The Economist INTELLIGENCE UNIT

PUBLIC POLICY

Under pressure

The economic costs of water stress and mismanagement

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About this report

This report summarises the key findings of a research programme developed by the Economist Intelligence Unit (EIU) with support from the Swiss Agency for Development and Cooperation (SDC) and FONPLATA-Development Bank. The findings are informed by the research conducted for the Blue Peace Index programme, an extensive literature review, a comprehensive data audit, and expert interviews conducted by the EIU between October 2020 and March 2021. The findings and views expressed do not necessarily reflect the views of the partners and experts.

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Executive summary

Fresh water is essential for human health, the global economy and broader societal wellbeing. Not only do we use it for drinking and hygiene, but we also consume it indirectly via the food we eat, the clothes we wear, and the products we buy. Yet the world has failed to manage its freshwater resources sustainably. Over the past century, available freshwater resources have been increasingly strained as withdrawal rates have risen almost sixfold, outpacing global population growth.[1]

Global demand for water is expected to grow further, by around 1% per year until 2050, driven by continued population growth, rising living standards, and the effects of climate change.[2] Demand of this magnitude will result in a sharp increase in the proportion of the world's population – and the share of the global economy – that is subject to water scarcity.

Moreover, the water crisis extends to water excess, as well as shortage. Just as the proportion of the global population and economy affected by scarcity is set to rise, so too is the share of those affected by regular flooding and rising sea levels.[3]

Water shortage and excess are already drivers of the most damaging natural disasters. One estimate indicates that nearly 75% of all natural disasters between 2001 and 2018 were water-related, and that during the past 20 years floods and droughts affected over 3bn people and caused total economic damage of almost US$700bn.[4]

In addition to water shortages and water excess, deterioration in water quality also generates additional costs for governments, businesses and communities, through detrimental impacts on the quality of soil, fisheries, and human health. This has a transboundary element too, as a World Bank study estimated that pollution of rivers in upstream regions can reduce GDP growth in downstream regions by between 1.4% and 2%.[5]

Policymakers and businesses are aware of the seriousness of water-related risks, but tend to focus on responding to consequences and immediate threats, such as natural disasters and displacement, rather than the underlying drivers. Yet the costs of water stress for communities and businesses are very real.

- Agriculture is by far the biggest consumer of water, accounting for up to 90% of total consumption in certain countries, and is thus inherently exposed to water stress or a permanent decline in water availability.[6] Agricultural production is essential for providing food to people around the world, but is also a major source of income and employment, particularly in emerging economies.
- The industrial sector, which accounts for a major share of water consumption in many developed markets, uses water as a direct input into products and for a host of processes. Most industries, particularly energy, food and drink, chemicals, and textiles and apparel use water as a major product input, or for industrial processes such as heating and cooling, transport, cleaning, product use and servicing, and energy supply.[7] For all businesses, securing access to safe water, sanitation and hygiene at the workplace is essential for employees' wellbeing and productivity.[8]
- Similarly, lack of access to safe water at home can have devastating consequences for people's health, productivity and labour participation.[9] This is even before accounting for the impact that the resulting healthcare costs, and the loss of life, dignity and prosperity have on the realisation of fundamental human rights.[10]
- Finally, the importance of water systems goes beyond the essential direct use for domestic purposes and economic activities. Water ecosystems, including watersheds and wetlands, provide a range of services that are essential for human life and wellbeing, including crop pollination, water purification and regulation, flood protection, erosion control, and carbon sequestration.[11]

Despite the complex nature of water systems, which sometimes present inherent trade-offs between the vital interests of individual stakeholders, there are clear steps that governments, companies and households alike can take to reduce the economic cost of water stress and mismanagement in the decades to come. Governments and policymakers need to move sustainable water management, including at basin and transboundary level, to the top of their agenda. Businesses and investors should improve their accounting and assessment of the impact and risk that their water footprint has on their bottom line. Finally, communities need to consider the value of water more holistically, and appreciate their direct and indirect water footprint.

1. Introduction

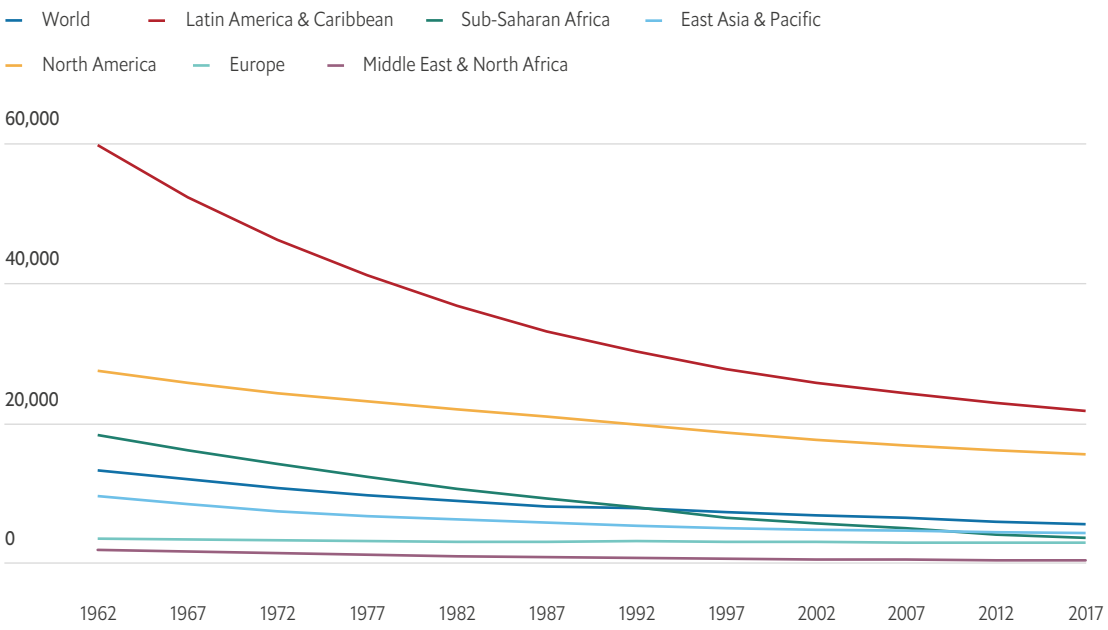
Water is paradoxical. While some are surrounded by it – often inundated with too much of it – hundreds of millions of people have so little of it that their livelihoods are threatened. Around 70% of the surface of the earth is covered by water, but the fresh water that people can drink is just a tiny fraction of the total – as little as 2.5%. And of this proportion, more than half is trapped in polar ice, glaciers and permafrost, which means that humankind survives on less than 1% of the planet's total reserves. Not all of this 1% is easily accessible, as much of it is in deep underground aquifers, meaning that only a very small proportion is directly accessible on the surface through lakes and rivers.[12]

Fresh water is being constantly reused through the water cycle. However, the growing global population (and its thirst for water) is fundamentally interfering with this natural cycle. By building dams and diverting rivers, releasing pollutants into the air and water, and chopping down vast tracts of rainforest, we are changing the way that water is distributed. We now live against a permanent background of water-related disasters, from disappearing lakes in Central Asia to submerging islands in the Pacific. In an increasing number of locations around the world, rainfall is either too little or too great, or insufficiently reliable. In the coming years, a city will in all likelihood run out of water. Another will suffer a flood so catastrophic that it is abandoned.

Our day-to-day use of water is inefficient. Thirsty crops are grown in arid regions. The manufacturing of clothing, a hugely water-intensive activity, is performed in low-wage countries, rather than those with abundant water. These inefficiencies inflate production costs and speed up environmental degradation. Meanwhile, consumers all around the world consider the constant availability of water a free public good, which makes it harder to limit its use and to charge an appropriate price for it. While economic considerations are at the heart of these decisions, as the backbone of life, there is a need to restore water's value at the centre of our economies and societies.

Our best hope in reducing the environmental impact of our need for water is to improve our knowledge of our own water consumption – not just in terms of what comes out of our taps, but also of the volumes used throughout the entire supply and value chains of the production of the goods and services that we buy – and to reduce the mismanagement of water further upstream. Total freshwater use increased approximately sixfold during the 20th century, outpacing global population growth.[13] However, encouragingly, over the past 20 years the increase in overall water use has slowed down, reflecting both a decline in the rate of global population growth and the impact of agricultural and industry policies to reduce the rampant growth in water consumption. Indeed, on a per-head basis, water consumption has actually fallen over the past 50 years, from a peak of just over 700 litres per person at the end of the 1970s to around 550 litres per person by 2010.[14] Nevertheless, because new fresh water cannot be created in any meaningful quantity, the amount available per head keeps falling as the global population rises.

Dwindling fast
Renewable internal freshwater resources per capita (m³)



Source: FAO

We use water in all aspects of our lives, but we can divide that usage into three major sectors. Globally, agriculture is responsible for around 70% of our total consumption, with industry next at 20%, and domestic use at 10%. There are major regional variations in these proportions, which largely reflect the level of economic development. In Asia and Africa, for example, 80% of water use is accounted for by the agricultural sector. In Europe and North America, the largest share is consumed by industry.

In this report we will outline the economic costs of water stress and mismanagement of our freshwater supplies.* We will consider the role that we expect climate change to play in disrupting existing trends, and use several case studies to look in greater detail at how governments and jurisdictions have sought to manage freshwater supplies in stressed rivers and basins. Finally, we highlight certain areas where action is urgently needed to improve our water usage and management in order to reduce the risk of further environmental degradation and resulting socioeconomic damage.

* In this report, we approach "water stress" as a broad concept covering water availability (including excess and variability), accessibility, and quality.

2. Water stress today

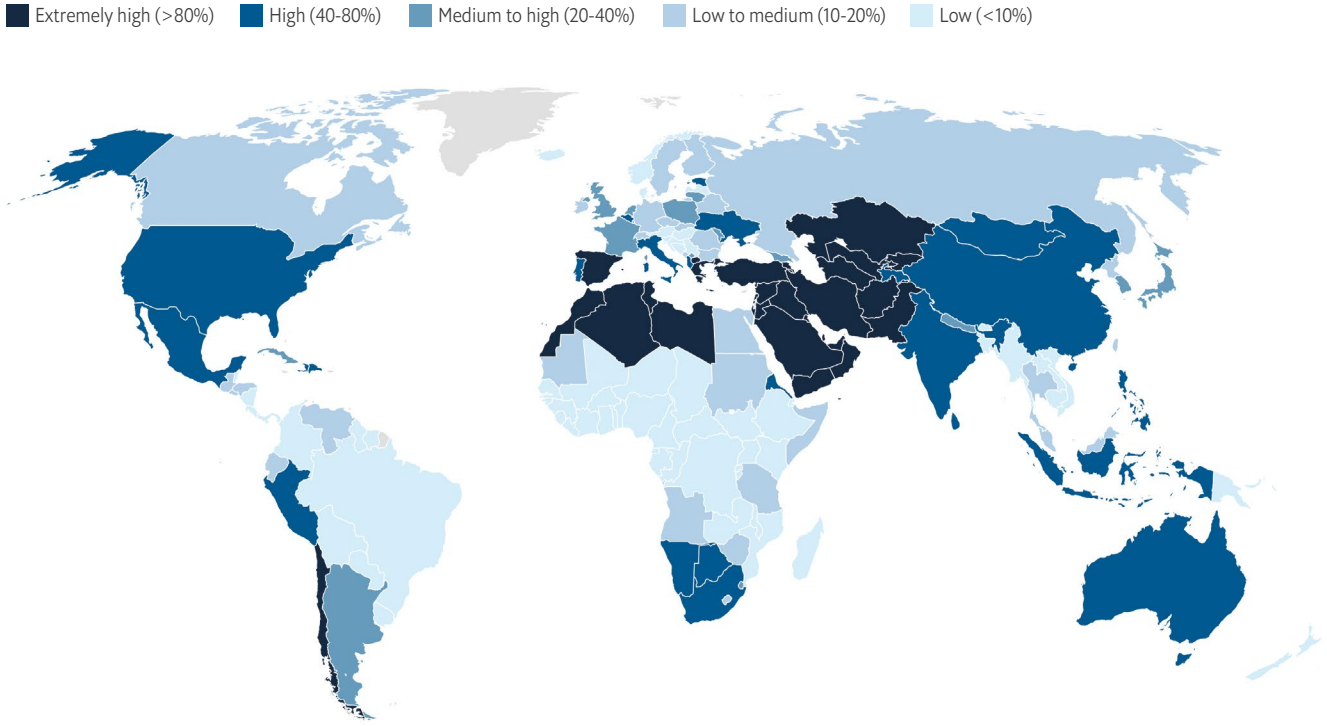
Global demand for water is expected to grow by around 1% per year until 2050, driven by continued population growth, rising living standards, and the various expected effects of climate change.[15] Demand of this magnitude will result in a sharp increase in the proportion of the world's population – and the share of the global economy – that is subject to water stress.

A study by the International Food Policy Research Institute (IFPRI) estimated that 36% of the world's population was subject to water scarcity a decade ago, and that this group was responsible for generating 22% of global economic output.[16]

By 2050, under a business-as-usual scenario, where countries make moderate improvements in reducing water waste and enhancing productivity, and where the energy mix moves slightly towards renewables, these proportions would rise to 52% of the world population and 45% of global GDP.[17]

Policymakers are aware of the problem. The water crisis, defined as "a significant decline in the available quality and quantity of fresh water, resulting in harmful effects on human health and/or economic activity", has been cited by respondents for years as one of the biggest risks facing the world.[18]

Stressing out
Water stress by country (Ratio of water withdrawals to water supply, 2040 forecast)



Note: Projections are based on a business-as-usual scenario
Source: World Resources Institute (WRI)

Nevertheless, it scores higher on potential impact than likelihood in the World Economic Forum's Global Risk Perception surveys.[19] Policymakers are aware of the seriousness of water scarcity, but are often focused on more immediate threats, such as extreme weather, natural disasters, and involuntary migration. The water crisis, often the underlying driver of these events, is evolving more slowly, which increases the risk that inaction will cause greater harm in the longer term.

Moreover, the water crisis extends to water excess, as well as shortage. Just as modelling by the IFPRI has suggested that the proportion of the global population and economy affected by scarcity is set to rise, so too is the share of those affected by rising sea levels and regular flooding. One study found that the proportion of people who will be subject to much higher fluvial flood risk is likely to double in many populous countries in the period to the mid-2040s, including China, India, Pakistan, Indonesia, the US, and many sub-Saharan African countries.[20] One estimate indicates that nearly 75% of all natural disasters between 2001 and 2018 were water-related, and during the past 20 years floods and droughts affected over 3bn people, and caused total economic damage of almost US$700bn.[21]

Meanwhile, other research suggests that the proportion of current land area inundated by rising sea levels by 2050 could be three times greater than previously thought, resulting in the number of people living below the tide line rising from 110m at present to 150m by the middle of the century.[22] Living below the tide line is possible and can be secured through the erection of sea walls, barriers and other forms of defence. However, such systems will need to be reinforced as sea levels continue to rise, at greater cost. Failure of levees and walls would also become

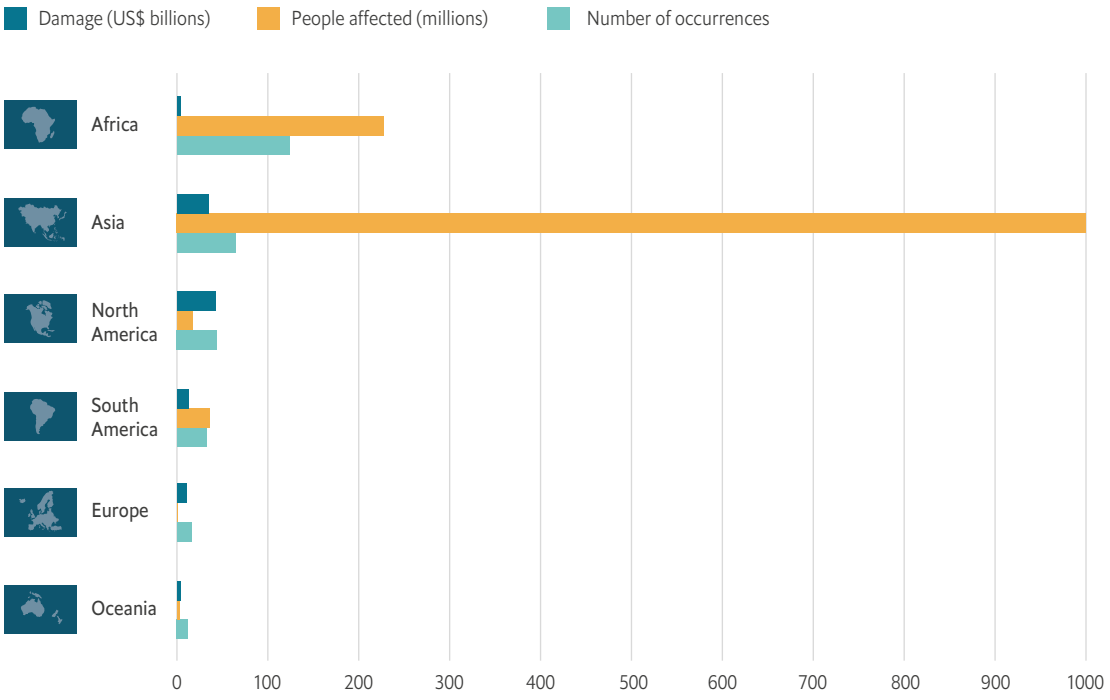
more commonplace and catastrophic, claiming more human lives and causing more damages. As Benjamin Strauss, Chief Executive of Climate Central asked the New York Times, "How deep a bowl do we want to live in?"[23]

Climate change is undoubtedly a key factor exacerbating global water stress today, and is expected to remain so for many years to come. It is important to note, though, that while climate change itself is a global phenomenon, its impacts on water availability are unevenly distributed across basins and regions due to their varying geographical, social and economic conditions. Even within transboundary basins, the impacts vary between upstream and downstream countries. In Central Asia, for example, higher surface temperatures are expected to lead to higher precipitation levels in the north of the region and lower levels in the south, along with more frequent episodes of extreme heat and greater aridity. At the same time, hotter temperatures will lead to the accelerated melting of glaciers, resulting in faster streamflows, in turn raising the risk of flooding in downstream countries in the short term. However, in the longer term, all countries in the region are expected to face a future with less water.[24]

2.1 Water scarcity

The primary climate-related cause of episodes of water stress is drought.[25] Droughts occur naturally and have been recorded regularly, if at unpredictable intervals, throughout human history due to fluctuations in weather patterns. Scientists suspect that climate change is triggering more frequent and more severe droughts, but the multitude of contributory factors to a drought – such as temperature, the proportion of precipitation that falls as rain, the storage of water in the form of glaciers, and the types of vegetation providing ground cover – have so far prevented a direct link from being drawn. However, a comprehensive study by the European Commission published in 2019 showed that the world experienced longer, more severe and more intense meteorological droughts during 1981–2016 than over the period 1951–1980, and linked this trend to higher temperatures.[26] Among specific drought hotspots in the Mediterranean basin, the Sahel, and the Congo River basin, the increase in drought episodes was associated with both lower precipitation and higher temperatures, but in north-east China, precipitation was not significantly different, suggesting that a hotter climate was responsible.

Drying up
Distribution and impact of drought by region (2001-2018)



Source: United Nations University Institute for Water, Environment and Health

If the link between climate change and incidence and severity of drought is still being established, it is clear that inadequate water management practices can make naturally occurring droughts more damaging, or even cause local droughts directly. For example, much of the western US is covered by "use it or lose it" legislation that governs water allocations. If landowners can be shown to not require the full volume of fresh water allocated to them, they are at risk of having that allocation reduced. Furthermore, those allocations are not regularly reviewed, so although the streamflow of the Colorado River, which supports the livelihoods of an estimated 45m people, is 25% lower than it used to be, farmers, ranchers and businesses are being incentivised to use every drop (and more) of their share.[27] Nor is this exclusively a US problem: the World Wide Fund for Nature (WWF) believes that EU member states also regularly over-allocate water by failing to account properly for the impacts of future droughts on water availability.[28]

Although the imagery of parched arable land and emaciated animals is powerful, droughts are not just a rural phenomenon. Several world cities have come dangerously close to running out of water in recent years, most notably Cape Town in South Africa in 2018, and São Paulo in Brazil in 2015. Cape Town's water crisis was driven in large part by strong population growth and economic development (which fuelled water-intensive industries, such as golf, wine production, and swimming pools) and a change in precipitation. Local authorities had taken steps to conserve water over the previous two decades (and per-head water use fell), but three years of lower rainfall saw the city's six reservoirs shrink to around one-quarter of their capacity, prompting rationing.[29]

Water levels subsequently rose in the city as a consequence of more rain and tighter water management. In this instance, a humanitarian disaster was avoided, but the economic costs were not. Such an example illustrates an all too common, yet incredibly dangerous, approach to water management – that of waiting to being on the brink of a catastrophe before finally taking action.

Droughts are highly expensive. Research by the US National Centers for Environmental Information identified 26 droughts in the US between 1980 and 2019, with an estimated average cost of US$9.6bn per drought. Of the seven types of natural disaster tracked in the research, only tropical cyclones were more expensive (at U$21.5bn per event).[30] The costs of droughts are wide-ranging. There are the first-order effects, such as crop and livestock failure, which reduce the income of farmers, and the additional costs of crop-switching to less thirsty produce. There are also losses further up the supply chain, as retailers are forced to find new, more expensive suppliers, and to customers to whom some price increases will be passed on. Interestingly, though, through the globalisation of supply chains, water-scarce countries have become increasingly reliant on importing goods produced in water-rich countries to meet the needs of their populations, meaning that many global water flows are "virtual" and end-users can in fact be very remote from the direct effects of drought. On the other hand, the businesses that use water directly for energy or industrial production, or that provide goods as services to farmers, fisheries, or river navigation, might all suffer. Finally the effects on the health of the environment and human population can have long-term impacts on productivity and prosperity of the affected communities.[31]

Case study: Drought and migration in the Senegal river basin

The tributaries of the Senegal River begin in the highlands of Guinea and in neighbouring Mali. They join up in central Mali and then form the border between Mauritania to the north and Senegal to the south. After more than 800km of westward travel, the Senegal River drains into the Atlantic Ocean.

The river's basin encompasses land in all four of these countries and provides a home to 12m people. It is not a straightforward place to live. The seven-month dry season sees almost no rain at all. When rain is due, it is often unreliable, which prevents the replenishment of the soil with nutrients required for farming. Likewise, raising livestock is more difficult if the land is parched. Overfishing and damming further upstream have also made earning a living more difficult. The World Bank notes that the latter has brought power and telecommunications capabilities, but has also reduced water availability.[32] Population growth has exacerbated these pressures and resulted in mass migration away from the basin and towards the region's biggest cities. Migration to find work is extremely common: one study by the UN's High Commissioner on Human Rights suggested that 90% of men in one region of Senegal had migrated at least once in their life because of water-related economic distress.[33]

The basin does, however, have relative effective governance. The Organisation pour la mise en valeur du fleuve Sénégal (OMVS), which was established in 1972, has been praised by the UN Food and Agriculture Organisation (FAO) for its work in ensuring "equitable sharing of water resources, through development and management, between co-basin states of a transboundary river".[34] The organisation has also played a role in reducing the incidence of crippling diseases, such as malaria and schistosomiasis.[35] The World Bank has reported evidence of migrant flows back to the region following a major investment project to improve local irrigation practices.[36]

That said, there is plenty of work to be done. As outlined in the Blue Peace Index, the basin's very low levels of drinking water access and elevated rate of undernourishment mean further improvements in national and transboundary water management are necessary in order to ensure the populations' access to the water and food they require.[37] One area for action is the development of better tools for evidence collection, such as hydro-meteorological stations. The individual riparian states also need to improve national mechanisms for water availability management, pollution control, and implementation of environmental policies. As a region that is at high risk of suffering severe effects of climate change, this absence of safeguards is a concern. This is particularly pertinent given that climate change is likely to exacerbate the unreliability of rainfall, while rising temperatures will make agricultural work more taxing, once again increasing the appeal of life in a city. Nonetheless, the long-term sustainability of resources, and efforts to avoid overstraining them, must be front and centre when pursuing development goals.

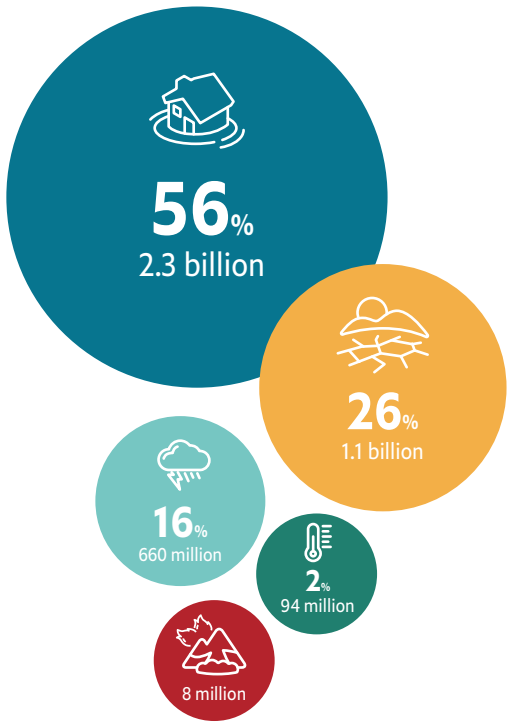
2.2 Water excess

Too much water also carries economic costs. Floods can be triggered by large amounts of precipitation falling either very quickly or consistently over a longer period, such that it eventually causes rivers and streams to burst their banks; by a storm causing the sea to surge inland and submerge coastal areas; or by the bursting of glacial lakes and flash flooding in mountainous regions. As with droughts, flooding is a naturally occurring phenomenon. It emerged as a problem only when humans began to occupy floodplains, such as the Mississippi Delta in the US and the Tigris-Euphrates in the Middle East, having discovered that the land was extremely fertile.

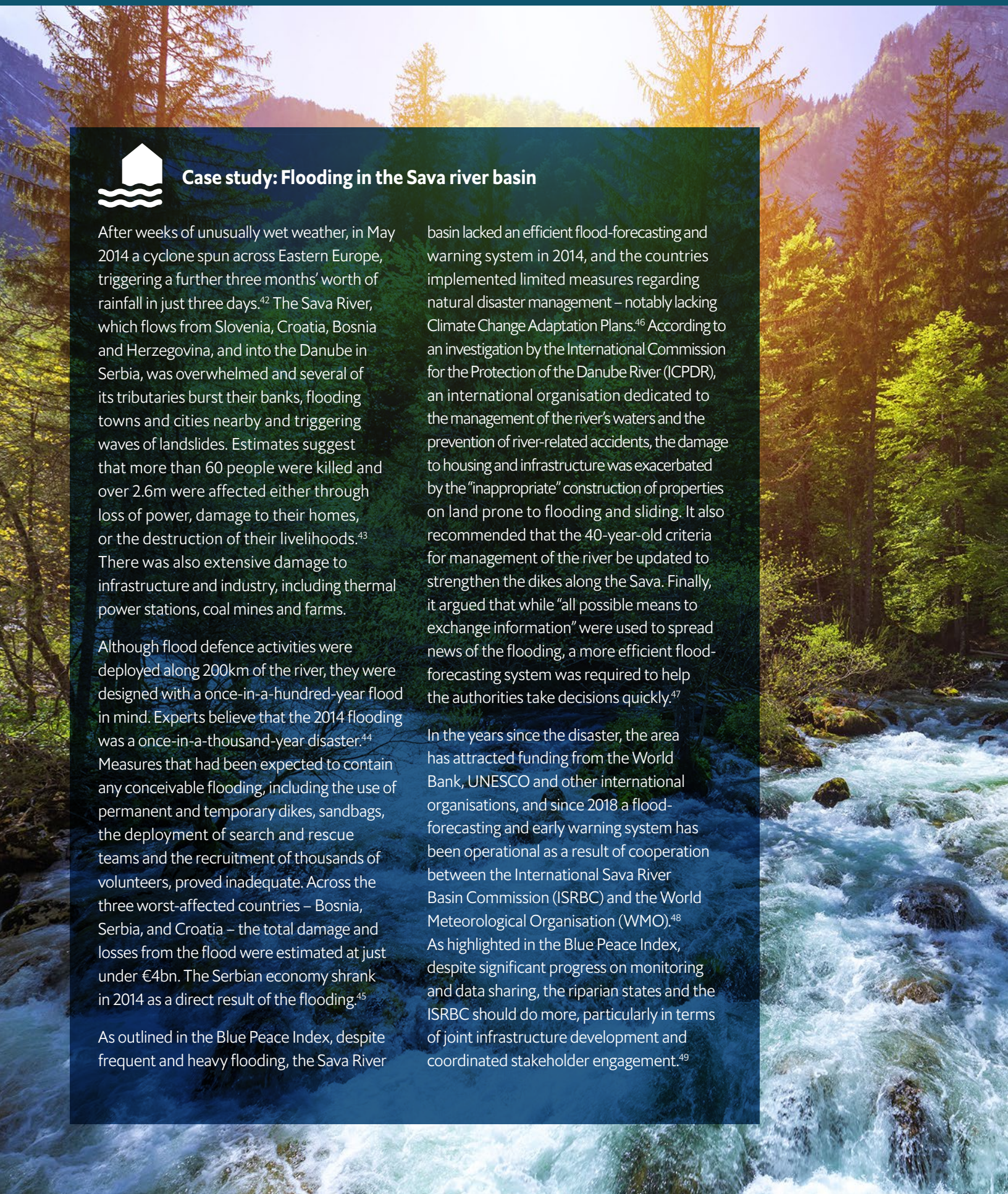
When our flood prevention efforts fail, as was evident in the city of New Orleans in the US when it was submerged during Hurricane Katrina in 2005, and in Vargas state in Venezuela in 1999, the impact can be devastating. Floods can destroy houses, businesses, infrastructure and farmland. Even when waters recede, they can leave behind layers of mud and silt, requiring intensive efforts to remove before the land can be restored, and they can even leave land completely infertile. At this point, conditions are ripe for diseases and infections to spread. The OECD describes flooding as "one of the most common, wide-reaching and destructive" natural disasters, estimating that every year it affects one out of every 32 people on the planet and incurs losses of US$40bn.[38]

There is a strong body of evidence to suggest that climate change is resulting in more extreme weather events and that the events themselves are becoming more intense. The US National Oceanic and Atmospheric Administration (NOAA) has recorded an average increase in the global sea surface temperature of 0.13°C each decade over the past century, while the Intergovernmental Panel on Climate Change (IPCC) is expecting this increase to continue so that average temperatures are between 1.6°C and 4.3°C higher by the end of the century, relative to the pre-industrial period.[39,40] A study published in Nature in 2018 suggested that these higher temperatures in the oceans can result in tropical storms carrying more water vapour, which means they both move more slowly and deposit more precipitation, which in turn raises the risk of floods.[41] The severity of storm surge flooding is also compounded by higher sea temperatures, with surges travelling further once they reach land.

Widespread impact
Numbers of people affected by weather-related disasters (1995 - 2015)



Source: Centre for Research on Epidemiology of Disasters; United Nations Office for Disaster Risk Reduction



Case study: Flooding in the Sava river basin

After weeks of unusually wet weather, in May 2014 a cyclone spun across Eastern Europe, triggering a further three months' worth of rainfall in just three days.[42] The Sava River, which flows from Slovenia, Croatia, Bosnia and Herzegovina, and into the Danube in Serbia, was overwhelmed and several of its tributaries burst their banks, flooding towns and cities nearby and triggering waves of landslides. Estimates suggest that more than 60 people were killed and over 2.6m were affected either through loss of power, damage to their homes, or the destruction of their livelihoods.[43] There was also extensive damage to infrastructure and industry, including thermal power stations, coal mines and farms.

Although flood defence activities were deployed along 200km of the river, they were designed with a once-in-a-hundred-year flood in mind. Experts believe that the 2014 flooding was a once-in-a-thousand-year disaster.[44] Measures that had been expected to contain any conceivable flooding, including the use of permanent and temporary dikes, sandbags, the deployment of search and rescue teams and the recruitment of thousands of volunteers, proved inadequate. Across the three worst-affected countries – Bosnia, Serbia, and Croatia – the total damage and losses from the flood were estimated at just under €4bn. The Serbian economy shrank in 2014 as a direct result of the flooding.[45]

As outlined in the Blue Peace Index, despite frequent and heavy flooding, the Sava River basin lacked an efficient flood-forecasting and warning system in 2014, and the countries implemented limited measures regarding natural disaster management – notably lacking Climate Change Adaptation Plans.[46] According to an investigation by the International Commission for the Protection of the Danube River (ICPDR), an international organisation dedicated to the management of the river's waters and the prevention of river-related accidents, the damage to housing and infrastructure was exacerbated by the "inappropriate" construction of properties on land prone to flooding and sliding. It also recommended that the 40-year-old criteria for management of the river be updated to strengthen the dikes along the Sava. Finally, it argued that while "all possible means to exchange information" were used to spread news of the flooding, a more efficient flood-forecasting system was required to help the authorities take decisions quickly.[47]

In the years since the disaster, the area has attracted funding from the World Bank, UNESCO and other international organisations, and since 2018 a flood-forecasting and early warning system has been operational as a result of cooperation between the International Sava River Basin Commission (ISRBC) and the World Meteorological Organisation (WMO).[48] As highlighted in the Blue Peace Index, despite significant progress on monitoring and data sharing, the riparian states and the ISRBC should do more, particularly in terms of joint infrastructure development and coordinated stakeholder engagement.[49]

2.3 Water quality

In addition to water shortages and water excess, deterioration in water quality also generates additional costs for governments, businesses and consumers. These costs are often more difficult to imagine. The impacts of drought and flooding are clear, but additional processes to clean water to make it fit for purpose, or lower agricultural yields because of pollutants in irrigation systems, can also be expensive. A World Bank study has found that when rivers become polluted in upstream regions, such as through damage to sanitation facilities or the release of chemicals, GDP growth in downstream regions is reduced by between 1.4% and 2%.[50]

Using water to irrigate crops is essential to make farming more efficient. Studies have shown that the 20% of global farmland that is irrigated produces 40% of world agricultural output.[51] However, the quality of the water used in irrigation is crucial in the success of the crops. Research by South African and Nigerian agronomists found that using waste or groundwater could cut the growth of some vegetable plants by one-half relative to irrigating with rainwater. Likewise, the concentrated presence of metals such as cadmium and chromium in water has been correlated with poor outcomes.[52] Unless properly controlled, dirty water used in agriculture risks contaminating potable water sources, introducing a range of risk factors to human health. The use of water by industry is another threat to the quality of the water in the surrounding ecosystem. The clearest example of this is the disposal of wastewater in rivers and streams, if this is not outlawed by legislation or if no alternative is available. There are numerous examples of how international cooperation can reduce pollution levels in major waterways – notably in the Rhine in Western Europe – but even with shared goals and robust standards in place, rivers and streams remain vulnerable to industrial accidents.[53]

Climate change will also affect the quality of available water. For example, as climate change makes heavy downpours of precipitation more common, the volume of surface runoff – the water that flows over the ground after a storm – will increase, and this moving water is at risk of picking up pollutants and dirt from the ground, transferring them into water bodies. Thus, water supplies could become contaminated, raising the costs of providing potable water in countries with access to safe water, and raising the risk of waterborne diseases in those that do not.

The IPCC has "very high confidence" that the higher water temperatures created by climate change will result in increased spread of waterborne diseases that can cause diarrhoea, fever, and flu-like symptoms.[54] Studies have found a great deal of evidence from around the world linking episodes of flooding and heavy rainfall with higher incidences of diarrhoea.[55] Climate change and the more frequent and severe extremities of the water cycle will thus exacerbate the devastating socioeconomic impacts of the water crises through multiple channels.

Case study: Agriculture and flooding in the La Plata river basin

The La Plata River is the second-largest drainage basin of the South American continent and one of the largest in the world, encompassing all of Paraguay, most of Uruguay, one-third of Argentina, the south-east of Bolivia, and the south-west of Brazil. Three of the continent's major rivers, the Paraguay, Uruguay and Parana, meet at the Rio de la Plata in the south-east corner of the basin and empty into the Atlantic Ocean.

The basin, home to an estimated 160m people, is crucial to the economies of the five countries: as much as 70% of their combined GDP is produced in the basin area.[56] In fact, "it is one of the most economically important basins globally," says Luis Pabon, a consultant at the Inter-American Development Bank.[57] It is the main source of electricity for the region, thanks to a series of huge hydroelectric power plants, while the major economic activity in the basin is agriculture. According to the FAO, the basin provides most of the food to the countries and the bulk of their total exports. For example, the one-third of Argentina's land area in the basin produces over 90% of the country's cereals and oil crops, and 85% of its beef. Other major crops include rice, wheat, soybeans and sugarcane.[58]

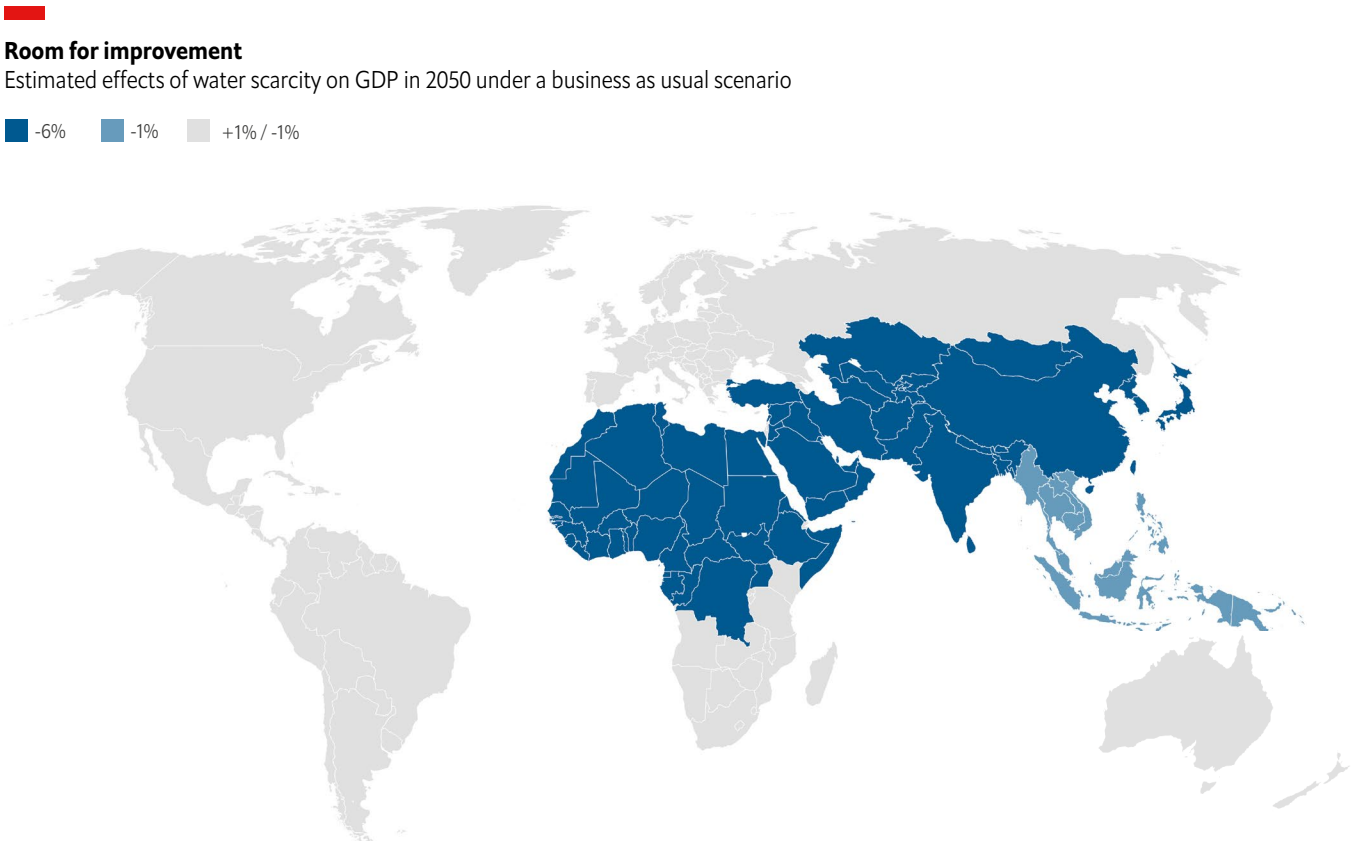
Although parts of the basin are among the few regions in the world where precipitation has increased over the past century, this actually provides a greater source of risk.[59] Valleys and flatlands in the basin have experienced more frequent flooding in the past 50 years, which is often fatal to herds of cattle and other livestock and wildlife. The IPCC's 2018 update claimed that it had high confidence that much of the area covered by the La Plata basin had experienced unusually high rainfall and that this had increased flood frequency and intensity.[60] It is widely believed that deforestation, the growth of urban centres along the rivers, and the intensity of farming have all contributed, along with the effects of climate change, to an increasing rate of major flooding.[61]

In 1967 the riparian states created an intergovernmental committee known as the CIC (Comité Intergubernamental Coordinador de la Cuenca del Plata) to coordinate the management of the basin. Two years later, The La Plata Basin Treaty came into force and has been supplemented with additional plans and agreements, including the establishment of a fund in 1974, FONPLATA, currently a fully fledged development bank that works to promote the sustainable development and integration of its member countries. Nevertheless, insufficient enforcement mechanisms mean that basin countries remain exposed to extreme weather events, both flooding and drought, which have resulted in forgone economic growth.[62] "We need to strengthen governance," says Luis Pabon. "The CIC Plata is a rather weak institution in practice. We need to harmonise economic and environmental policies and regulations, encourage joint planning and decision-making, and crucially, increase stakeholder participation."[63]

3. The economic costs of water stress and mismanagement

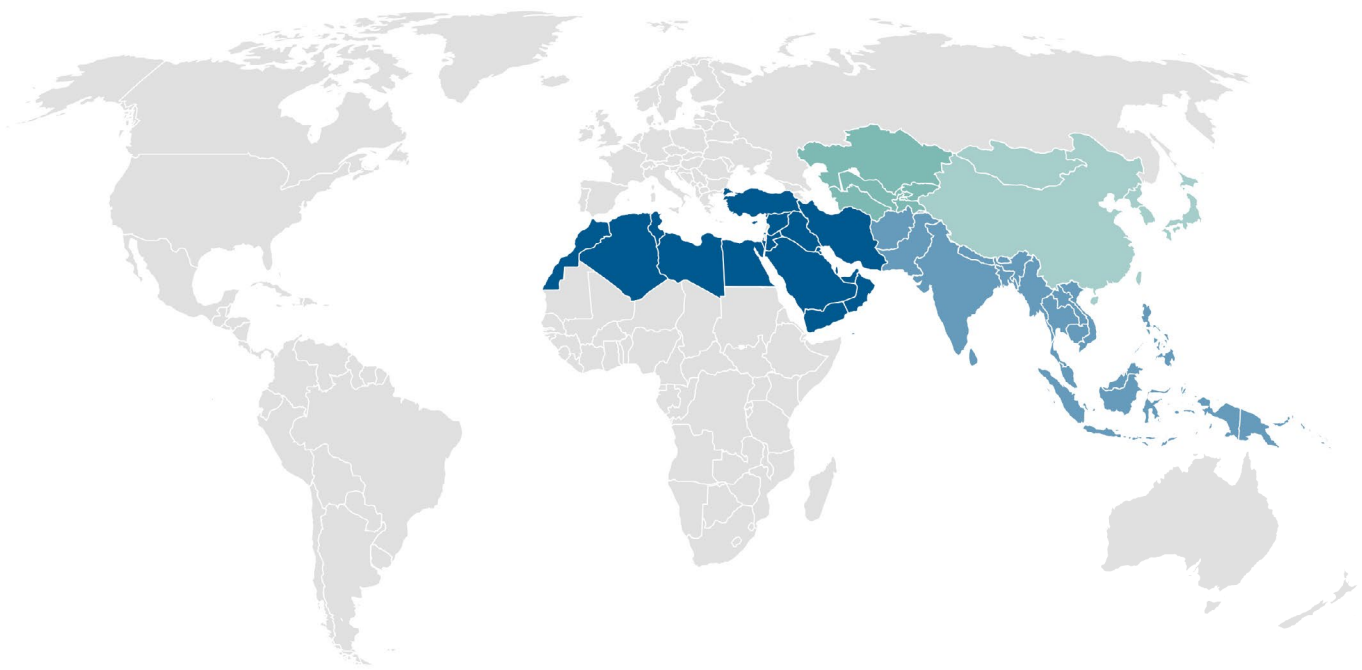
Fresh water is a resource that is essential not only for individual human health, but also for functioning communities, businesses and economies, and for the environment on which they are built. Water scarcity, exacerbated by climate change, could hinder economic growth, spur migration, and spark conflict, impacting societies through a number of channels. A World Bank report finds that unless action is taken soon, water will become scarce in regions where it is currently abundant – such as Central Africa and East Asia – and scarcity will greatly worsen in regions where water is already in short supply – such as the Middle East and the Sahel in Africa. These regions could see their growth rates decline by as much as 6% of GDP by 2050 due to water-related impacts on agriculture, health, and incomes.[64]

Room for improvement
Estimated effects of water scarcity on GDP in 2050 under a business as usual scenario



Source: World Bank

Room for improvement
Estimated effects of water scarcity on GDP in 2050 under an efficient water policies scenario



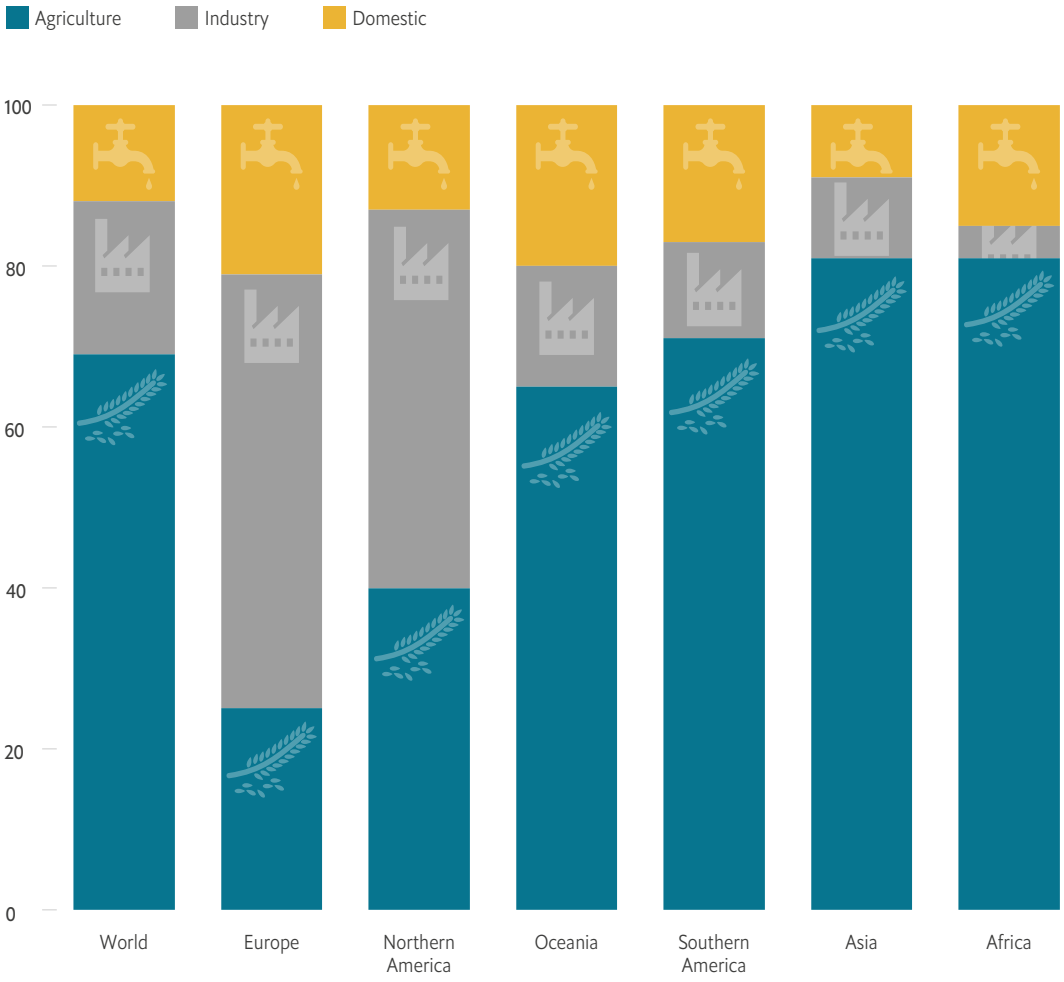
Source: World Bank

3.1 Agriculture

Of all the industry sectors, the links between agriculture and water are the strongest. Agriculture is by far the biggest consumer of water, accounting for up to 90% of total consumption in certain countries, and would therefore be the most exposed sector in the event of water stress or a permanent decline in water availability.[65] Without enough water, it is not possible to irrigate crops, cultivate fish or rear livestock. Agriculture needs not just water, but good-quality water. A 2018 study by ECORYS found that in Europe the agriculture sector had the second-highest reliance on water quality – as well as quantity – among the region's industries.[66]

Although the share of agriculture in global GDP is on a downward trend, falling to 3.3% in 2018 according to the World Bank, from 5.5% two decades before, it remains a huge sector for many developing countries in particular. Even in large emerging markets, such as India, Thailand or Turkey, it accounts for 16%, 8% and 6.4% of GDP, respectively.[67] Without a reliable and plentiful supply of water, agriculture will be unable to continue to support these economies.

Watering the world
Water withdrawal shares by sector (% of total withdrawals, 2015)



Source: FAO, AQUASTAT

Agriculture is also labour-intensive: 43% of Indian, 31% of Thai and 18% of Turkish workers are engaged in agriculture.[68] Even if the sector is less productive than manufacturing or services, any deterioration in water availability which makes agricultural work uneconomic risks leading to a sharp rise in unemployment that other industries may not be able to absorb. Second-round effects then include lower private consumption (if agricultural workers lose their income) and potentially higher inflation, unless lower domestic agricultural output is compensated by cheaper foreign imports.

Case study: Excess salinity in the Mekong river basin

The Mekong River has its origins in the Tibetan plateau and runs through China, Myanmar, Laos, Thailand, Cambodia and Vietnam, before flowing into the South China Sea. Its basin is essential for all of the Southeast Asian nations. It provides fresh water for irrigating crops, sustains fisheries, and provides water for thirsty industries such as power generation and garment manufacturing.

However, the basin is also struggling with excess salinity. Swathes of the delta are inundated by the sea every year for a period of several weeks, until the seawater is pushed back out by fresh water from further upstream. Yet those employed in agriculture and fishing have observed that, in recent years, the period of excess salinity is lasting for longer, which is killing fish and preventing crop growth. In some areas of southern Vietnam, studies have recorded a loss of rice production of more than 50% because of prolonged periods of basin salinity.[69] Globally, the economic losses owing to salt-induced land degradation are estimated at US$27.3bn per year.[70]

There are several factors behind this phenomenon. First, the construction of upstream dams has affected how fresh water flows into the basin. There are 11 dams along the Chinese stretch of the Mekong alone and a further two in Laos.[71] The dams prevent freshwater lakes which usually feed the lower Mekong, such as Tonlé Sap in Cambodia, from filling and discharging the water that pushes the seawater in the delta back out.[72] Dams also prevent the flow of sediment from upstream. Second, the lower Mekong is a rich source of sand that is useful in construction projects. When the sand is removed (especially when combined with the lack of sediment flowing from further upstream), the riverbeds deepen, permitting more seawater into the river, which in turn requires more fresh water to flush it out.[73] Given that the supply of fresh water is being compromised, the outcome is longer periods of high salinity.

A coordinated response is required to prevent this phenomenon from worsening, but China and Myanmar are only observer members of the Mekong River Commission (MRC), the main decision-making body.[74] As outlined in the Blue Peace Index, the lack of a single platform on which to discuss the health of the river and its implications for riparian states holds back cooperation not just on salinity but also flood response and climate change mitigation, both of which will have a major impact on agricultural productivity and the standard of living of the millions living beside the river.

Moreover, although the riparian states and the MRC have made significant progress in the technical areas of water management, such as monitoring and data sharing, greater focus on following the integrated water resource management (IWRM) principles, pollution control, and inclusive stakeholder engagement are essential for the long-term sustainability of the development of the basin. As Naho Mirumachi of King's College London explains, "infrastructure development – whether traditional or nature-based – is important, but on its own cannot solve the issues, unless local stakeholders and communities are empowered and effectively involved in planning and decision-making."[75]

The challenge for agriculture, then, is how to become more efficient in order to feed a growing global population while simultaneously using less water. The FAO estimates that agricultural production will need to rise by 70% from current levels by 2050 in order to account for population growth and the changing diets of those in low-income countries who are becoming wealthier.[76] This latter factor should not be underestimated. According to McKinsey, growing a kilogram of wheat uses 1,300 litres of water, but a kilogram of beef needs 16,000 litres.[77]

The World Bank believes that achieving this goal will need a greater correlation between global supply chains and local hydrological and climate conditions – in short, growing crops in places where local weather can support them. Water effectiveness is currently poor in agriculture as highly water-intensive crops are often produced in arid regions and exported. Tackling the challenge also requires using the water that does exist locally in a more effective way, through the more widespread adoption of efficient irrigation practices. Deploying even a basic flood irrigation system, where water from rivers or streams is allowed to inundate a field where crops are being grown, tends to double the yield compared with crops grown exclusively with rainwater.[78] Yet flood irrigation can also be improved upon – approximately 50% of the water used in this process is wasted. Drip irrigation systems, which feed water slowly into the soil surrounding the roots of plants, are much more efficient, but also much more expensive to install and operate.[79]

Likewise, farmers' decisions on what crops to grow and when has an enormous effect on their water consumption. Other variables crucial to these decisions include market prices for the crops under consideration, the suitability of the local soil, the cost of water, and international trade barriers. The global agricultural sector using water most efficiently would require both farmers aligning crop growth with local agricultural conditions more effectively, and the international trade of goods being as frictionless as possible. Reducing food waste could also lower the economic cost of water scarcity for agriculture. The FAO estimates that as much as one-third of total food production is wasted before it is consumed.[80] Produce is lost or has to be discarded along every step of all supply chains. This could be because of overly restrictive regulation, a lack of cold storage, or sluggish harvesting. In high-income countries, households routinely buy more food than they need to eat. In low- and middle-income grower markets, investment in infrastructure, transport and packaging industries would reduce waste, while in high-income consuming nations, the FAO recommends better education of consumers of the environmental cost of buying cheap food that is allowed to rot.[81]

3.2 Energy

The energy sector uses a fraction of the water consumed by agriculture, but still represents 3% of the global total.[82] The most direct use of water in the energy sector is for hydropower generation, which remains the largest renewable electricity technology by capacity and generation, providing the bulk of electricity generation in a considerable number of countries, ranging from Norway, to Ethiopia, Paraguay and Kyrgyzstan.[83]

Hydropower relies on water passing through turbines to generate electricity. Most of the water withdrawn is returned to the river, but the regime of river flow varies depending on a large number of factors such as technology type (run-of-river or reservoir), reservoir size, climate, engineering, and amount of demand from end-users.[84] Development of large-scale hydropower dams can have significant impacts on water availability and quality, as well as changes in habitat conditions, fragmentation of fish migration pathways, loss of biodiversity, and erosion of ecosystem services.[85] However, hydropower also provides one of the most highly visible examples of the impact that water stress – from drought or fluctuations in water availability – can have on an essential aspect of socioeconomic development. Inadequate access to electricity in developing countries has dire social and economic impacts.[86] However, in Africa, where hydropower accounts for 22% of electricity generation, climate has already affected the capacity of Zambia's largest hydropower plant, leading to blackouts. Hydropower plays an important role in many countries' decarbonisation pathways, but is particularly vulnerable to climate impacts.

Yet, the water–energy nexus is much more complex. Beyond hydropower, the use of water in the sector can be split between that which is used in power generation (which, according to the International Energy Agency (IEA), is around one-third of the total), and that used for extracting and refining primary energy products, such as coal, oil and biofuels (which accounts for the other two-thirds).[87]

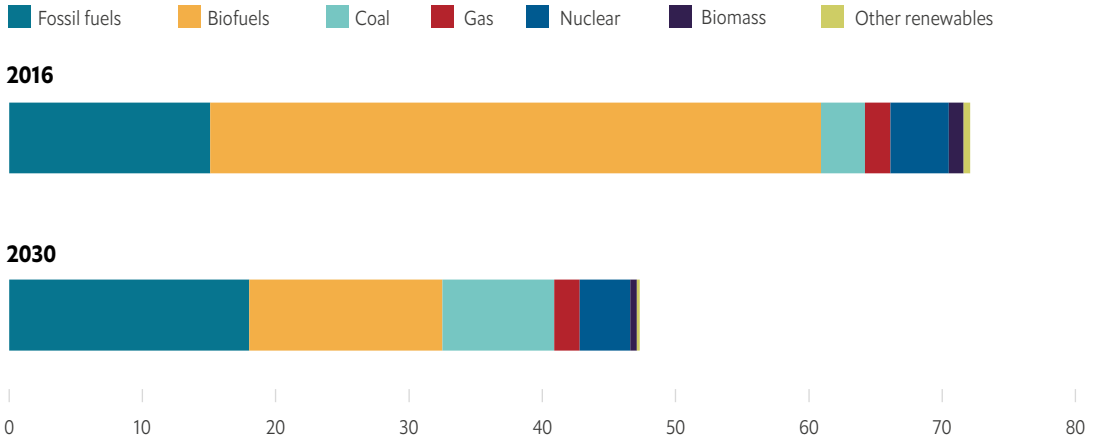
Thermal power plants use differing amounts of water depending on the fuel, the weather, their function in the electricity grid, and the type of cooling deployed. However, the technology behind thermal power generation relies on abundant water and the process creates plenty of "thermal pollution", which the IEA defines as water discharged at a different temperature compared with that at which it was withdrawn, which means it cannot be directly returned to source.[88] Limited water availability would increase the price of thermal power generation, or, in some circumstances, render it uneconomical.

There are also huge variations in the amount of water used to grow, extract, cool and transport primary energy products. Biofuels, such as bioethanol, represent the largest amount of water consumption in this sub-category, because of the need to grow base crops, such as corn or sugarcane, which are then fermented.

The growing conditions and the type of irrigation used determine the level of water intensity. Water may have to be removed from mines before coal can be extracted, while the coal itself may need to be washed before it can be processed. Crude oil extraction tends to require less water than biofuels but more than coal. The pursuit of tight oil through fracking has created negative headlines in areas that already see intense competition for water resources and due to the risk of contaminating groundwater.

It is not necessarily the case that using more renewable sources of energy will reduce the amount of water that the sector consumes. Although solar and wind power need minimal water, biofuels are very thirsty, as is nuclear power. This is an important point with regard to how we view the energy industry. A full-throated adoption of renewables over fossil fuels would represent an enormous step towards limiting greenhouse gas emissions, but it would do little to temper the water crisis.

Thirsty energies
Global water consumption in the energy sector by fuel type in the Sustainable Development Scenario, (2016-2030, billion cubic meters)



Note: Other renewables include wind, solar photovoltaic, concentrated solar power, and geothermal
Source: IEA

Case study: Water-energy-food cooperation challenges in Central Asia

The Central Asian republics of the former Soviet Union are not short of fresh water on average, but their supplies are unevenly distributed. Their failure to cooperate efficiently on water is leading to major opportunity costs, from lower agricultural yields to weaker health outcomes and smaller intra-regional trade. In the region, the main sources of fresh water are located in upstream Tajikistan and Kyrgyzstan, which leave Uzbekistan, Kazakhstan and Turkmenistan reliant on flows from their neighbours. The Amu Darya flows from the mountains of Tajikistan and Afghanistan to the steppe and desert areas in Uzbekistan and Turkmenistan. Historically the river has been a key tributary for the Aral Sea, but it has been exploited extensively since the mid-20th century, particularly for irrigation, ultimately resulting in the river drying up before reaching the Aral Sea.[89] Similarly, the Syr Darya flows from the mountains of Kyrgyzstan and Tajikistan, delivering the main source of fresh water through Uzbekistan's fertile Ferghana Valley and south-western Kazakhstan. Over-exploitation of water from Syr Darya has similarly led to severe depletion of water flows and, combined with the vanishing of the Amu Darya, caused the quasi-disappearance of the Aral Sea.[90]

The Soviet Union developed heavy infrastructure and a resource-sharing arrangement across the basins, whereby dams and reservoirs were constructed in the upstream nations, releasing their contents to irrigate the downstream countries in summer. In return, the downstream nations, which are richer in fossil fuels, supplied energy to their upstream counterparts in winter. When the Soviet Union broke up, individual countries started focusing on their national development projects and as regional energy prices, which had been kept artificially low, began to rise towards world market prices, the stored water in Tajikistan and Kyrgyzstan became much more valuable to use for hydropower generation than in supplying their neighbours.

The newly independent nations recognised the need to collectively manage the water resources generated from the transboundary Amu and Syr Darya Rivers, and gradually merged existing institutions and established new ones to form a complex set of institutional arrangements under the International Fund for Saving the Aral Sea (IFAS) framework. The existing water allocation agreement is monitored by the Interstate Commission for Water Coordination of Central Asia (ICWC), which holds regular meetings, has a secretariat, the ICWC Scientific Information Centre (SIC), and regional branches. The highest body of the IFAS, the Executive Committee, has a rotating presidency and rotating staff

(Continued...)

(on a three-year basis), which presents a challenge for policy continuity, and ultimately for its power and influence.

Moreover, as outlined in the Blue Peace Index, the mandates of these organisations have proven to be too narrow and lack the capacity for broad transboundary water management. In the absence of shared goals, a culture of competition rather than cooperation has taken root,[91] and the political fragility of the region means that cross-border integration is incredibly limited.

Although the efficiency and effectiveness of this governance structure have been questioned, attempts to reform various parts of the IFAS framework between 2008 and 2012, led by Kazakhstan, but supported by Tajikistan and Kyrgyzstan in particular, were unsuccessful.[92] In 2016, Kyrgyzstan announced that it would "freeze" its membership of the IFAS, citing dissatisfaction over the lack of accommodation of its interests, and it has not attended ICWC water allocation meetings since. Kyrgyzstan's president attended an IFAS meeting as a guest in 2018, at which the other member states acknowledged the country's grievances, but no progress or changes have been achieved as a result.[93]

Both upstream and downstream countries suffer from this failure to work together. Downstream nations are receiving less water than they need to sustain their agricultural sectors and they lack strategic visions of development that meet the needs of their climates. Undermining rural livelihoods also risks pushing disaffected economic migrants towards the cities, which may lack the infrastructure to cope, resulting in even deeper political grievances.[94] The upstream countries still have enough water, but a lack of regional development hampers their connectedness to global markets, and access to international borrowing and best-practice on water management techniques. The opportunity cost of frosty regional relations on water could be costing Central Asian countries an estimated US$4.5bn a year as a consequence of lower agricultural productivity, higher energy prices and limited access to capital markets.[95]

It is also worth considering that drawing water from deeper underground, desalination and other techniques to reuse water, which are expected to be increasingly deployed among water-stressed countries in the coming years, are also highly energy-intensive. The IEA estimates that the current volume of water that undergoes the desalination process represents less than 1% of total global consumption, but already absorbs 25% of the water sector's energy consumption.[96] This risks creating a circular problem whereby shortages of water compel policymakers to invest in desalination or deeper extraction, which require substantial amounts of electricity, which is generated from inputs that use large volumes of water.

Anecdotal evidence suggests that the energy sector is already struggling with a lack of available water. The World Bank found in 2014 that 50% of global power, utility and energy companies reported water-related impacts on their operations in the preceding five years, while two-thirds identified water availability as a risk to their future output.[97] For example, in South Africa, the recurring water shortages necessitated that all new power plants use dry cooling systems, which use less water but are more expensive to build and are less efficient.[98]

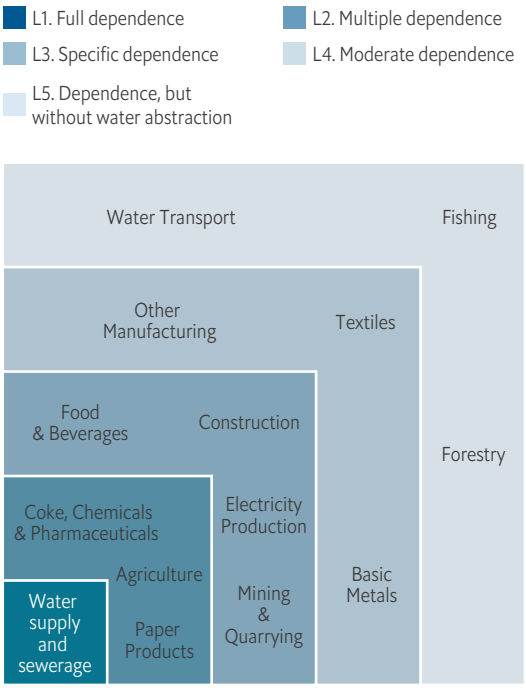
The economic costs of inadequate water for the energy sector are thus potentially vast. If the supply of energy is throttled by a lack of water availability, it will fail to keep up with expected growth in demand, resulting in higher prices and, for those who cannot afford it, curtailed access.[99] That said, there are ways that the energy sector can use water more efficiently. These include a greater focus on reusing wastewater from energy processes; using heat from industries to generate energy; building water and energy infrastructure side-by-side to reduce waste products; and a greater use of data to understand which processes are particularly inefficient and how they can be streamlined.[100]

3.3 Industry and services

The industrial sector, which accounts for a major share of water consumption in many developed markets, uses water as a direct input into products and for a host of processes. "Pretty much all businesses either depend on or impact water," says Tatiana Fedotova, a Water Stewardship Consultant at the Swiss Agency for Development and Cooperation.[101] For some industries, such as pulp and paper, food and drink, and textiles and apparel, the role of water is clear. But even for those components of the industry sector where water is not a major product input, it is crucial for industrial processes such as heating and cooling, transport, cleaning, product use and servicing, as well as energy supply.[102] Crucially, securing access to safe water, sanitation and hygiene at the workplace is essential for employees' wellbeing and productivity.[103]

Industrial demand for water is expected to continue to grow globally in the coming decades, with the possible exceptions of North America and Western Europe.[104] Any water-related disruption could have severe consequences for industry, resulting in competing demand for water resources and a potential fall in investment as businesses may become less competitive, profitable and viable.

Widespread dependency
EU economic sectors that are highly dependent on water



Source: Ecorys

Changes to water supply carry a host of risks for industrial companies. For firms where water is an input, the potential for too little, too much, or water that is too polluted to use, means that there is the risk that production could be halted, or at least output slowed. Revenue projections would also have to change if the cost of water itself rose, because of the need to dig deeper boreholes and pump from further underground, or clean water more thoroughly. These changes would clearly affect their revenue and costs. Indeed, according to research by CDP, an NGO that focuses on measuring the environmental impact of corporations, corporate respondents to its 2018 Global Water Report recorded losses of US$38.5bn owing to water-related issues.[105] But there are other financial risks too. Water shortages or damage to infrastructure from water excess would be likely to push up prices for energy, insurance, transport, services bought from other suppliers, and even inventory storage.

There could also be indirect effects through regulatory or reputational changes. The former could increase the costs of running a business, make it more difficult to attract external financing for an existing company, alter the competitive landscape, or result in an operating licence being withdrawn. Firms could suffer reputational damage if they are perceived as being out of step with public opinion or if their operations are shown to be detrimental to the environment or disadvantaged communities. In 2014 Coca-Cola, for example, was ordered by the state government to close a bottling plant in northern India because it was deemed to be withdrawing too much groundwater.[106]

Nor would the impact of a major fall in water availability be confined to the water-stressed countries themselves, owing to our highly interconnected and globalised world. If the cost of producing goods and providing services for export rises in water-stressed countries, then at least some of this cost would be passed on to consumers. In this respect, water scarcity could be a driver of increased consumer and producer price inflation around the world, albeit from current very low levels. Both importing and exporting countries bear responsibility for ensuring that water is managed in a sustainable way to ensure sustainable economic development.

There is evidence that large industrial companies are becoming more aware of their water usage and its impact on the planet, but the same data suggests that this awareness has not prevented them from continuing to use more water. CDP found that the proportion of firms surveyed that are experiencing "water risk exposure" is

rising, and stood at almost 80% in 2018. More than one-third of respondents claimed to have set targets to reduce water withdrawals, compared with around one-fifth three years before. However, the number of companies that reported an increase in their water usage rose by similar proportions, from one-fifth in 2015 to one-third in 2018.[107] Other data from the CDP indicates that fewer than 60% of the firms surveyed met the charity's baseline for water accounting, illustrating that the majority fail to sufficiently monitor where their water comes from, how much of it they use, and the impact of their wastewater.[108] There was a stark sectoral difference: more than four in five firms working in mineral extraction were engaged, but that fell to fewer than one in five among retailers.[109] It is also worth stating that the CDP's sample skews towards large corporations which can afford such investments in their own business practices.

There are some organisations that offer an approach for others to emulate. The Alliance for Water Stewardship (AWS) suggests a process – which can be summarised as gathering evidence on water use, making a plan to use less, evaluating the plan's success and sharing results – which it believes will improve water governance, drive up water quality, promote education and increase sanitation.[110] CDP promotes an "A list" of firms in its water security report that meet its highest standards for water conservation. For inclusion, firms must keep track of water use through their value chains, demonstrate an understanding of how water scarcity could affect their financial performance, and have implemented a strategy to mitigate these risks. Just 30 of the 760 firms surveyed met this threshold. In 2018 they included French cosmetics firm, L'Oréal, global drinks manufacturer, Diageo, and British–Swedish pharmaceutical company, AstraZeneca.[111] L'Oréal has, for example, managed to cut its water consumption by one-third over the past 15 years, while at the same time increase total output of its products by a similar amount. The net effect has been to lower the water intensity of its goods by almost one-half.[112]

There are numerous ways that firms can achieve similar results, beginning with understanding how much water they (and their suppliers) use and where it is sourced. Once armed with data, companies can explore ways to reduce the water used at especially inefficient stages of the production processes or the locations where water is sourced, if they are accessing it from particularly stressed areas. In larger companies, this is highly likely to involve conversations with their suppliers further down the supply chain. Companies can also set a shadow price for water when making investment decisions, in order to include their environmental impact in their costings.[113] They can set targets to maintain or reduce their usage and, in a step that CDP is particularly keen to see, tie the remuneration of executive-level employees to their performance in relation to their targets. This is still an unusual practice, even in sectors like resource extraction, chemicals and food, where fewer than one-third of firms have incentives in place for top executives to meet water targets.[114] Publication of a water policy is another way that could ensure greater compliance once targets have been set. If this includes commitments on replenishing water supplies, it would offer firms an opportunity to demonstrate their value to the local communities in which they operate.[115]

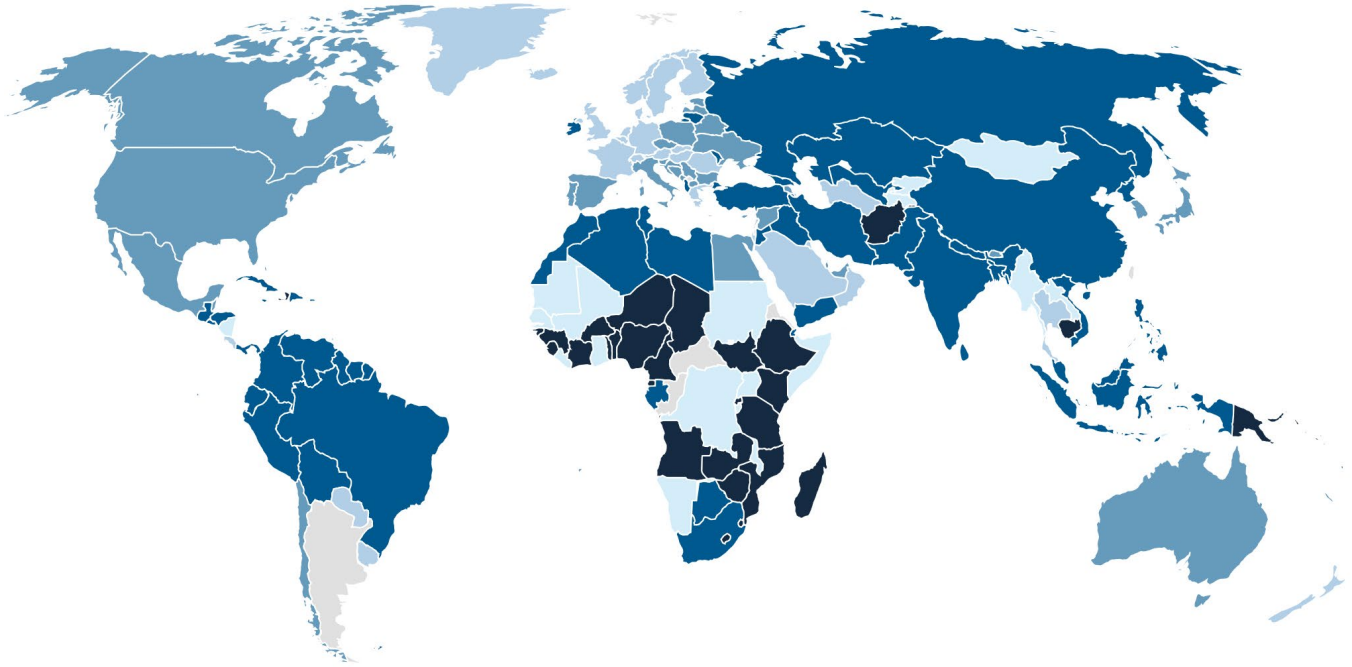
3.4 Households

Domestic use is the fourth major source of water consumption. As a proportion of the total, it varies widely by country. It is often high in low-income countries in Asia and Sub-Saharan Africa because of a smaller industrial base, and in several high-income nations, such as the UK and Denmark, which have small agricultural sectors that are adequately fed by rainfall.[116]

Domestic demand for water is expected to continue to rise quickly in the coming decades, driven by projections of a larger global population and by a greater proportion of this population being connected to safe and clean supplies of water into their homes. Despite significant improvement over the past two decades, the World Health Organisation (WHO) estimates that in 2017, 29% of the global population, or approximately 2.4bn people, still did not have access to clean water at home.[117] Connecting as many of these people as possible to water networks will push up the level of global domestic water demand, even if their consumption is minimal by the standards of developed economies. There is a clear economic case for spending on water infrastructure: the WHO believes that every US dollar invested in water and sanitation generates a fourfold return because of higher labour participation and productivity and lower healthcare costs.[118] There is also a social case to be made since access to water and sanitation is recognised by the UN as a human right. The lack of access to safe, sufficient and affordable water, sanitation and hygiene facilities is acknowledged as having a devastating impact on health, dignity and prosperity, and bears significant consequences for the realisation of other human rights.[119] Today, the lack of access to basic water, sanitation and hygiene services results in the deaths of an estimated 1,800 children per day,[120] and each day 6,000 children die of water-borne diseases.[121]

Yet, supplying clean water is difficult and expensive. In countries without abundant supplies of surface water, it has to be collected from groundwater, which can increasingly recede below the surface. Such water also has to be purified if it is to be truly safe. Freshwater supplies in countries without established networks of clean water in homes are more at risk of being contaminated by industrial waste, pesticides and fertilisers, as well as by the presence of natural minerals such as fluoride, which tend to be more abundant the deeper the groundwater lies.[122]

Clean water inequality
Proportion of population using unimproved drinking water sources (2017)



Source: WHO; UNICEF Joint Monitoring Programme

Those communities that lack reliable access to clean water at home are also at permanent risk of displacement. The choice to migrate, either internally or internationally, is a complicated one and research has shown that it is rarely down to a single factor.[123] However, several international organisations project that displacement of people because of a lack of available water, either for personal consumption or for use in subsistence farming, is likely to increase in the coming decades.[124] In addition to the emotional impact of leaving behind one's home and community, migration has an economic cost for the region being depopulated. Net outflows of migrants mean a smaller labour force to maintain existing industry or to rebuild in a different area of comparative advantage.

But even if governments can make major progress in delivering safe water to homes, there is no guarantee that the recipients will be capable or willing to pay for it. Water is rarely priced sufficiently high to account for the costs incurred in making it potable and delivering it to the end-consumer, partly because it is widely regarded as a public good rather than a product that should be purchased. Perhaps because water provision is not usually revenue-generating for governments, water infrastructure is often inadequately maintained. Leakage rates even in Europe are dismaying, with most countries reporting that 15–30% of the water in the public supply is lost before it is consumed.[125]

Case study: Health outcomes in Tigris–Euphrates

The primary sources of surface fresh water in Iraq are the country's two grand rivers, the Tigris and Euphrates. Both begin to the north in the valleys of eastern Turkey and then flow north to south through Iraq on parallel courses, before meeting up at the Shatt al-Arab in the country's south-eastern tip before flowing into the Persian Gulf. Neither river is in a healthy state: streamflows in the Euphrates have fallen by up to 45% over the past 50 years because of the construction of dams and barrages upstream.[126] The figures are similar for the Tigris.[127]

The quality of the water that remains is also a concern. According to a study published in the International Journal of Science and Research in 2016, which used the internationally recognised water quality index benchmarks, water in the Tigris measured at three sites between 2013 and 2015 was rated between poor and very polluted.[128] In mid-2018 the southern city of Basra experienced an appalling rise in the number of people reporting to hospitals with symptoms indicative of water-related diseases. These included diarrhoea, stomach pain and vomiting. Between August and November, more than 100,000 people were hospitalised. In that year the volume of water feeding the Shatt al-Arab from the Tigris and Euphrates had been particularly low. According to media reports, this resulted in more concentrated levels of sewage, industrial pollutants and salinity in the river's water.[129]

The health crisis, which followed previous outbreaks of water-borne diseases in 2009 and 2015, was amplified by two institutional failures. First, local and national law enforcement failed to uphold existing laws that prevent companies from dumping agricultural and industrial waste into the country's rivers beyond established thresholds. Second, there was a "total absence" of any advisory system for the authorities to use to inform residents about the quality of their water and what they should do to reduce the risks of drinking unsafe water. Nor has such a system been established since the crisis.[130]

Part of the problem is also rooted upstream. The extensive damming of the two rivers, which continued with the launch of the Ilisu Dam on the Tigris in southern Turkey in 2018, means less water flowing into Iraq, which makes it more difficult to keep clean the water that continues to flow.[131] As outlined in the Blue Peace Index, unlike other transboundary rivers, there is no regional water cooperation mechanism or multilateral agreement at the basin level that defines acceptable actions and behaviour among riparian states. Cooperation that does exist is either confined to only some countries or covers only narrow areas. The riparian countries have experienced significant security, political and economic upheavals in recent years, with Iraq and Syria particularly devastated by civil wars. This has contributed to inadequate attention being paid to the development of institutional capacities, technical cooperation, and implementation of pollution control and other environmental measures, further exacerbating the already high levels of water stress in the region.[132]

Given the increasing pressure on the streamflow that remains as a result of climate change, a more comprehensive approach to water management is required to protect the health of the population that is reliant on the rivers.

There are ways to maximise the efficiency of domestic water use. The first step is to continue to connect people to a water network. Although this will increase total consumption, it generates huge amounts of economic value elsewhere. Public information campaigns on the importance of using water sensibly are another consideration. Minimising leaks through repairs to infrastructure may also prove worthwhile if they prevent the price of electricity, for example, rising in the future, or provide a buffer to increasing water demands from large population increases, especially in developing countries. Finally, policymakers should consider how to price water fairly, so that heavy users with the means to pay for it subsidise the access for those who use less and lack the resources to afford it.

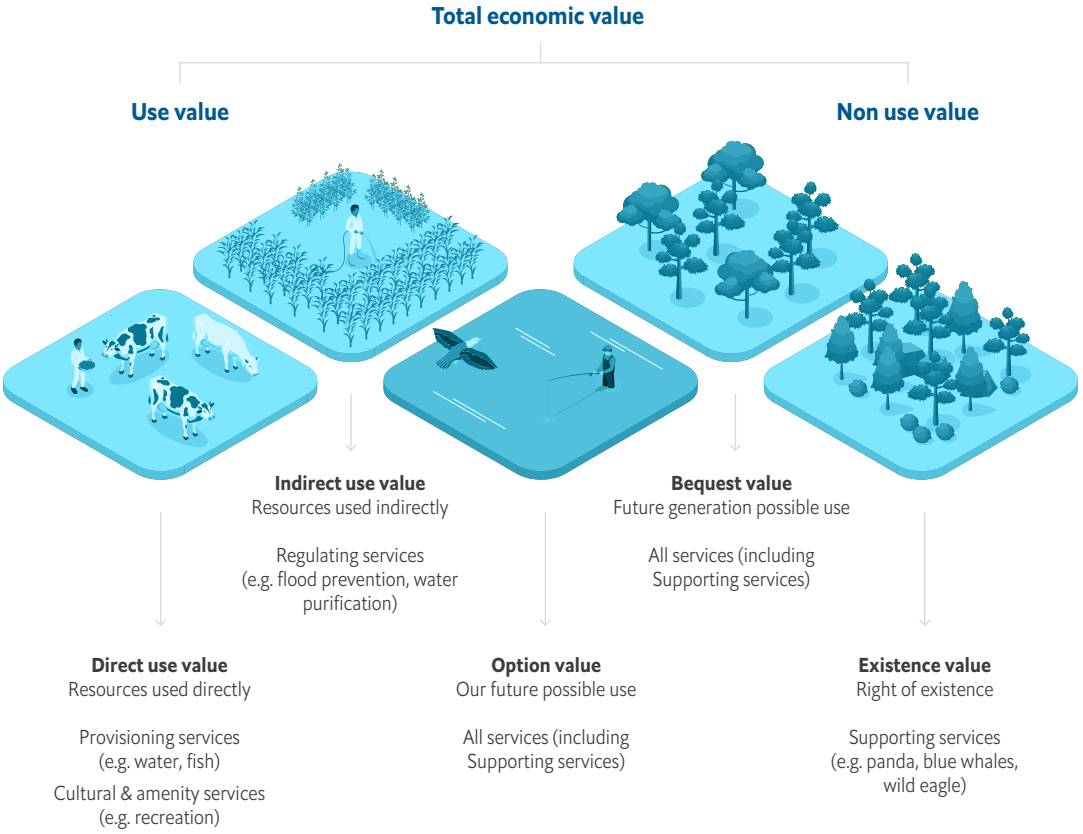
3.5 Ecosystems

The importance of water systems goes beyond the essential direct use for domestic purposes and economic activities. Ecosystems, including watersheds and wetlands, through their biodiversity, are vital to human well-being.

They contribute to national and local communities and economies by providing a range of crucial services, including crop pollination, water purification and regulation, flood protection, erosion control, and carbon sequestration. According to the OECD, ecosystem services are worth an estimated US$125–140trn annually, a figure which is often overlooked.[133] Wetlands specifically constitute an important source of water and nutrients that are necessary for biological productivity and, ultimately, the survival of entire populations. "Wetlands are of the most productive ecosystems on earth," according to Luis Pabon at the Inter-American Development Bank.[134]

For instance, in the Pantanal – the largest wetland on earth, spanning Brazil, Paraguay and Bolivia as a part of the La Plata Basin – over 1.2m people rely on it for income, food, and drinking water, and millions more benefit from its flood protection.[135] Notably, the wetland is responsible for the production of approximately 40% of Brazil's soy and more than 20% of its cattle.[136] But it is not just humans who benefit from its services – over 4,700 plant and animal species call the Pantanal home.[137] What truly stand out, however, are the Pantanal's ecosystem services, including groundwater recharge and sequestration, which are valued at $112bn.[138]

Wetlands: Irreplaceable value



Source: de Groot D., Brander L., Finlayson M. (2016)

Despite the knowledge of these benefits, 50% of the world's wetlands were destroyed during the 20th century; in the 50 years since 1970, the population of freshwater species has declined by 83%, owing to threats to freshwater habitats including the drainage of wetlands.[139,140] The destruction of wetlands has resulted in increased flood and drought damage, nutrient runoff and water pollution, erosion, and a decline in wildlife populations. "Water provision directly affects crops and livestock, food security of vulnerable populations, and employment of thousands of people. Much of the earth's economic activity is directly related to the availability of water and biodiversity protection, which includes both plants and animals," says Alfonso Malky, Latin America Technical Director of the Conservation Strategy Fund.

Biodiversity is critical for maintaining ecosystem health as losses threaten the structure and proper functioning of the ecosystem, reducing its productivity and lowering the quality of its services. The adverse impact of biodiversity losses on the growth of crops and animals, upon which many populations depend for their livelihoods, means that, ultimately, economic health is directly linked to that of nature.

Case study: Deforestation in Latin America

The Amazon is the world's second-longest river, ranging from the Andes mountains in the west, to the Atlantic Ocean on the north-eastern coast of Brazil, the river's mouth. The Amazon Basin, which holds approximately one-fifth of the planet's fresh water, spans more than 6m square km, covering the greater part of Brazil and Peru, large swathes of Colombia, Ecuador and Bolivia, with a smaller incursion into Venezuela. Over 30m people live in the Amazon biome, mostly within the major riparians mentioned above, but also in Guyana, Suriname and French Guiana.

Brazil dominates the river's course, encompassing two-thirds of the main stream and the largest portion of its basin. Two-thirds of the basin are covered by the Amazon rainforest, running along the floodplains, lining the Amazon's blackwater rivers, and providing the swamps, marshes and streams that allow the breadth of biodiversity to flourish.[141] The Amazon, and Latin America more broadly, influence the water cycles and overall biodiversity of the world. Latin America is one of the most biodiverse regions globally. According to the United Nations Environment Programme (UNEP), around 60% of terrestrial life worldwide, and diverse marine and freshwater species, can be found in Latin America and the Caribbean. "The region also plays an important role regulating the climate worldwide, since the Amazon absorbs the Atlantic Ocean's moisture, falling then as rain, and then continuing with hydrological cycles. Amazon forests also help regulate temperature and humidity and are linked to regional climate patterns," says Alfonso Malky of the Conservation Strategy Fund.

Beyond the direct impact on the livelihoods of millions of people in the region, deforestation and biodiversity loss in Latin America can impact water cycles around the world, meaning that droughts and floods globally will be related to the deforestation of the Amazon to some degree, even before accounting for its role in global carbon storage. Despite this vital importance, deforestation of the Amazon rainforest not only continues, but has recently surged to the highest levels in over a decade.[142]

Moreover, the local population's access to water is at risk as a result of water pollution, deforestation and climate change. According to the World Water Quality Assessment published by UNEP, severe pollution affects around 25% of Latin American river stretches. The damming of the Amazon River also exacerbates these environmental challenges. There are reportedly plans for up to 500 new dams on the Amazon to be completed in the coming decades.[143] Some projects have already wrought havoc. The Belo Monte Dam, currently under construction, will be the world's fourth-largest hydroelectric project and its development has already disrupted the region. In 2015, flooding from its reservoir affected almost 420 square km of lowlands and forests, displacing over 20,000 people, and spreading diseases including dengue fever.[144] A recent study by the Conservation Strategy Fund that analysed the economic, social and environmental impacts of a group of 75 road sections in the Amazon showed that comprehensive evaluation processes, accompanied by planning processes at regional and national levels, would avoid millions of dollars in economic losses, as well as irreversible impacts in terms of deforestation and biodiversity loss.[145]

As highlighted in the Blue Peace Index, collaborative data sharing, pollution monitoring and control, as well as joint and coordinated infrastructure development, including environmental impact assessments, are some of the areas that require action at national and transboundary levels. To continue to guarantee access to safe and potable water, reduce the rate of deforestation, and halt river and aquifer pollution, it is necessary to act to protect the region's wetlands and encourage their sustainable management and use.

4. Areas for actions

Despite the complex nature of water systems, which sometimes present inherent trade-offs between the vital interests of individual stakeholders, there are clear steps that governments, companies and households alike can take to reduce the economic cost of water stress and mismanagement in the decades to come. Some of these have an international focus, given the extent to which rivers and lakes are transboundary entities, and policies need to be adopted by all parties to be as effective as possible. But there is also much that stakeholders can do themselves, at their own level, to ensure that water is withdrawn, consumed and replenished as efficiently as possible.

Governments, businesses and consumers should all approach their water consumption from the broadest possible perspective. One such conceptual method is the Total Economic Value (TEV) framework incorporated into the water frameworks of the EU and the OECD, which splits water use into use and non-use values. Examples of the former include water consumed directly at home or work, as well as water used as an input into business processes such as manufacturing. Non-use values attempt to ascribe worth to aspects such as saving water for future generations ("bequeath values"), allowing others with a greater current need to use water instead ("altruistic values"), and the knowledge that water is available if it is required ("existence values"). The principles of this sort of approach can be used by companies to create a shadow price for water in their business plans, to encompass not just the water used directly, but that left in or on the ground, either for others to use contemporaneously or in the future.

Water as a political priority

First, water needs to become a greater political priority. As the World Economic Forum's Global Risks Reports suggest, senior policymakers have long been aware of the threat posed by the water crisis. These concerns have already produced a series of transboundary agreements on water management of several major basins, including those of the Mekong, the Sava and the Senegal Rivers. But there are still major water systems that lack even a basic, top-level agreement between riparian states, including the Tigris–Euphrates basin. The most effective transboundary arrangements and institutions are independent of government and capable of imposing regulation themselves, but are linked indirectly with the highest levels of the executive.[146] For example, the International Commission for the Protection of the Danube River (ICPDR), which has 14 member states as well as the EU, has its own legal identity and can act autonomously and set targets for reducing pollution and flooding and improving environmental health. It then works with the members to help them meet these goals.[147] Such an elevated status is not easy to achieve because it requires governments to cede sovereignty of part of their territory to an organisation over which they have no authority. But without this feature, such regulatory bodies can be pushed aside if, for example, one member decides it wants to build a dam to reduce its electricity costs.

The extent to which these organisations for transboundary water management should be political is a difficult question, heavily

dependent on the contextual situation. On the one hand, tying water up with other priorities, such as the "coal for water" system established between Central Asian states when they were part of the Soviet Union, managed to overcome the unequal distribution of resources by creating co-dependencies that survived through a major political transition. Without a political focus, such agreements can be confined to the scientific and technical aspects of water management and therefore risk being sidelined by decision-makers. Inviting politics into water management also ensures that it is discussed by those with real power. On the other hand, water is essential to human life everywhere and there is a risk of it being seen as nothing more than a bargaining chip if it is allowed to be traded away in political negotiations. The right balance for each basin or water system is likely to be unique to those actors and the circumstances that they find themselves in, since each basin and system is unique in terms of its history, challenges, and economic and political contexts.

Basin-level approach

The agreements are also most likely to be successful if they follow the principles of integrated water resource management (IWRM). According to the Global Water Partnership, an international organisation dedicated to water management, these include "managing water resources at the lowest possible level; optimising supply; managing demand; providing equitable access to water resources through participatory and transparent governance and management; and establishing improved and integrated policy, regulatory and institutional frameworks".[148] For governments, meeting these principles means working alongside other states where basins are shared, taking into account the implications of policy decisions for those they share water with, and, where necessary, forgoing the cheapest or quickest solution if that has detrimental effects on populations outside of their borders.

There is much to gain by engaging at the basin level. The circularity of water systems means that countries are unlikely to escape the negative consequences of water pollution in their neighbouring states, and research has suggested that the more deeply riparian states cooperate with one another on water, the lower the incidence of war and conflict between them.[149] In Brazil, for example, environmental regulations are far stricter than in several of its neighbours, explains Luis Pabon of the Inter-American Development Bank. But because of a lack of international harmonisation, the simplest solution for some producers has been to move polluting processes across the country's borders, rather than modifying processes to be less damaging.[150]

Evidence-based policymaking

Equipped with principles to guide their approach, governments should begin by improving their data collection and knowledge surrounding water, and use that data to inform their policymaking, particularly as digitisation has made the generation, analysis and monitoring of data far faster and more accessible. High-quality data and knowledge about the water cycles in river basins, and the impact of human-led activities like dams and industry are critical to ensuring that riparian communities can respond effectively to emerging challenges. Scientific evidence, insights from stakeholders, technology, and funding from donors are all necessary to obtain a full picture.

Without these, there is a risk that at this time of fast-moving ecological and hydrological changes, the speed of global warming and its effects on water systems could outpace governments' understanding. If that knowledge is operating with a lag or is not present, it is impossible to design holistic policymaking and develop mitigation and adaptation measures that will remain appropriate for an extended period. This knowledge also needs to be transmitted to the public, where appropriate.

Businesses have a role to play

There is a role here for businesses, too, especially large corporations working in smaller economies with higher levels of water stress where their activities have an outsized effect. Firms appear to be waking up to the importance of monitoring where their water comes from, how much of it they use, and the impact of their wastewater – for environmental reasons but equally for financial ones.

Becoming water-responsible brings positive returns on investment for organisations. Nonetheless, it is highly unlikely that small and medium-sized enterprises in emerging markets are doing this sort of monitoring. As such, there is a role for governments to play in providing subsidies and other similar incentives to encourage this transition.

Just like governments, once firms have the knowledge about their interactions with water systems, they can begin the more complicated process of learning how to make themselves more water-efficient. This might involve moving production facilities to locations with more-abundant water supplies, or where there are already more sophisticated recycling systems in place. Or it might mean changes to their product range to focus on goods with a smaller water footprint. Included in this strategy ought to be a consideration not just of the quantity of water that they withdraw, but also the quality of water that they expel. In order to participate in circular water management they need to control their pollution and reuse and

recycle their wastewater wherever possible. Where targets are set they should be local as well as global. "Over the last few years, many companies have announced plans to reduce a certain percentage of water use in manufacturing. Whilst these global goals are a good starting point, they do not tell you much about a company's impact on actual water resources in a specific location that might be water-stressed, as for that to be the case, the right target has to be very localised, or what is called 'context-based'," claims Tatiana Fedotova, a Water Stewardship Consultant at the Swiss Agency for Development and Cooperation.[151] A net overall reduction in water withdrawals might sound impressive, but it could actually be harmful if more withdrawals were moved from areas where water is plentiful but regulation is tight, to locations with more relaxed laws but a greater incidence of water scarcity.

Investors have a role to play

Investors and multilateral institutions, such as the IMF and the World Bank, can also steer funding towards firms and projects that are committed to sustainable water management practices and, conversely, can try to improve the behaviour of laggards by attaching conditions (or costs) to their borrowing. This behaviour would not be entirely altruistic. If their clients are exposed to the economic costs of poor water management, then this affects the value and performance of the investors' assets. This pressure can achieve some tangible results. After two fatal and ruinous tailings dam disasters in Brazil in 2015 and 2018, it was institutional investors that pushed for the establishment of global management standards of such dams in the hope of preventing further loss of life and environmental degradation.[152]

Ms Fedotova also believes that investors are becoming more interested in commercial loans surrounding water as an asset, which would create another potential area where standards could be raised.[153] Portfolio managers, for example, are increasingly recognising that physical, reputational and regulatory water risk could adversely impact the value of their investments, particularly in water-intensive industries, including food, mining, textiles and utilities.[154] As a result, the number of companies reporting on water through CDP's annual questionnaires on climate, water and deforestation risk increased yet again in 2020, with 2,934 businesses disclosing, up from 2,433 in 2019.[155] But an increase in reporting is only the first step, and investors have a critical role to play in encouraging companies to take action to reduce their risk.

Considering the economic cost of water

Next, governments should consider how effectively they consider the economics of water. At present, this varies considerably by country. According to a special report by *The Economist*, property owners in India have the right to use all of the water that exists on and under their land. (India also has some of the world's worst figures on the depletion of groundwater.) By contrast, in Israel, which is at the forefront of water technology, all water is the property of the state. Other countries fall somewhere in the middle. Any ambiguity in legislation also risks access and usage becoming highly litigious. Again, a one-size-fits-all approach is not neither possible nor desirable but laws do have to make consumers accountable – and not just the end-users. Those that drain the groundwater that they own could be charged more for heavy

consumption, while state provision could lower the unit price for those with low or no incomes in order to maintain access for all.[156]

Public understanding of the consequences of water consumption can also be improved. It is simple and widely understood in many countries that turning off the tap while brushing your teeth is an easy way to reduce consumption. Likewise, so can minimising the use of sprinklers on garden lawns. But societies are less aware of the hidden water consumption within almost all consumer goods, from food to clothing to semiconductors. After all, only 10–20% of water consumption takes place in the home. The water footprint approach seeks to illustrate the hidden link between the consumption of goods and the depletion of water in regions where goods are often produced. The approach measures humanity's pressure on freshwater resources in volumes of water consumed and polluted, and can be used to measure the footprint of an organisation, a value chain, or even a particular product.[157] Without doubt, reducing direct water consumption is a good start, but such improvements can be counteracted by increasing consumption of virtual water through rising imports. Guidance printed on packaging to advise customers of the water intensity of the products on the shelves would make water more of a consideration in purchasing decisions and spur companies to cut their consumption as another way to differentiate themselves from their competitors.

Prioritising environment-friendly solutions

Finally, after a period where human interference has degraded water systems around the world, resulting in a warmer planet and less predictable supplies, policymakers could consider harnessing nature's ability to repair itself, learning to reconsider the value of our environment. Nature-based solutions imitate natural processes to repair or improve the quality and quantity of water resources. The International Union for the Conservation of Nature (IUCN) uses the example of forests running alongside a river. Cutting down the forest could enable more ready access to the water, for power generation or industrial purposes, or to enable the construction of new homes. But keeping the forest intact will enable the trees to reduce evaporation and regulate the water and soil run-off from the river, preventing reservoirs further downstream from becoming clogged up with sediment and enabling the power plant next door to run more efficiently.[158] Other examples include peatlands that store carbon, wetlands that filter dirty water, and floodplains that absorb excess water. According to the IUCN, nature-based solutions can provide up to 37% of the emission reductions needed between now and 2030 to keep global warming below 2°C,[159] which will have an impact on water resources. "Nature-based solutions are also a cost-effective way to build infrastructure resilient to a changing climate, while also providing other social benefits," says Alfonso Malky of the Conservation Strategy Fund. Interfering with these natural solutions, by building homes on flood-prone areas and cutting down forests that absorb carbon from the air, increases the pace of environmental degradation and changes to water systems.

Summary

Over the past century, available freshwater resources have been increasingly strained as withdrawal rates have outpacing global population growth. Global demand for water is expected to grow further, driven by continued population growth, rising living standards, and the effects of climate change. Yet the available water resources have not been managed well. Increased water scarcity, more frequent and severe floods and inadequate water quality present a significant risk to the health of communities and ecosystems, as well as global agricultural, energy and industrial systems. Water shortage and excess are already drivers of the most damaging natural disasters. One study estimates that nearly 75% of all natural disasters between 2001 and 2018 were water-related, and that during the past 20 years floods and droughts affected over 3bn people and caused total economic damage of almost US$700bn.[160] The indirect costs of water stress for communities and businesses go beyond this, and are already vast and expected to increase substantially in the future.

Despite the complex nature of water systems, which sometimes present inherent trade-offs between the vital interests of individual stakeholders, there are clear steps that governments, companies and households alike can take to reduce the economic cost of water stress and mismanagement in the decades to come. Governments and policymakers need to move sustainable water management, including at basin and transboundary level, to the top of their agenda. Businesses and investors should improve their accounting and assessment of the impact and risk that their water footprint has on their bottom line. Finally, communities need to consider the value of water more holistically, and appreciate their direct and indirect water footprint.

Action required

The three main causes of water stress and insecurity, 1) **Water Shortage**; 2) **Water excess**; and 3) **Poor water quality**, have an impact on global and local economies through their adverse effects on:

Agriculture | **Energy** | **Industry** | **Household** | **Ecosystems**

Responses

To reduce the economic costs of water stress and insecurity, actions must be undertaken by:

Consumers | **Producers** | **Financiers** | **Regulators** | **Interest groups**

Source: EIU analysis

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