance-Funding-Flows-and-Opportunities-What-Gets-Measured-Gets-Financed-Report-Final.pdf.
47. https://unfccc.int/sites/default/files/resource/cp2022_08_add1_cma2022_07_add.1.pdf.

Develop a Local Foundation of Governance and Regulatory Enforcement

Strong, impartial, and collaborative local governance is essential to managing the potentially conflicting interests of the many water users in a basin, often across jurisdictions. Upstream activities can greatly affect downstream supplies and quality, so collective action, agreements, and partnerships are crucial. The goal is to achieve both equity and efficiency.

So far, governance has fallen short in several ways. It is often lacking in transparency and enabling legislation, and it is vulnerable to corruption. Many existing arrangements have excluded numerous stakeholders—notably women and indigenous groups—from the decision-making process. Many municipalities and water agencies lack the expertise and budget to oversee water systems effectively. Without full participation and information, governance won't possess the legitimacy and capacity to enforce its decisions.

To strengthen local and regional governance in regions with high water risk, collective action is critical. Only from a starting point of broad-based legitimacy can governments successfully oversee local resources at the catchment or basin level. Collaborative, inclusive governance bodies should include previously excluded stakeholders, especially members of small communities and those who depend on the ecosystem as a whole. Industry-wide and cross-industry water initiatives such as the Sustainable Apparel Coalition, the Beverage Industry Environmental Roundtable, the International Council on Mining & Metals, and the Strategic Water Partnership Network provide ready platforms to amplify efforts.

To get started, municipalities and other local governmental organizations need to identify existing resources, risks, opportunities, and stakeholders that are specific to their basin, determine the required capabilities, and start developing them. Local governments typically need technical expertise to manage and support on-the-ground projects and to ensure regular maintenance after a project begins operating. Governments should also invest in capabilities for next-generation water management, including the following:

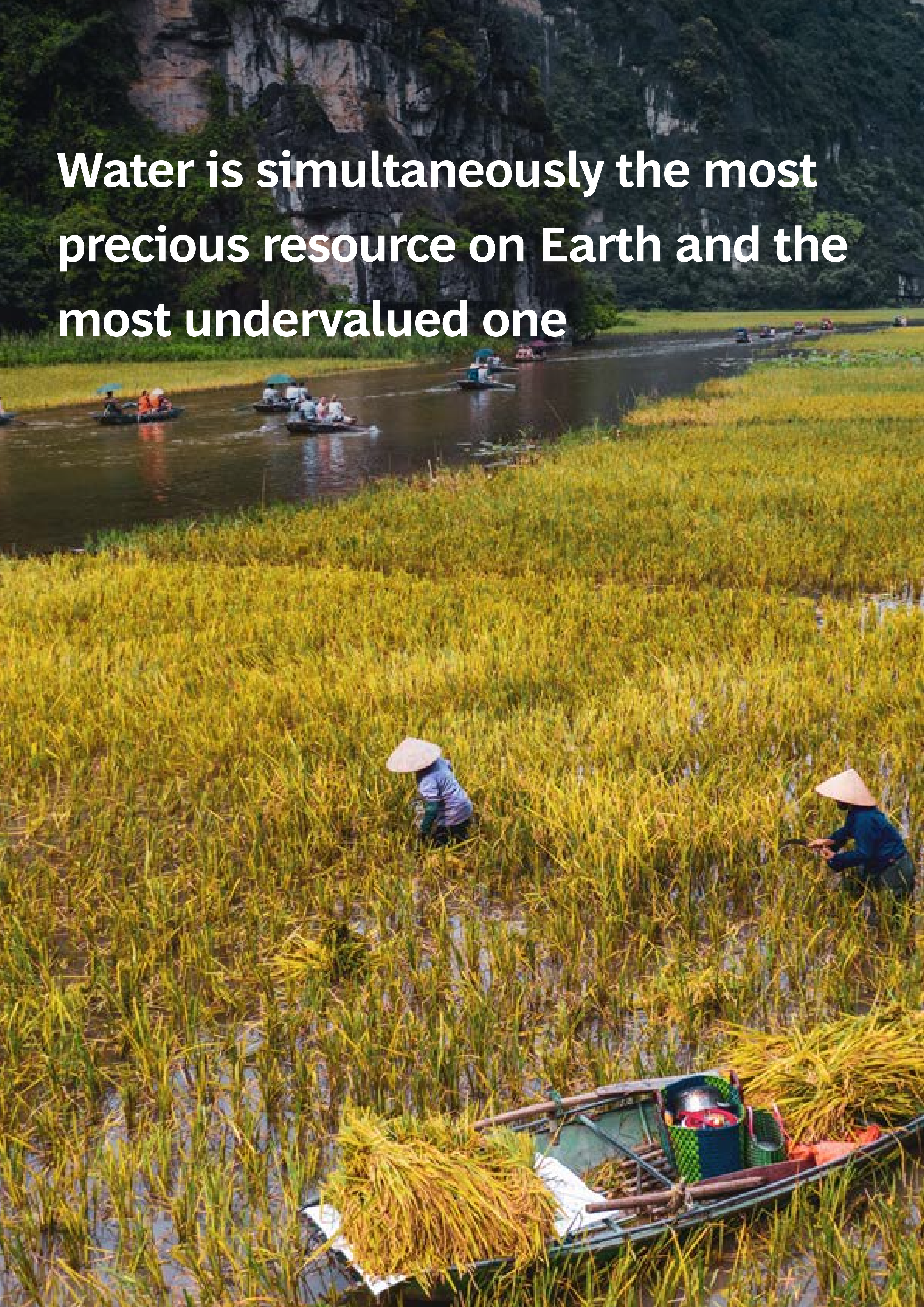
- Granular flood and drought risk modeling
- Potential subsidies for NbS mapping and integration into public procurement processes
- Digital platforms for monitoring leaks in existing infrastructure

With better monitoring and data, decision makers can move toward evidence-based water management, rather than simply favoring the loudest or best-connected interest groups. That includes evaluating current resources in accordance with criteria such as "blue drop" (quantity per natural streamflow of water) and "green drop" (quality from wastewater processing).

The global water crisis has crept up gradually, as people around the world built economies and societies that took access to freshwater for granted. With thoughtful, informed investments and policy shifts that encourage building in—rather than building over—natural ecosystem services, we can better prepare ourselves for expected water constraints in much of the world.

Above all, we need to work collaboratively to address the complexity of the water crisis. Governments, financial institutions, nonprofit organizations, and corporations must work together in supportive, inclusive conditions to build resilient water systems that deliver on water as a human right, facilitate economic growth, and overcome the challenges of climate change.

Water is simultaneously the most precious resource on Earth and the most undervalued one



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