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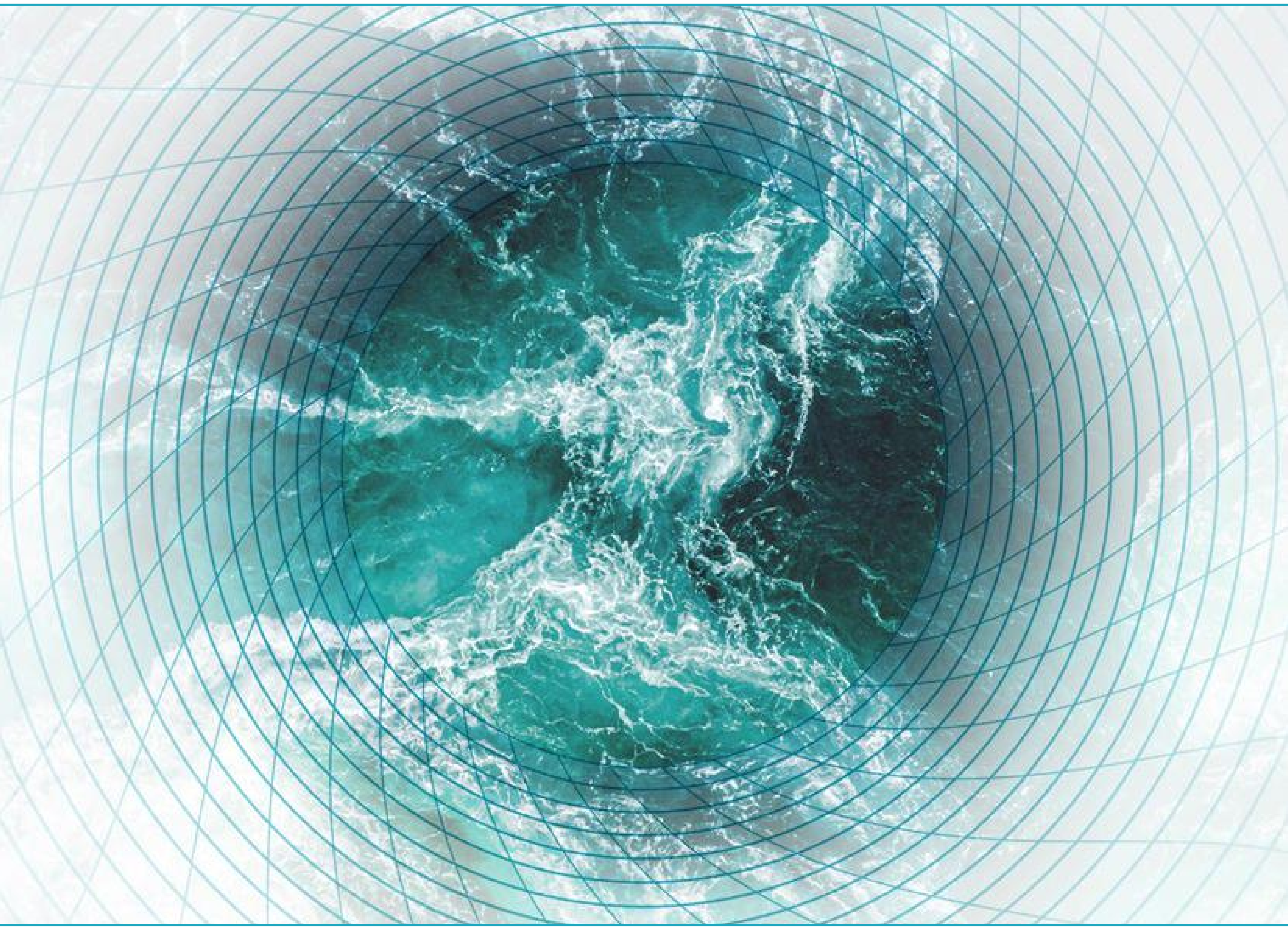


BOILING POINT

Global growth, climate change and the increasing pressure for water resources

October 2021

Sustainable Investing Expertise by ROBECOSAM

Contents

Executive summary

Water is essential, not only for life but also for social and economic progress. Yet despite this status as a critical asset, its true value is underestimated and its use is largely unsustainable. Increases in water demand coupled with limited supply and uneven distribution are leading to water stressed regions across the globe. Current trends like climate change, population growth, industrialization and decreasing water quality will strain supplies and further exacerbate water stress.

The extent and impact of the water crisis is not uniform: the developing world suffers disproportionately higher levels of water stress and lower levels of quality compared to developed countries. Moreover, the underlying drivers, exacerbating factors and available resources vary substantially across regions. As a result, solutions are also not uniform. The diversity and complexity of challenges faced means they will each require a unique balance of financial investment, governmental regulation, technological advances, nature-based approaches and/or market incentives to be successful.

The RobecoSAM Sustainable Water strategy focuses on investments in listed companies that seek to enhance water supplies, protect water quality and increase access and distribution to urban and rural populations worldwide. The strategy is composed of diversified investment clusters that capture value and growth opportunities across market segments and classes of solutions throughout the global water value chain.

Though the challenges are significant, they are not insurmountable and overcoming them will boost productivity, encourage economic growth and contribute to sustainable development in emerging and developed regions across the globe.

The RobecoSAM Sustainable Water strategy is helping accelerate change through capital investments in companies that are creating positive impact and sustainable progress.

1

Water – precious but increasingly scarce

Clean water is essential, not only for life but also for social well-being and economic growth. It impacts the development of nations and populations across several critical areas – from basic human needs such as the drinking water, sanitation and food production required for physical health to broader needs such as energy, commerce and education required for social development, economic growth and wealth creation. To ensure a population's physical and social needs are met and its economic development secured, water availability must be sustainable.

However, the current use of water resources is largely unsustainable. Even though in many parts of the world water is considered a precious commodity, its use is still too high and its price far too low to accurately reflect its true value. This leads to overconsumption in some regions even as other regions suffer water stress and scarcity. While water supplies are limited, water demand is set to dramatically increase, fueled by climate change, industrial development, population growth and changing demographics. Without action and investment, the imbalance between supply and demand will continue to grow.

Water availability

Limited supplies – made worse by access and distribution

Although 66 % of our planet is covered in water, only 3.5 % of it is freshwater. Moreover, only around one-third of freshwater supplies are accessible via ground and surface waters. The single source of this available water is precipitation over the Earth's land mass, which is estimated to be around 110,000 km³ annually.

Freshwater sources

Precipitation – Water released from clouds in the form of rain, freezing rain, sleet, snow or hail. It is the primary connection in the water cycle that provides for the delivery of atmospheric water to the Earth. Most precipitation falls as rain. [2]

Surface waters – Any body of water found on the Earth's surface. Surface waters that are freshwater sources include rivers, streams and lakes, wetlands, reservoirs, springs and creeks. Oceans are also considered surface waters but consist of saltwater. Surface waters can persist all year long or for only part of the year. [5]

Ground waters – Water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers. [6]

Approximately 61 % of this precipitation evaporates back into the atmosphere, leaving around 42,920 km³ for drinking, sanitation, agriculture and industrial use.[7] This represents ten times more than total annual usage, which means the challenge lies in increasing water access and distribution around the globe.

Precipitation – the luck of location

Despite sufficient precipitation, its distribution is uneven around the globe (Figure 1). Most rain falls around the equator and on the eastern side of large continents, which means large volumes of freshwater are available to these parts of South and North America, Sub-Saharan Africa, and East Asia. The western coasts of continents, the subtropics, as well as regions east of large mountain ranges receive significantly less precipitation relative to their landmass, leading to regional water scarcity.[8] Additionally, in most regions, the amount of precipitation varies significantly over the year. Physical water scarcity is thus often not a chronic state but rather a seasonal phenomenon. Whilst 0.5 billion people live in areas with severe physical water scarcity all year round, more than 3.9 billion live in areas that have water scarcity at least one month a year.[9] In these regions, water scarcity can largely be addressed via usage management and more effective infrastructure.

Figure 1 | Falling short – Global rainfall is ample but uneven

There's more than enough water to cover global needs. Where it falls is the problem. Three decades of data show areas which receive the most and least precipitation annually. Data shown is annual rainfall from 1961–1990 in mm/year.

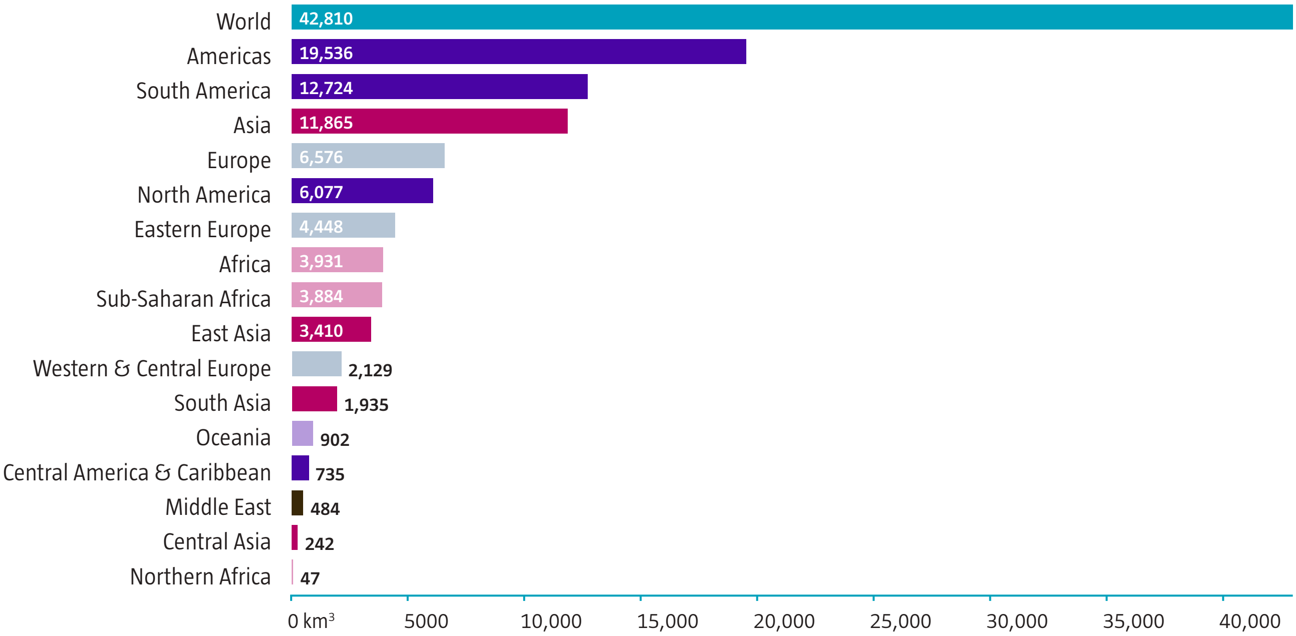
Source: UN Food and Agriculture Organization, FAO, 2021

Groundwater – more discharge than recharge

Most precipitation runs into surface waters such as lakes and rivers or penetrates and accumulates in groundwater storage areas in soil and underground aquifers. Surface waters are easily accessible but also highly susceptible to drought and contamination. Groundwater, on the other hand, is a self-cleaning, safe water source, particularly at times when surface waters are not readily available due to drought or pollution. Groundwater provides at least half of the world's population with drinking water without prior treatment and accounts for more than 40 % of the water used for irrigation.[7, 10]

Because of the slower recharge rate of groundwater reservoirs – often decades to centuries – they are prone to depletion. Thirty percent of the world's largest aquifers are steadily depleting, many of which in regions already suffering from water scarcity.[11]

Figure 2 | Volume variations – global disparities in groundwater replenishment and retention



The graphic displays internal renewable freshwater resources, the quantity of internal freshwater from inflowing river basins and recharging groundwater aquifers. As with precipitation, there are also large regional disparities related to the replenishment and retention of inflowing ground and surface waters.

Source: Water Use and Stress, Our World in Data, H. Ritchie and M. Roser, 2017

Water and women – the link between physical, social, and economic health

Nearly 800 million people around the world lack access to safe water and for many, the time-consuming task of securing access to quality water limits the time spent on other socially productive and economically beneficial activities, such as schooling and education and gainful employment.
As water collection largely falls to women and girls, not only their health but also their economic and future prospects suffer. Many spend hours a day walking to distant water sources to fetch daily water supplies – a daily walk that, extended over years, ends in a marginalized life.

Moreover, the health consequences are equally disproportionate. Access to clean water and sanitation is particularly crucial for young girls and women during menstruation, pregnancy and childbirth. One million deaths each year are associated with unclean births. In 2019, infections accounted for 26 % of neonatal deaths.

For hundreds of millions of women and girls around the world, access to clean water would become the great equalizer – freeing time, improving health, boosting education and expanding opportunities for social, economic growth across communities.

Source: WHO, UNICEF

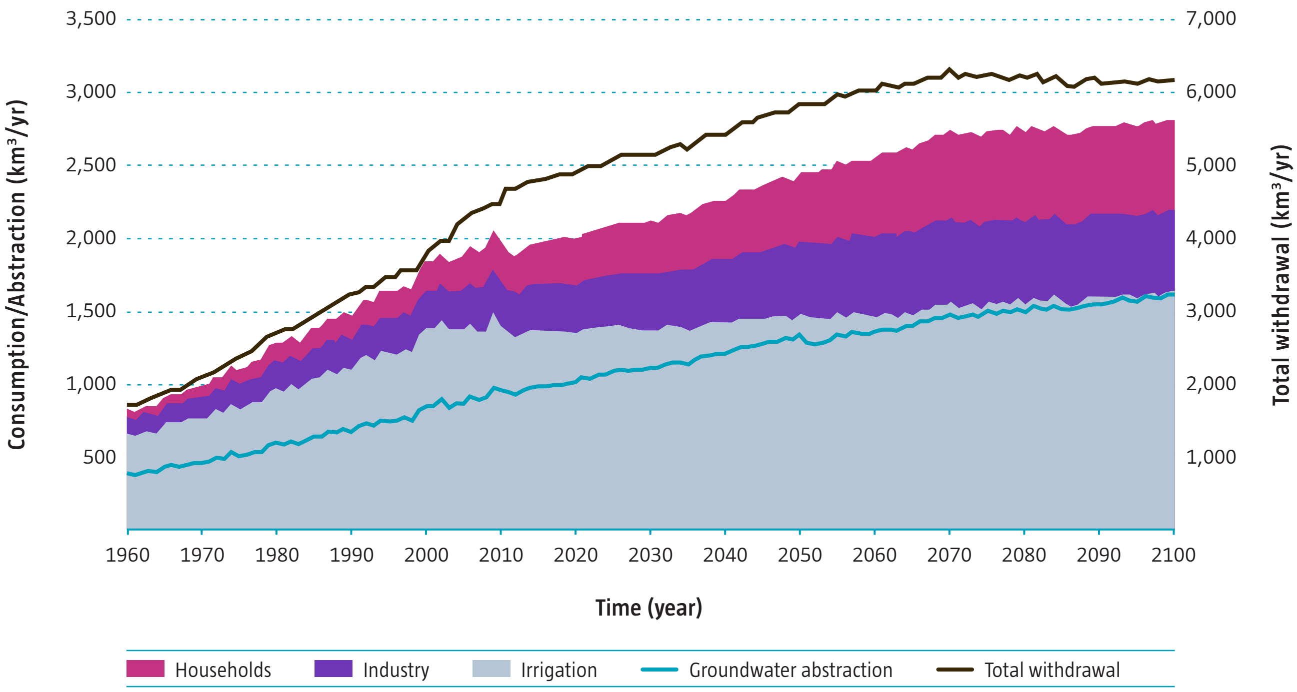
Water demand

Growing populations – a major driver of water consumption

The global population is growing and with it the amount of water consumed. Total freshwater use has increased by a factor of six over the past 100 years and continues to rise around 1 to 2 % annually (Figure 3).[12] By 2050, it is expected to reach between 5,500 and 6,000 km³.[13, 14]

This rise in demand reduces the amount of available renewable water per capita from sources that are replenished via precipitation. Annual per capita water availability declined from 7,374 m³ in 1997 to 5,732 m³ in 2017, a decrease of 22 % over 20 years (Figure 4).[14]

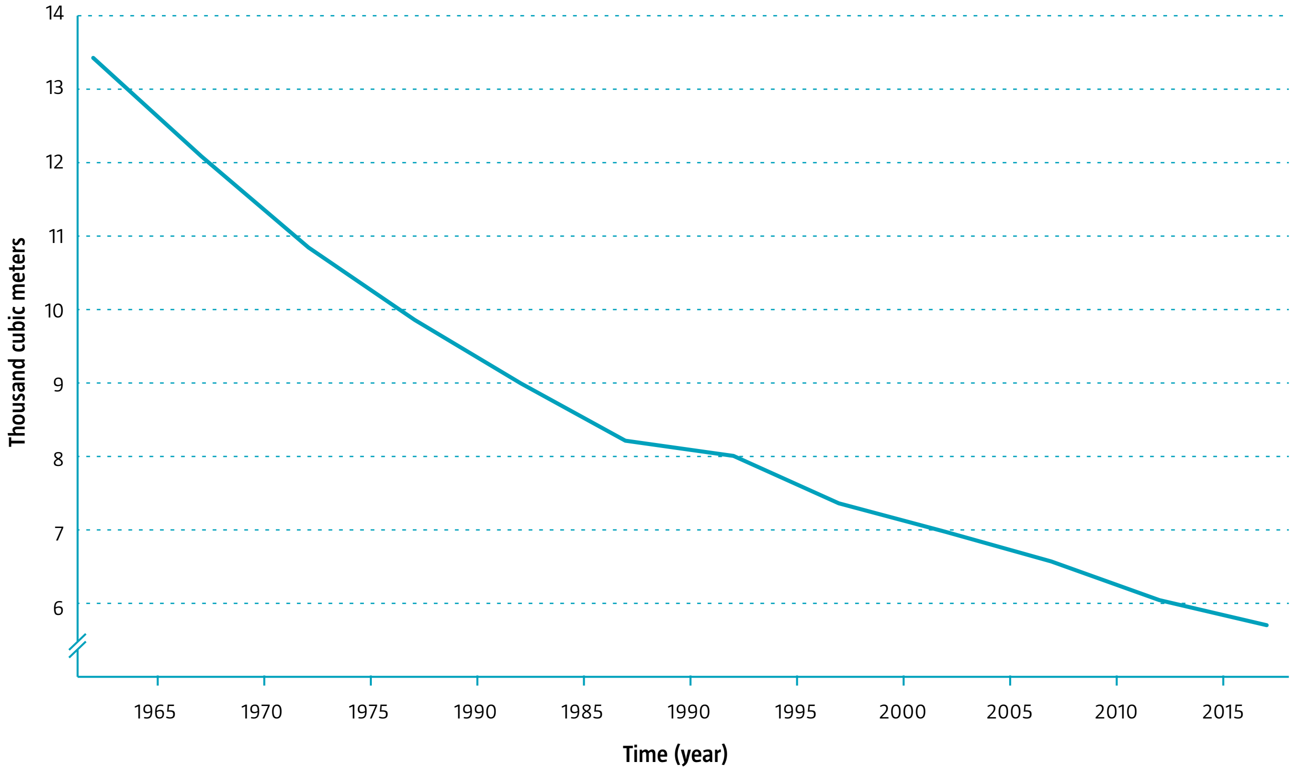
Figure 3 | Unquenchable thirst – global water consumption expected to rise this century



Water withdrawals from all sources will continue to rise this century. Consumption and groundwater abstraction is displayed on the left axis. Consumption refers to water used by households, industry and irrigation but which is not returned back into the water system. Total withdrawal is displayed on the right axis.

Source: Wada, Y., Bierkens, M., Environmental Research Letters, 2014

Figure 4 | Sinking lower – freshwater availability is on the decline



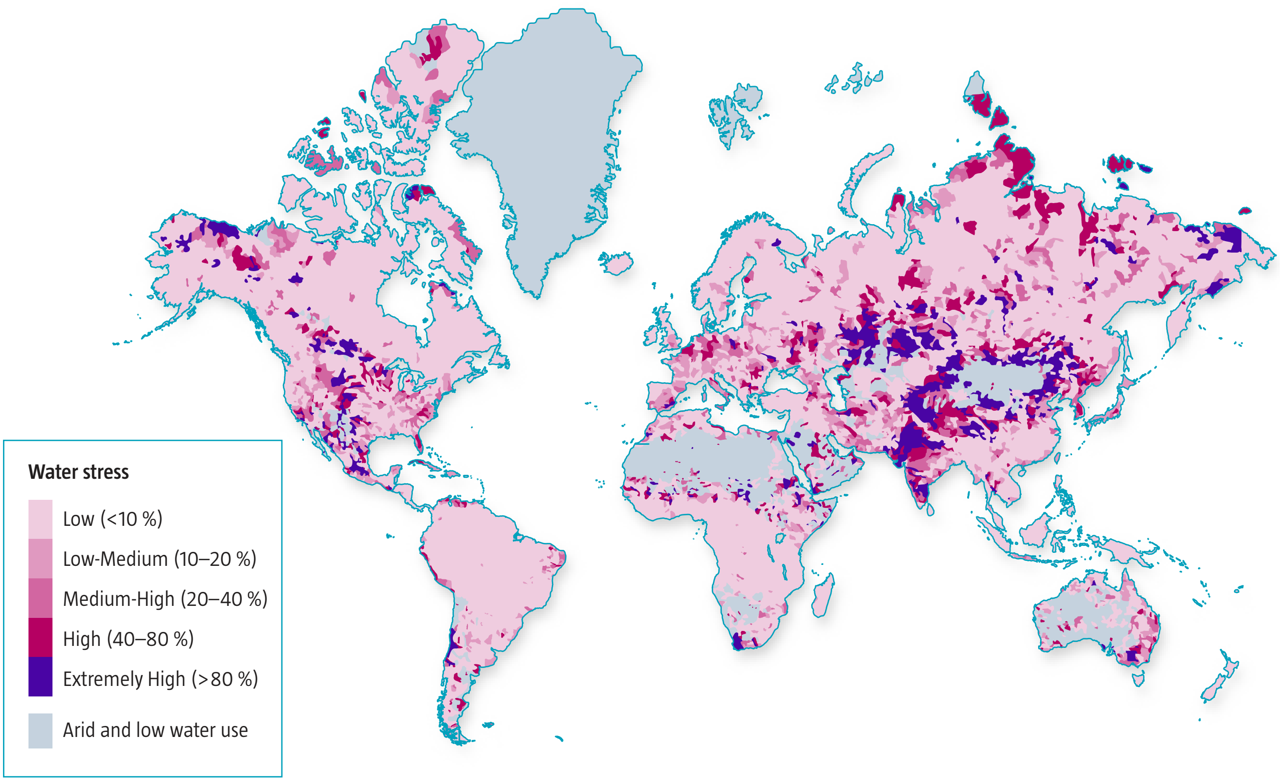
Water availability per person continues to sink

Source: World Bank, 2021

The global reduction in water availability per capita, coupled with uneven distribution and uneven population density, is leading to water-stressed regions on every continent. Water stress is measured by the Water Exploration Index (WEI) which records water consumption as a percentage of annually renewable water reserves through precipitation and inflow of surface water. A WEI of 20 % is a critical value that signals the beginning of a water shortfall; 40 % indicates a high risk of water stress.[15]

Several regions in Europe already have a WEI of over 40 %, but the regions of greatest concern are northern India, China, California and South Africa, where urbanization, changing precipitation, and extreme weather are combining with increasing populations to exacerbate water stress (Figure 5).[16]

Figure 5 | Regions at risk – every continent contains regions of water stress



Lower precipitation and denser populations is contributing to water stress in many world regions.

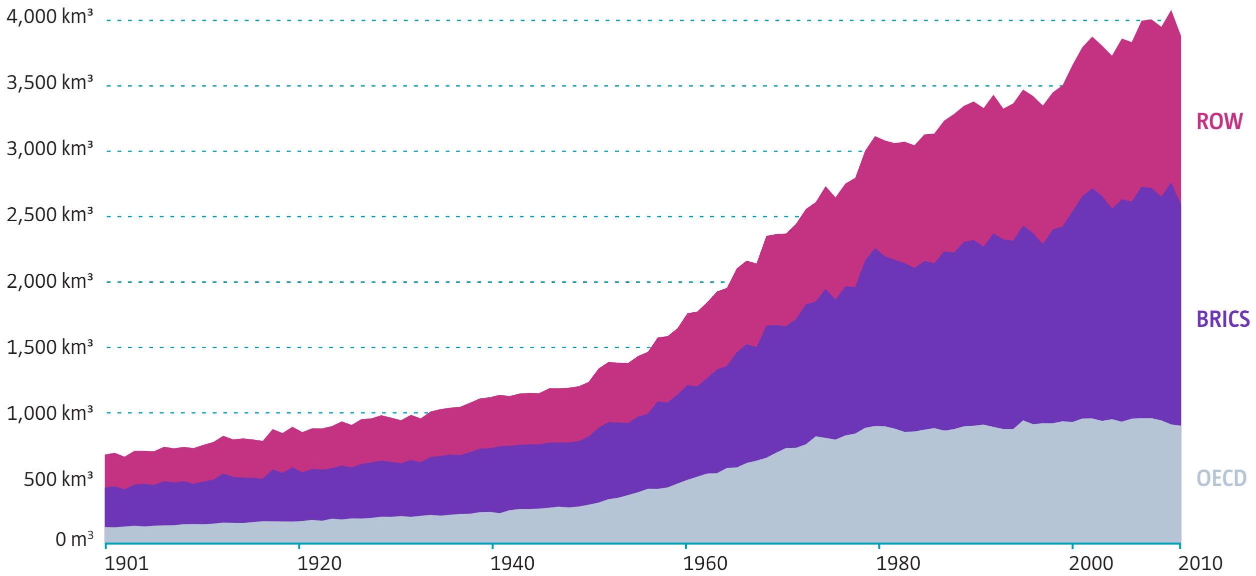
Source: World Resources Institute, 2019

The rise in demand is not globally uniform: demand in OECD member countries has stabilized while BRICS have seen a modest increase. Regions outside of these areas have seen larger demand increases (Figure 6).[17] The highest increase can be traced back to greater industrial demand, which includes energy generation as well as higher per capita consumption due to rising living standards in developing countries.[13]

Figure 6 | Water use around the globe – total consumption in developing regions on the rise

Freshwater use by aggregated region, 1901 to 2010

Global freshwater withdrawals for agricultural, industrial and domestic uses by aggregated regional groupings. OECD members are defined as countries who were members in 2010 and their membership was carried back in time. BRICS countries are Brazil, Russia, India, China and South Africa. ROW refers to the Rest of the World, excluding OECD and BRICS countries.



Water consumption in the different economic regions of the world.

Source: Ritchie, H, Roser, M, Water Use and Stress, Our World in Data, 2018

Water-hungry sectors

Water use can be roughly divided into three areas: agriculture, urban water management and industrial production. The ratio of distribution depends strongly on the economic development of regions.

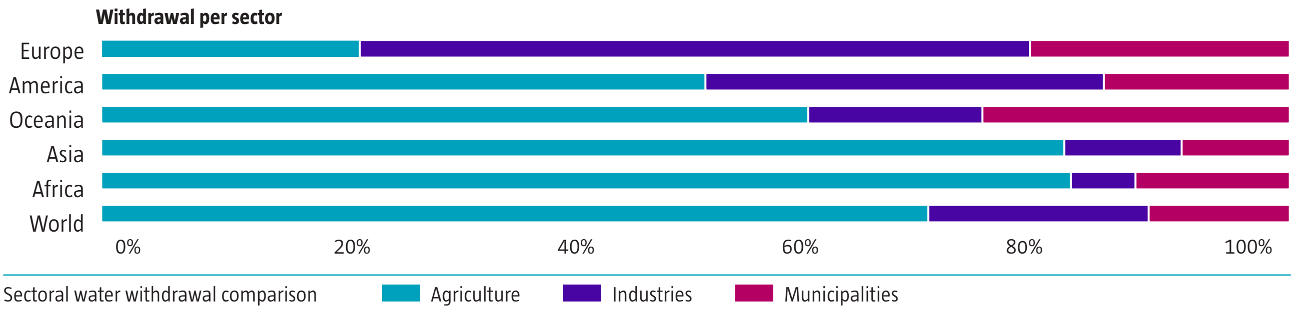
The agriculture sector currently accounts for 69 % of global water withdrawals, which are mainly used for irrigation but also include water for livestock and aquaculture.[7] Industry (including energy and power generation) accounts for 19 %, while municipalities are responsible for the remaining 12 %.[12] There are, however, major regional differences in water use. In developed countries, approximately 50 % is consumed by industry whereas in most developing countries, more than 80 % is used for agricultural purposes (Figure 7).

Agriculture

The major part (80 %) of the world's cultivated cropland receives water via direct precipitation and accounts for 60 % of the food produced. Rainfed agriculture uses direct precipitation amounting to about 5,173 km³ annually. Irrigated agriculture accounts for 40 % of food production on only 20 % of the cultivated lands, with an annual global water consumption of 2,230 km³ per year.[18] This underscores the vital importance of irrigation for food production. Around 40 % of that water is extracted from groundwaters, with the remainder derived from surface waters.

While agriculture is responsible for an average of 70 % of global water withdrawals, regional comparisons reveal dramatic differences. Agriculture in European countries with moderate climates accounts for as little as 10 % of total country withdrawals, the rest flowing to industries and municipalities. Proportions are however flipped in the developing world, where irrigated agriculture absorbs as much as 95 % of total water withdrawals.[12]

Figure 7 | Agriculture dominates water withdrawals in developing regions



Total waterwithdrawal and total and relative water withdrawal for agriculture (2010)

	Total water withdrawal (km³/yr)	Agricultural water withdrawal (km³/yr)	Agricultural water withdrawal as % of total water withdrawal
Africa	226	183	81
Americas	854	412	48
Asia	2,584	2,103	81
Europe	322	88	27
Oceania	19	11	58
World	**4,005**	**2,797**	**69**

Water consumption within developed economies is more evenly diversified across agriculture, industry and municipalities. Consumption in developing economies is dominated by agriculture.

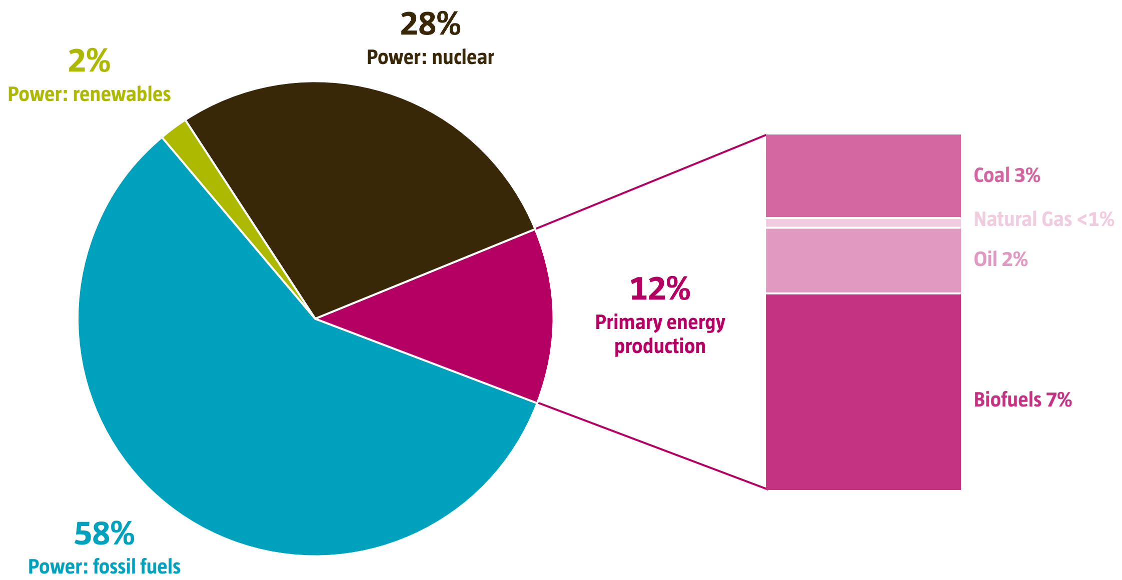
Source: UN World Water Development Report, 2021, UN Food and agriculture department (FAO), 2014

Energy and industry

Water plays a crucial role in both energy and industrial production. Primary energy and power production is responsible for approximately 10 % of total water withdrawals, of which 3 % are consumed and not available for further use. A similar share is used by other sources of industrial production such as semiconductor manufacturing or mining industries.[19] Primary energy and power production sectors use water mainly for hydrocarbon extraction, processing and refining; for irrigation of biofuel feedstock crops; and for cooling systems in power generation (Figure 8). Moreover, the link between water and energy is further intensified when considering the vast amounts of energy needed to transport, treat and distribute water throughout the economy.[20]

Figure 8 | Currents and flows – water use and energy production

Total withdrawals: 398 km³



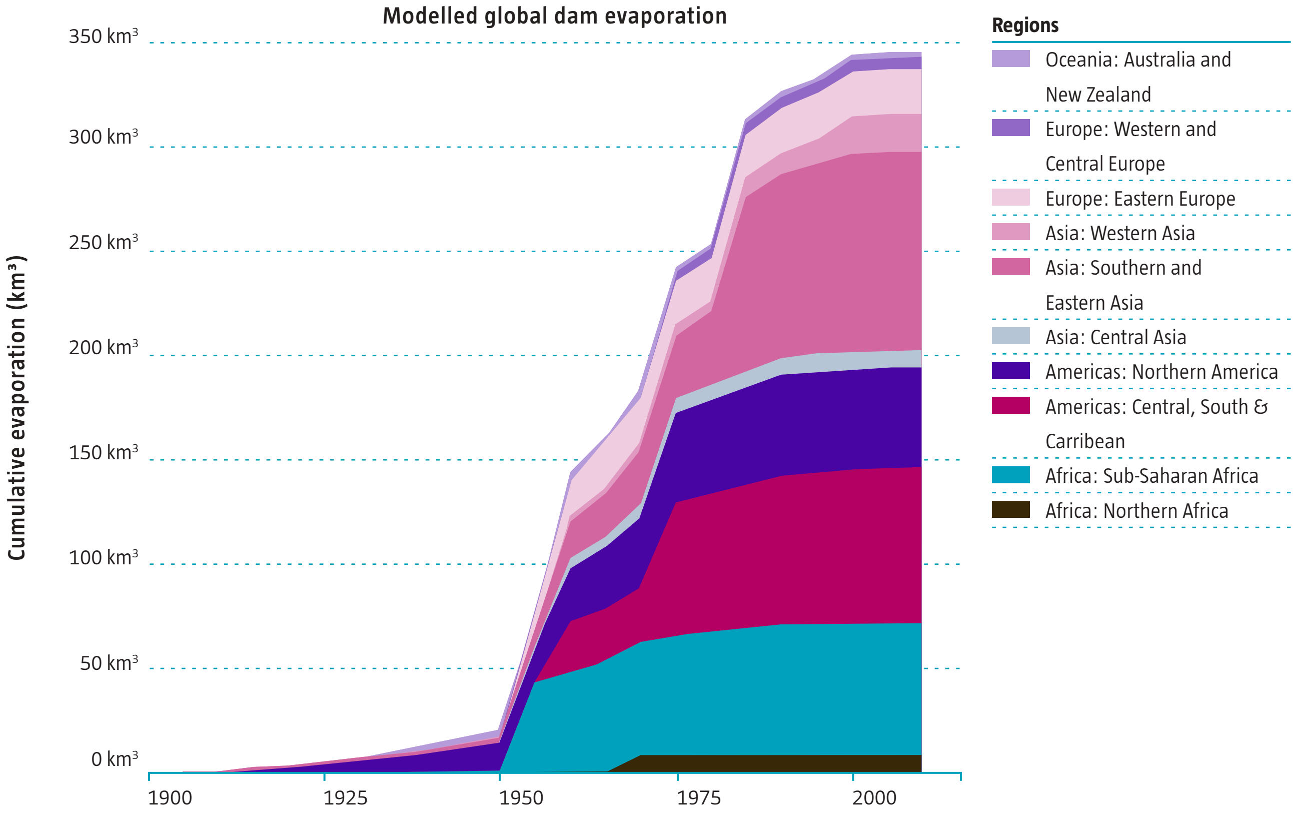
Power generation is by far the largest source of energy-related water withdrawals

Source: World Energy Outlook 2016, International Energy Agency, 2016

Water loss via dams

Despite its low share in overall power generation, hydropower is still an important source of energy, accounting for as much as 80 to 100 % of electricity in some regions, both developed and developing.[21] However, not all dams are built for energy production. Other dam functions include flood control, water supply, irrigation, stock/farm ponds as well as recreation. Because of their large surface areas, these artificial lakes and reservoirs lose more water to evaporation than would have otherwise been lost by natural water flow absent the dam. Evaporated water is considered lost because it cannot be re-captured and used. Depending on a dam's geographic location, these losses can be substantial. Total global water loss of dams is around 346 km³ per year, similar to the amount used in power generation (Figure 9).[22]

Figure 9 | Evaporating assets – water loss via dams



Dams are a significant source of water loss via evaporation.

Source: Kohli, A., Frenken, K., Evaporation from artificial lakes and reservoirs, AQUASTAT, FAO, 2015

Agriculture is and will continue to be the main consumer of water, but the share used for industrial and energy production (including dams) is rising and expected to increase proportionally in the future.

Municipal use

Compared with agriculture and industry, municipalities account for a relatively smaller portion of national water withdrawals. As expected, there are also large disparities in the amount of water regions consume. On average, developed countries water usage range from 150 to 560 liters per day per person, whereas in developing countries, typical daily consumption is much lower, with many falling below 50 liters per person.[23] Besides the increase in consumption stemming from economic growth, urbanization has also had a major impact on water use. Whereas rural regions often use less water, urban regions tend to have a higher use per capita.[24] In 2018, more than half the world's population (4.2 billion) lived in cities. Around 3.2 billion of these urban dwellers live in less developed regions compared with 1.0 billion in developed regions. This ratio is expected to rise, with the majority of urban population growth expected to occur in the least developed regions.[25]

Urban regions also produce vast amounts of wastewater that pollutes existing water resources and further limits the availability of clean water. It is estimated that globally, over 80 % of all wastewater is excreted untreated into the environment: water that eventually re-enters the water cycle.[26] Untreated wastewater is also an important source of GHG emissions and, therefore, improved wastewater treatment can contribute to climate change mitigation. According to the International Water Association, treating wastewater reduces its GHG emissions by two thirds.[27]

Water quality – creating health and wealth

Water quality through pollution has deteriorated in nearly all major river systems in Asia, Africa and Latin America. The principal offender is wastewater from municipalities and agricultural runoffs that are loaded with fertilizers and other micro-nutrients.[28] Moreover, in addition to chemical pollution, agricultural runoff adds to the production of harmful bacteria, algae, and eutrophication[a]. Globally, an estimated 80 % of all wastewater is released untreated into the environment.[26] Whereas more than half of wastewater in developed countries undergoes at least basic treatment (55.5 % in 2020)[29], that figure drops to an estimated 8 % in developing countries.[12]

Pollution in river waters has been shown to have a negative impact on downstream economic activity. Heavily polluted rivers significantly impact GDP, reducing downstream economic growth by a third. More alarmingly, in middle-income countries where pollution is most severe, it reduces downstream GDP growth by 50 %.[12]

The lack of treatment further endangers safe water supplies, especially from rivers and lakes. In 2017, 29 % of the global population had no access to a safely managed drinking water service. Dirty drinking water strongly correlates with preventable illnesses such as diarrhea. Economic losses arising from undernutrition, often caused by sicknesses like diarrhea, are estimated to be more than USD 2.0 trillion annually.[30]

a Eutrophication is the excessive growth of plant and algae in lakes, ponds and other surface waters. It robs fish and aquatic organisms of oxygen and promotes cyanobacterial growth.

2

A deeper dive – changing climates, shifting populations and industrializing nations will intensify scarcity

Projections for the coming decades paint a grim picture. More than half of the world's population could experience water scarcity at least one month per year by 2050.[31] The main drivers of water scarcity – water resource availability, water demand and water pollution – are strongly linked to climate change, population and economic growth and vary substantially by region. Global averages do not fully reflect local realities, where conditions can be more severe and more destructive. To understand how to mitigate and manage water scarcity, it is important to examine these underlying drivers separately.

Water availability

Climate change

Snow and ice

Climate change is a fundamental factor influencing the future availability of water. The main factors affecting the reliable supply of water are the rise of global temperatures and changing weather patterns. Higher mean temperatures reduce global snow and ice cover. These snow and ice reservoirs are key in balancing the distribution of precipitation throughout the year.[32] In dryer regions, where the rain season is during the colder months, snow and ice store water and slowly release it during the warmer months, leading to a more balanced supply of surface water over the year. Tropical mountain ranges and their adjacent lowlands – topographic features that define much of, for example, northern India, Bangladesh and Myanmar – are at the greatest risk.[33]

Quality degradation

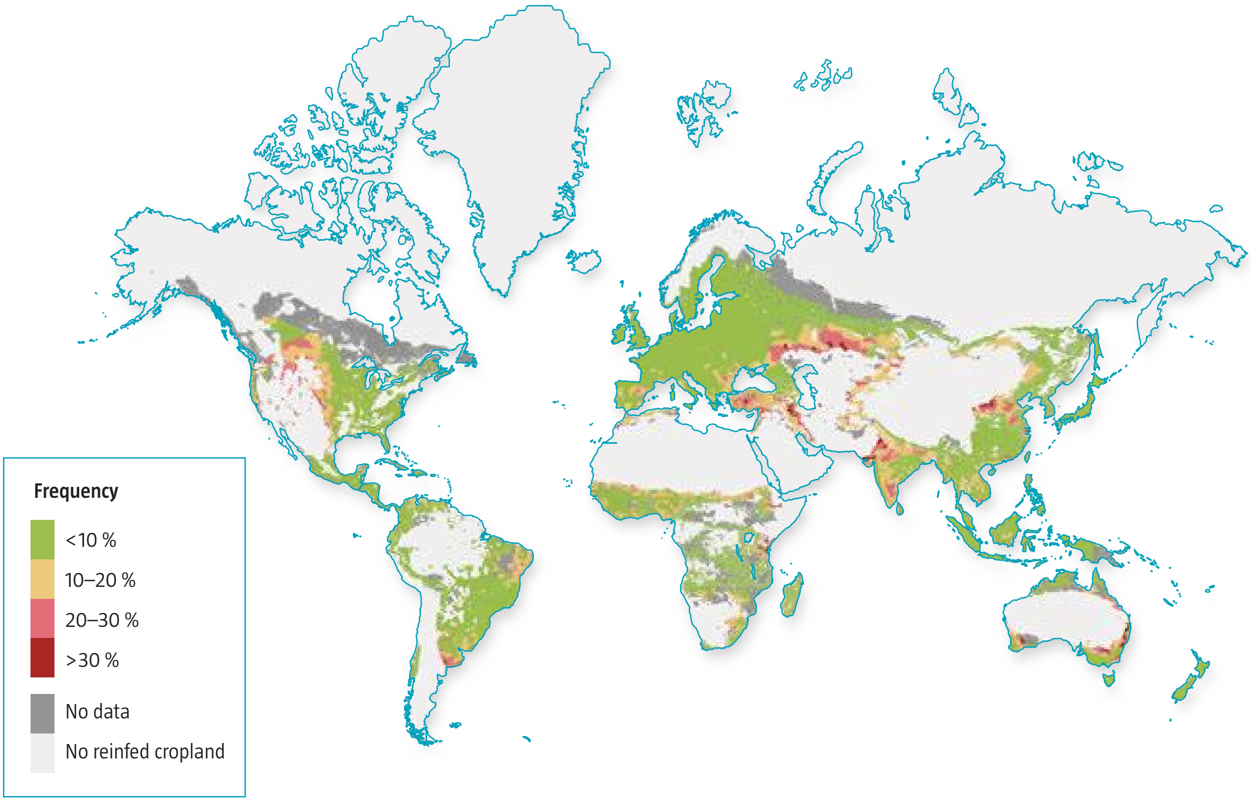
In addition to melting ice and snow, higher water temperatures are degrading water quality of aquatic ecosystems by lowering the concentration of dissolved oxygen. Too little dissolved oxygen kills fish and other organisms and allows toxic algae and bacteria to flourish. Many of these threatened organisms help purify water by metabolizing toxins and keeping harmful bacteria in check. Moreover, the benefits of maintaining water quality extend beyond the upkeep of aquatic life to other valuable ecosystem services.

Healthy waters encourage balanced biodiversity between aquatic plants and other organisms, which ultimately promotes natural carbon capture and storage via photosynthesis. Not only does algae overgrowth interrupt the process, it also contributes to further GHG emissions.[34] Moreover, poor water quality carries negative agricultural benefits for fisheries and human recreation.[3]

Droughts and floods

The change in weather patterns, especially extreme weather events such as droughts and floods, is causing a series of chain reactions that put further strain on available water and wastewater services. During droughts, surface waters dry up and increase reliance on groundwater sources. Shrinking water volumes concentrate pollutants to harmful levels. Additionally, the surface soil of drought-stricken areas deflects rather than absorbs rainfall, leading to decreased recharge of aquifers and increased risks of floods. Flooding, in turn, destroys farmland, damages infrastructure and raises the risk of water-borne diseases. Globally, flood events have quadrupled, and droughts have doubled since 1980 (Figure 10). And in the past decade, these events have surged by more than 50 % and 35 %, respectively. The economic damage caused over the last 20 years is nearly USD 700 billion.[3]

Figure 10 | **The frequency and geography of severe droughts on rainfed cropland (1984–2018)**



The map depicts the frequency of droughts on rainfed croplands worldwide over the period 1984–2018. Dark red and pink areas were more frequently affected by severe drought, croplands in light green and yellow areas less so.

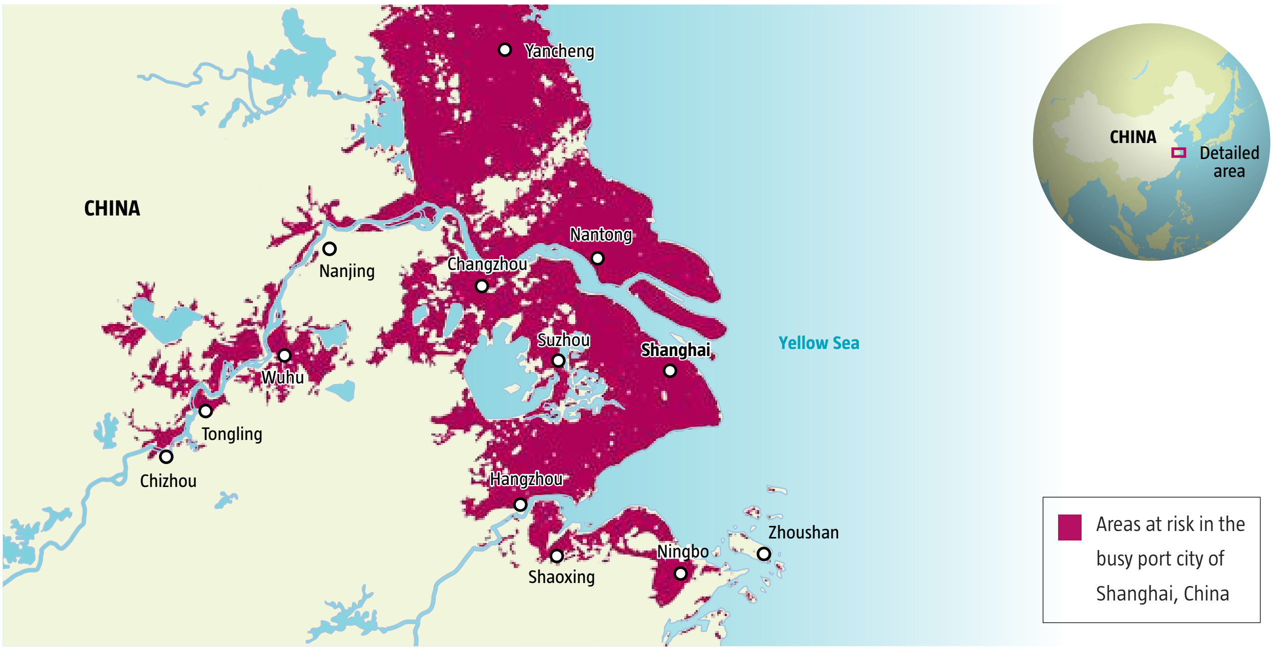
Source: FAO, 2020

Cyclical weather patterns such as monsoons are changing as well. Rainfed regions on the Indian subcontinent and Southeast Asia are receiving less precipitation, which in turn is leading to the overexploitation of ground and surface water resources.[35] Moreover, aquifers in the region are already overexploited and cannot sustain further overextraction.

Rising sea-levels

Rising temperatures and the depletion of existing natural groundwater reservoirs are both causing seal levels to rise. As temperatures rise, snow cover and ice caps melt, increasing ocean water volumes. Moreover, the depletion of about 4,500 km³ of natural groundwater to the ocean has caused sea levels to rise by around 12.6 mm (or 6 % of the total rise) since 1900.[36] Higher sea levels leading to saltwater intrusion into drinking water aquifers that supply coastal areas and to coastal flooding which endangers agricultural land. Without intervention, by 2050 rising sea levels will threaten the water resources and livelihoods of around 300 million people and by 2100 will negatively impact 5 to 10 % of the world's population. The regions most affected include China, India, Bangladesh, Indonesia, Thailand and Vietnam (Figure 11).[37]

Figure 11 | Rising sea levels threaten coasts and commerce



The map shows areas at risk in the busy port city of Shanghai, China. Coastal regions are threatened by rising sea levels and storm-induced flooding caused by global warming.

Source: Climate Central, 2018

Finally, the rise in ocean temperatures is also increasing the frequency and strength of tropical storms, hurricanes and typhoons. Warmer sea temperatures create the conditions necessary to form and sustain tropical storms, thus increasing their frequency, duration and severity. Tropical cyclones (hurricanes and typhoons) are the largest driver of damage and financial losses. In North America, the top four years measured in terms of hurricane-related losses all happened between 2005 and 2018 with damages totaling more than 266 billion in 2005 alone.[38] In 2020, the US experienced a record-breaking number of severe storms and climate disasters. Of the 30 tropical cyclones that developed off its coastlines, 12 made landfall and 7 registered as a climate disaster each with damages totaling at least USD 1 billion.[39]

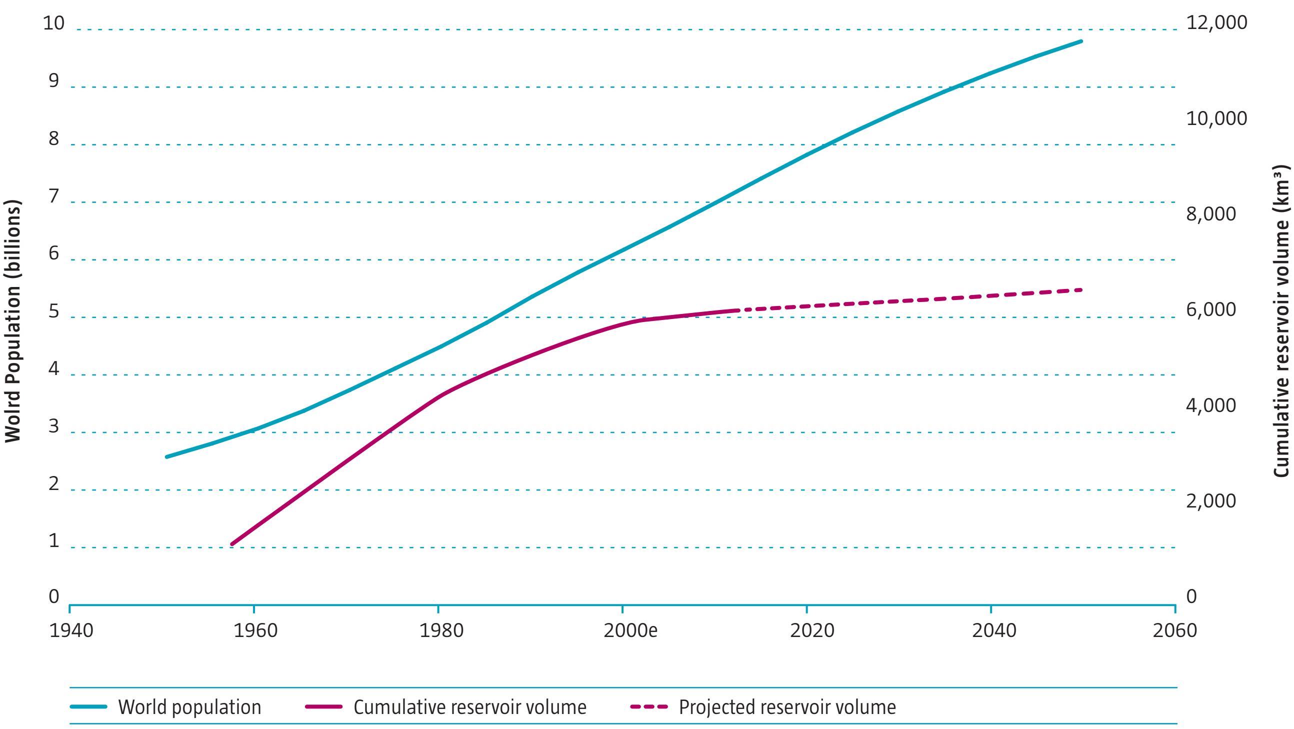
Water demand

Demographic change – population-growth

The world's current population stands at roughly eight billion people, and although growth rates are expected to level off slowly, the total population will continue to increase in the coming decades. Expectations for 2030 and 2050 are 8.6 billion and 9.8 billion, respectively.[25] Demand for water will naturally increase in response to both increased headcount and improved living standards. This is of particular concern in emerging markets such as India and China, where water resources are already under stress.

Increased consumption decreases both water availability and artificial storage capacity per capita. Artificial storage capacity, of which dams are a good example, provides an important buffer in times of reduced precipitation. Sedimentation of stones and particles in dams contributes to a 1% loss of built artificial storage reserves annually (Figure 12). The risk of storage capacity shortages is high in many parts of Africa, Australia, northern China, India, Spain and the western US.[40] Capacity shortages adds to the overextraction of both surface and natural groundwater storage.

Figure 12 | Global water reserves are flatlining even as populations swell



As global populations grow, reservoir capacities are shrinking, leaving less water per capita in the future.

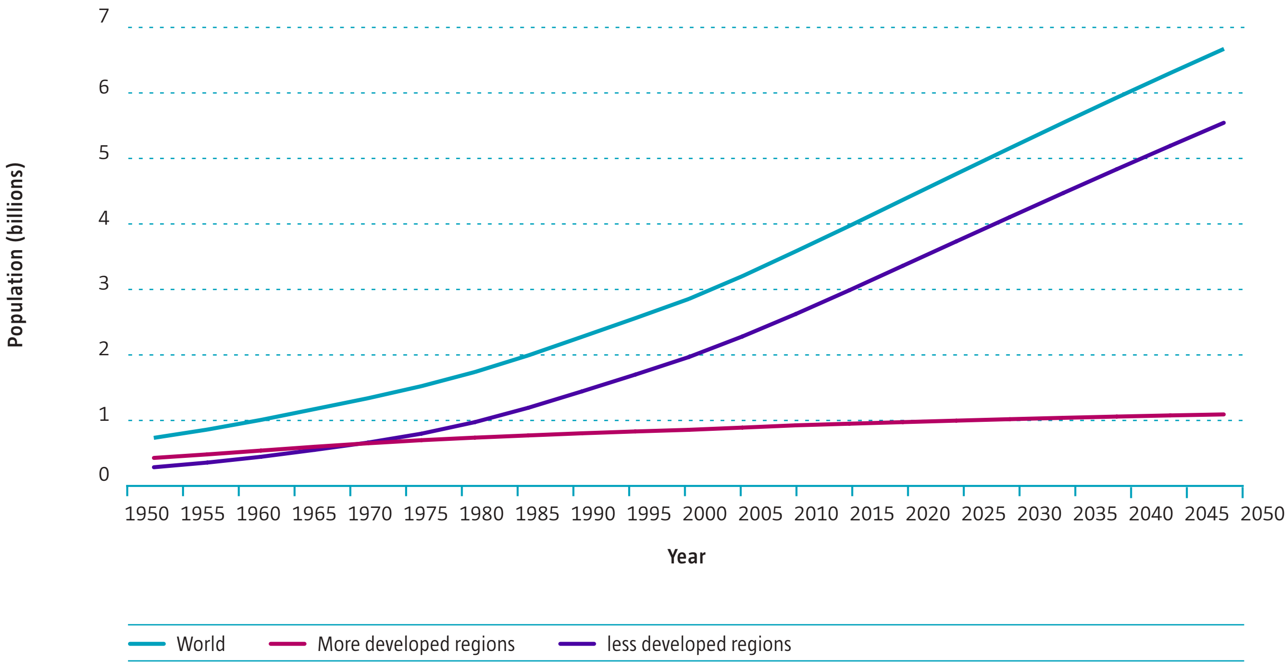
Source: UN Water, 2021

Urbanization

At present, the majority of the world's population lives in cities (4.2 billion out of 7.6 billion in 2018). This share will rise to 60 % in 2030 and 66.4 % in 2050.[25] The trend is of particular concern in emerging markets, where most of the urban growth is expected (Figure 13). The biggest increases in both urban population and water demand are expected in Africa and Asia (300 %) as well as Central and South America (200 %).[41] The rapid growth of cities means demand for clean water and sanitation services will quickly overtake existing supply, requiring huge infrastructure investments. In many emerging economies, urban water services – especially piped water and treated wastewater – are already overused or non-existent (Figure 14).

Figure 13 | Rural diaspora – global migrations to cities continues unabated

Estimated and projected urban populations of the world, the more developed regions and the less developed regions, 1950–2050



Global urban population development (1950–2050). Cities will continue to grow as rural populations in less developed regions relocate to urban settings.

Source: UN Department of Economic and Social Affairs, 2019

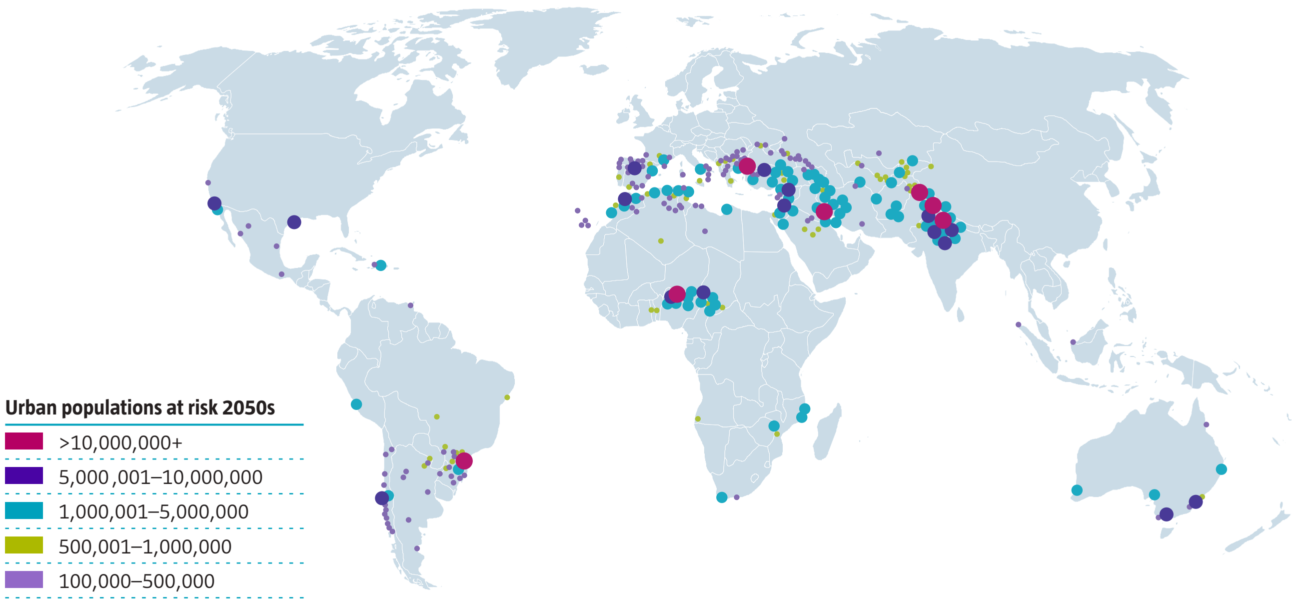
Figure 14 | Widening gaps – as populations grow, deficiencies in piped water provisions sharpen

The gap between installed piped water infrastructure and what is needed to cover expanding urban demand is widening.

Source: World Resources Institute, 2019

Through 2030, 45 major urban areas with more than three million citizens are expected to feel high to extremely high water stress (Figure 15).[42] More alarming still is that the increasing influx to urban areas is largely from rural regions where livelihoods have been decimated by water scarcity. Water demand in these urban areas is expected to grow even faster due to increased wealth in many emerging countries. Better access to water, dietary shifts from grain-based to protein-based diets and increased consumption will further strain demand for clean water.[43] Most of these cities depend on groundwater and are not equipped with sustainable usage systems.

Figure 15 | Urban populations at risk of water stress by 2050



Major urban centers at risk of water stress by 2050.

Source: Climate change and cities, Center for Climate Systems Research, Columbia University, 2018

The major problem in developed urban areas is aging infrastructure. For example, 22 % of all piped water in England and Wales is lost due to water leakage. Yet investments lag because of the high fixed costs associated with large-scale infrastructure improvements.[44] In many areas, replacements are urgently needed. In London, a third (109 km) of the Victorian water mains are over 150 years old and half are well over 100 years old.[45]

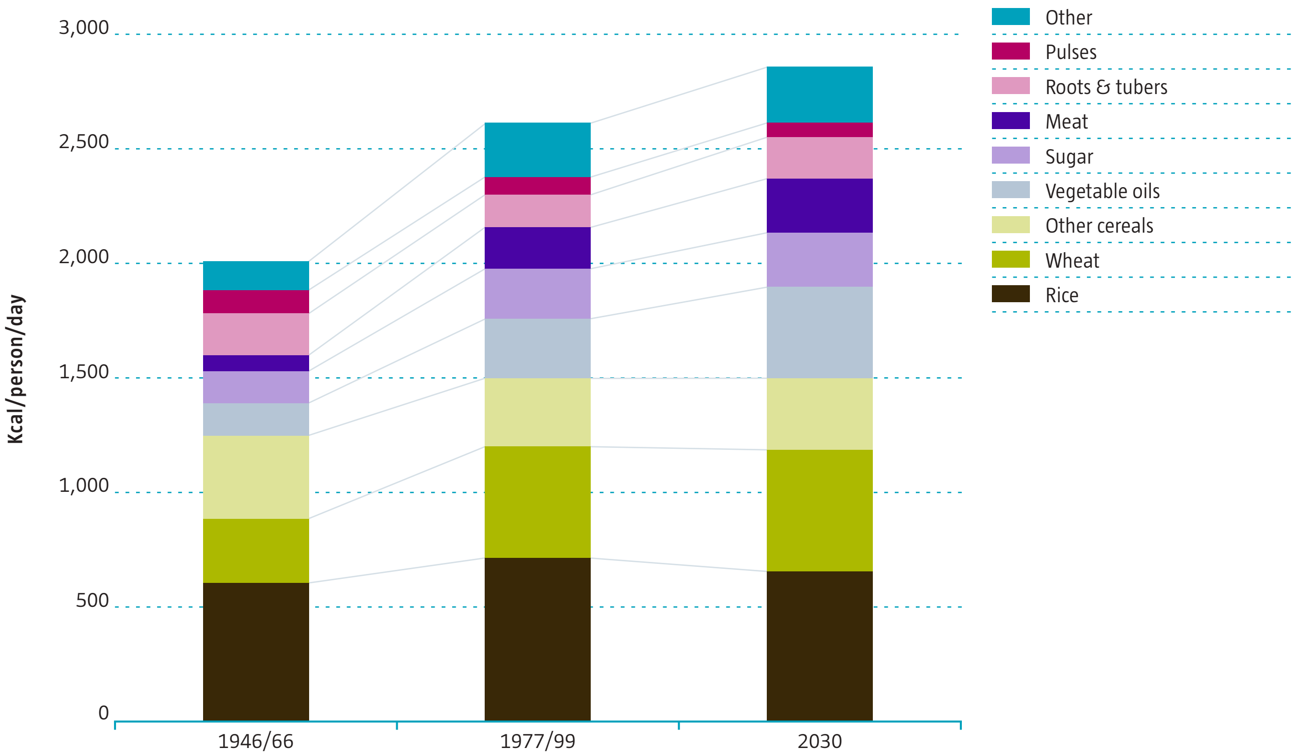
Population growth and food production

Under business-as-usual scenarios, the world will need about 60 % more food by 2050, which means water usage for irrigated food production will need to increase by more than 50 %.[46] This increase can be attributed to a combination of population growth and rising living standards. Water-stressed regions like Egypt already need to import wheat and rice to sustain food supplies.[47] Growing middle classes in emerging markets are increasingly acquiring western dietary habits, which are more protein and hence more water intensive (Figure 16).

Projections for 2030 are alarming: meat production (including beef, pork, poultry and sheep) is expected to increase by 77 % in developing countries and 23 % in their developed counterparts relative to 2015–2017 levels.[46] Another study with projections extended through 2050 shows northwest China, North Africa and parts of the Middle East and India experiencing the greatest food and water threats.[43]

Figure 16 | Counting Calories – calories consumed per capita are increasing globally

Global Progress in Food Consumption



Globally, people are eating more calories overall; consumption of meat and vegetable oils in particular is rising as diets in emerging markets shift towards western standards.

Source: UN World Water Development Report, 2021

If current trends and food production practices hold, food provision will need about 50 % more water by 2050. Additional water for irrigation amounts to only around 10 %, which means the world will face a 40 % global renewable water deficit by 2050.[12]

Plant-based diets provide a sustainable alternative as they are much less water intensive per calorie compared with meat-based ones. The promotion of sustainable diets that are healthy, affordable, culturally accepted and environmentally friendly can help to resolve the water deficit by about 20 % compared with current diets.[12] Additionally, around 14 % of the economic value of food produced globally is lost just after harvest and prior to retail distribution. That means 24 % of total freshwater resources are wasted on food that never reaches consumers.[12] Thus, reducing food waste also saves water.

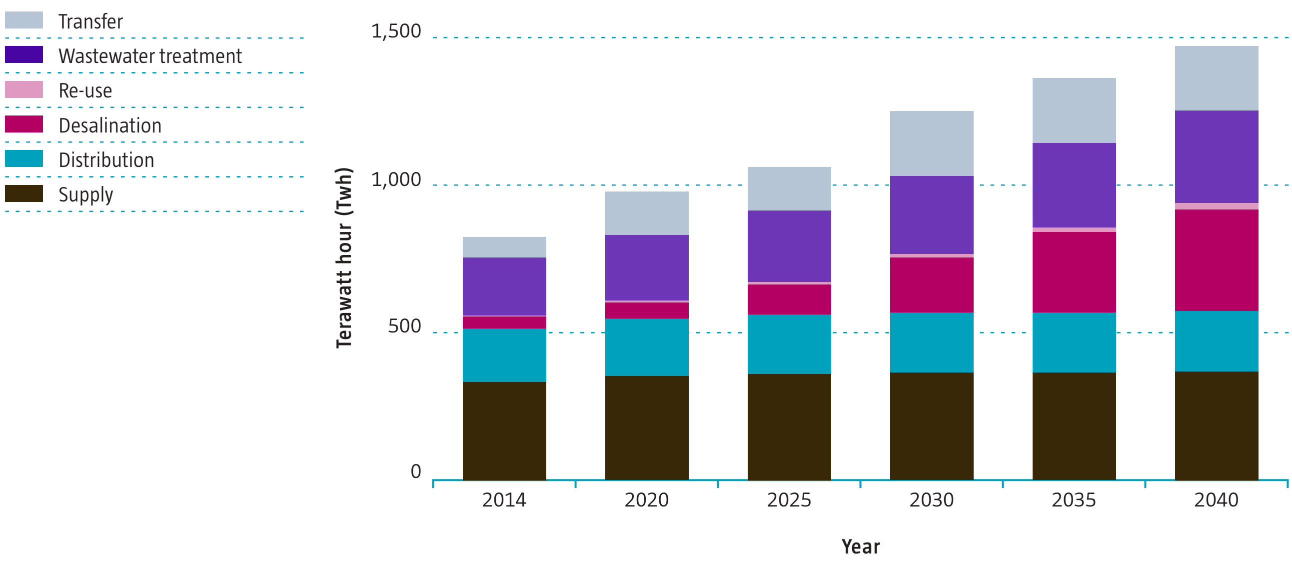
Finally, other methods are available to counter the food deficit. Proper water accounting, the enforcement of strict withdrawal regulations and the adoption of highly efficient irrigation systems could all significantly reduce water loss (70 %) and help boost available supplies, while maintaining current levels of crop yields.[48]

Energy production and water consumption

Energy production is strongly correlated with current water usage and future water risks. Therefore, efforts to better manage consumption within the energy sector will have a significant positive impact on water consumption.

Producing primary energy resources, especially fossil fuels such as oil from fracking, requires large amounts of water. On the other hand, the supply and distribution of water require large amounts of energy themselves, so less water use can substantially reduce the energy demand for water. This interdependence is expected to intensify in the coming decades with both resources facing increased demand. Water-related energy demand is expected to rise by nearly 60 % between 2014 and 2040 (Figure 17).[20] Reducing unnecessary water consumption and increasing the water-use efficiency could reduce water-related energy use by up to 15 % through 2040.[19]

Figure 17 | More currents – electricity needed for water sector activities is rising



Estimated and projected electricity consumption of the water sector (2014–2040) based on usage.

Source: IEA, 2018

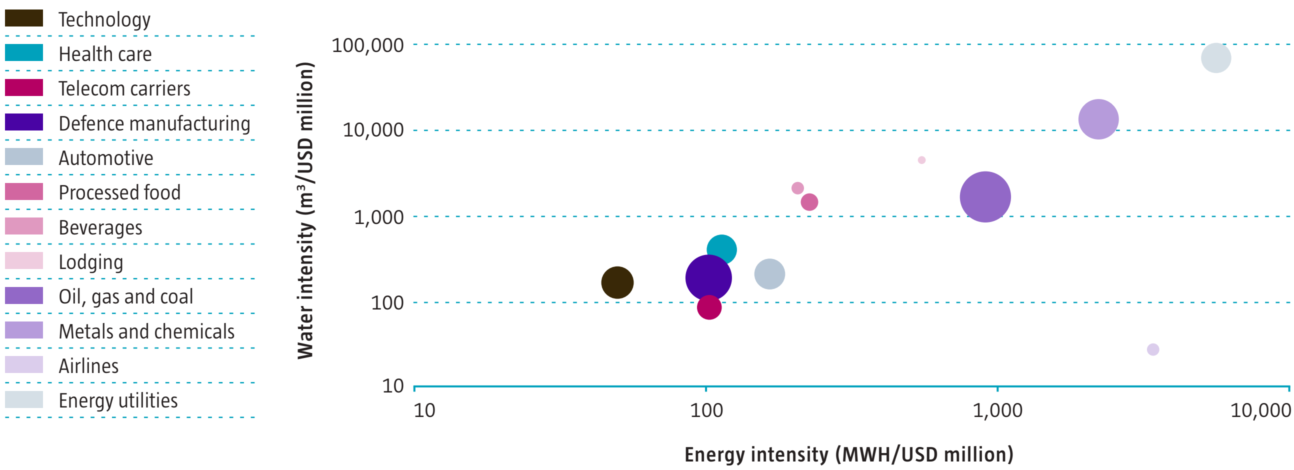
This water-energy nexus can be used to further reduce both water consumption and hydrocarbon production/use for power generation, especially in combination with low-carbon renewable energy technologies such as wind or solar power. For highly industrialized countries, this can have a significant impact on water usage. Studies show that the switch to renewable power production could reduce water withdrawals by as much as 50 % in Great Britain and 25 % in Australia, the US and Germany.[49] In the EU, a recent study by the WEF, Accenture and more than 30 CEOs of global energy companies concluded that a switch from fossil fuels to renewables could generate water savings of up to 205 billion liters by 2030. In addition, the switch would cut health costs by EUR 43 billion due to lower air pollution, reduce CO_2 emissions by 117 million tons, and generate up to one million jobs.[50]

Whilst decarbonizing energy production will reduce water consumption, other elements of decarbonization strategies have the potential to increase it. Plant-based fuels, or biofuels, as well as reforestation for carbon capture and storage will also require significant volumes of water. This will further intensify the need for strict water management and monitoring, in order to limit the negative impacts of decarbonization on water supplies without slowing the transition to renewable energy.[19]

The impact of industrialization on demand for water

Besides the energy sector, several other industrial sectors are at risk of water insecurity, with mineral mining, metals, chemicals and fossil fuels set to be the most impacted, followed by food and beverages and manufacturing (particularly defensive and automotive machinery) (Figure 18).

Figure 18 | Industries at risk – water and energy intensity of major industries



Water and energy intensities of major industries (Data 2013). Industries with higher water and energy intensities face greater risks from water stress. Bubble areas are proportional to total industrial revenue.

Source: World Resource Institute, 2016

Risks range from direct production risk due to water inaccessibility to regulatory and reputational risks due to overconsumption. Higher costs of raw material and freshwater as well as supply chain disruptions carry the highest risk potential for manufacturing and food and beverage production. In addition to these risks, mining operations and industrial metal production face increased environmental risks due to potential flooding and overflows of storage reservoirs containing contaminants. Furthermore, regulatory and reputational risks will be increasingly important considerations, especially as increasing water withdrawals and intensities may spur competition, conflict and controversy with local communities, threatening companies' licenses to operate. Sustainable use of water within the local context will help mitigate these risks.

Water demand from industry is expected to increase on all continents except North and Central America by 2050. The highest increases are expected in Africa (353 %), Asia (240 %) and Europe (153 %) relative to water demand in 2010.[10]

Contamination and pollution

Water scarcity is not only caused by limited water resources but increasingly also by the quality of water available for safe use. Agriculture, industry and human settlements are the main sources of pollution. Agriculture discharges approximately 700 million tons of pollution annually into the environment and waterways including pesticides, fertilizers, nutrients, organic matter, drugs and antibiotic residue, sediments and salts.[24]

Unsurprisingly, in most high-income countries and in many emerging markets, pollution from agriculture has overtaken contaminations from industry and human settlements. Nitrate has become the most common chemical contaminant in aquifers in Europe, the US and China[51], leading to algae and bacterial overgrowth and eutrophication. In China, more than 60 % of the lakes experience toxic blooms of harmful cyanobacteria; the same problem is responsible for an estimated USD 2.2 billion worth of damage annually in the US.[3]

In low-income countries, industrial and municipal wastewater is the source of most water pollution and still contributes a significant portion to water pollution in emerging economies. Globally, industry dumps 300 to 400 million tons of heavy metals, solvents, toxic sludge and other industrial grade waste into the environment every year[24] and approximately 80 % of global municipal wastewater is discharged untreated into water bodies.[28,52]

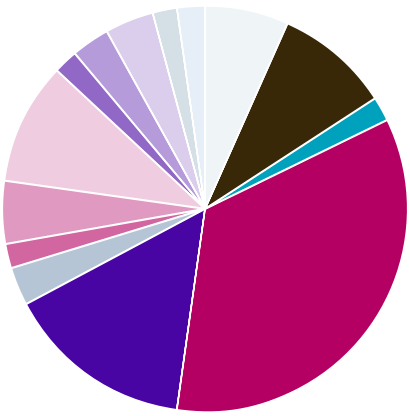
Even when environmental water sources are clean, water in many urban regions arrives to the end user contaminated. A constant water flow helps prevent the proliferation of harmful pathogens. But water stress, especially in the Global South, means intermittent water supplies (when water pressure in transmission pipes is not continual), resulting in a negative build-up of pressure that pulls external contaminants into the fissures of leaky pipes. As a result, intermittent water supplies increase the risks of water-borne illness and disease in both rural and urban communities. Weak pressure, intermittent flows and leaky pipes are all symptomatic of a weak utilities infrastructure, which could largely be remedied with targeted investments.[16]


3

The global water market

The water market is dominated by large economies such as the US and EU, but emerging economies such as China or India are gaining rapidly. The implementation of stricter environmental standards in markets globally as well as an increased emphasis on sustainable development mean water markets can expect rising investment tides and favorable growth rates in the coming decades.

Figure 19 | Global water market size and subsectors



Pumps	7%
Valves	9%
Water Test	2%
Wastewater Treatment	35%
Industrials Water Treatment	15%
Residential Water Treatment	3%
Produced Water	2%
Filtration	5%
Infrastructure	10%
Automation Systems	2%
Desalination	3%
Engineering Consulting	4%
Irrigation	2%
Ballast Water	2%

The global water market is composed of multiple sub-sectors. Percentages are based on estimated sales revenue in 2019.

Source: UBS, 2019

Market growth

The global water market is expected to grow at a faster rate than any time since 2010. Despite the pandemic, which shrank market values by 17.7 % to USD 805.3 billion[53], expectations for 2023 stand at USD 914.9 billion – a 50 % increase since 2014. This growth can be traced back to major water quality and infrastructure plans in large economies such as the US, Saudi Arabia, China and Southeast Asia. China's 14th five-year plan foresees new, tougher environmental targets including the recovery of 90 % of municipal sludge and wastewater reuse rates of 25 % in areas of water scarcity. These present new opportunities for growth in one of the world's largest water markets.[54]

Pledges and projections are promising but the volume of investment lags behind what is needed to maintain existing infrastructure as well as to keep pace with increased demands from urbanization, climate change and environmental protection standards. Global estimates differ, but all point towards needed investment ranging from USD 6.7 trillion by 2030 to USD 22.6 trillion by 2050.[55]

Market diversification

The global water market is diversified across several sub-market segments which, for simplicity, can be aggregated into larger clusters (Figure 19). Utility operating equipment is by far the largest cluster, representing 65 % of all expenditures. It is followed by industrial operating equipment which accounts for 17 % of total market expenses, infrastructure (14 %), and irrigation and point-of-use equipment (4 %).[56]

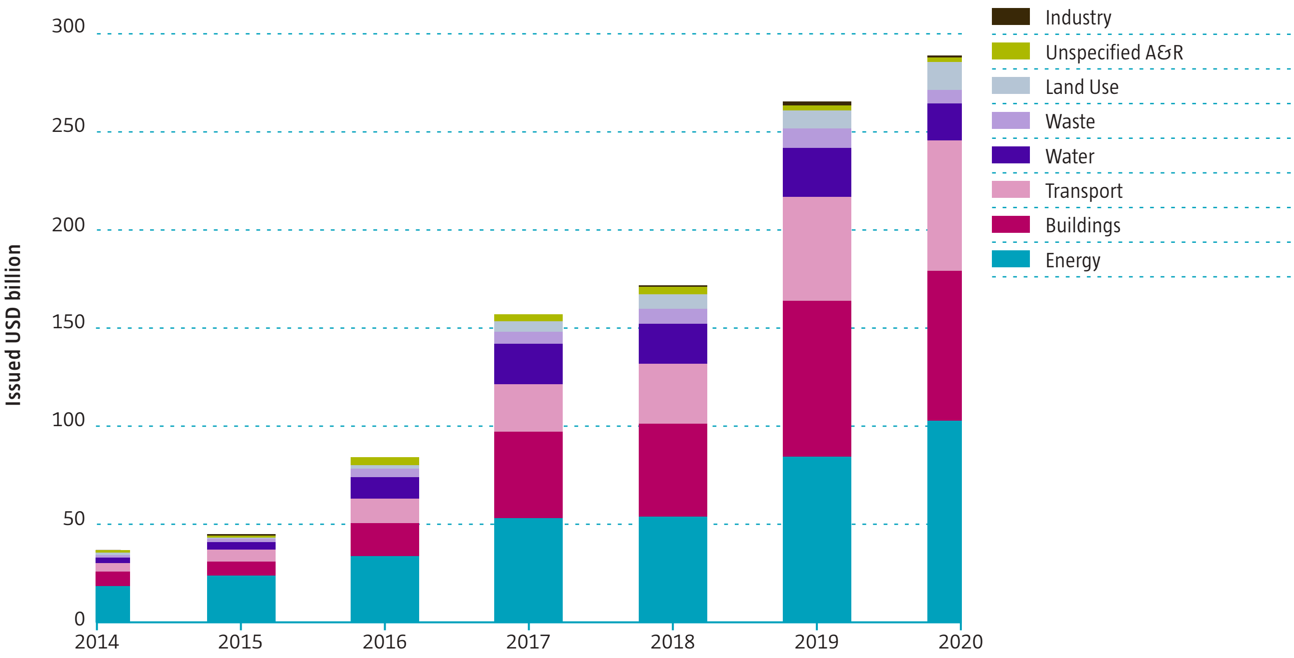
Investments to combat climate change

Recent investment trends towards mitigating and combatting climate change are also benefitting the water industry. Financing aimed at these areas already reached USD 510–530 billion in 2017. Given the increasing recognition of their mitigation potential, they provide an excellent environment for further investments into water and sanitation projects.[3]

The World Bank pledged to invest USD 200 billion in countries taking ambitious climate action from 2021–2025. About a quarter of these funds are earmarked for mitigation measures that include water sector activities such as water catchment management, rainwater harvesting and rehabilitating water distribution networks.[57] In addition, regional development banks have devoted USD 6 billion for similar projects to provide water security.[3]

Private sector-financed climate bonds, which fund projects dedicated to low-carbon, resilient infrastructure and development efforts, are also being used to fund water projects (Figure 20). Other sources of private financing are bilateral public climate finance and project developers.[3]

Figure 20 | Increasing issues – the market for climate bonds continues to grow



Annual issuance of CBI-certified climate bonds together with their sector-focus area. The need and demand for climate bonds to help mitigate climate risks, continues to increase.

Source: Climate Bonds Initiative (CBI), 2020

Green bonds

The green bond market has rapidly grown from USD 3.4 billion in issues in 2012 to USD 288 billion in 2020. However, only a small portion (9 %) of issued bonds that passed CBI[b] certification were in the water sector.[58] Moreover, most of this growth was in developed economies. In 2019, issuance from the US, China and France topped the list with approximately 44 % of global issuance.[58] In contrast, bond issuance in emerging economies is growing at a slower pace. According to one study, only 3.6 % of private financing flowed to low-income countries between 2012 and 2015.[59]

The slower growth in emerging markets is attributed to smaller and early-stage capital markets, limited investor demand and the lack of knowledge and awareness in green offerings.[60] However, as global concerns over climate change and environmental risks (including water stress) mount, green bonds in emerging economies are expected to see rapid growth in the future.

b CBI, Climate Bonds Initiative is an international, investor-focused not-for-profit dedicated to mobilizing bond markets for climate change solutions.

Global infrastructure

The OECD estimates that USD 900 billion to 1.5 trillion in water infrastructure investments will be needed per annum to achieve SDG 6 (Clean Water and Sanitation for All) by 2030. Most of that investment (around 70 %) should be directed towards the Global South, with a focus on rapidly growing urban areas.[61] Moreover, just USD 100 billion would be enough to ensure the basic SDG targets 6.1 and 6.2, aimed at securing access to safe drinking water and sanitation. Investments in developed countries are mostly required for renovation and upgrades to existing infrastructure.[61, 62]

SDG 6 – Clean Water and Sanitation for All

Sustainable Development Goal 6 aims to secure safe drinking water and sanitation access for all by focusing on the sustainable management of water resources, wastewater and ecosystems. Eleven global indicators track progress towards SDG 6, based on country data compiled and verified by the United Nations agencies.[3]

Overall, investments in water infrastructure pay off. A study by Gardner et al. found that for every dollar invested in public water data systems, four dollars in social benefits are created.[63] Furthermore, investments into drinking water have a benefit-to-cost ratio of 3.4 and 6.8 for urban and rural areas, respectively. Because basic sanitation is generally more expensive to supply compared with drinking water, investments in sanitation yielded lower (albeit positive) benefit-to-cost ratios of 2.5 and 5.2, respectively.[64]

The WHO estimates that USD 141 billion will be needed over five years to provide universal drinking water to urban areas. That's just over a tenth of the cost of inaction, which is estimated to be USD 260 billion annually.[16]

Government initiatives

Besides investments from multinational organizations, governmental spending plays a vital role in the provision of capital to reach SDG 6. In March 2021, the Biden administration in the US announced a large infrastructure program with USD 111 billion in investments earmarked for water infrastructure in order to improve and protect drinking water quality and access, wastewater management and water system resilience.[65]

China has long struggled with water scarcity, particularly in its western and northern provinces, which make it a consistent investment theme within its strategic Five-Year Plans (FYP). Its 13th Five-Year Plan (2015–2020) included USD 81 billion in investments into municipal treatments systems.[66] As part of its 14th Five-Year Plan (2021–2025), China will focus on reallocating water distribution from water-rich to water-poor regions, modernizing irrigation systems, improving water conservation, and mitigating and preventing flood risks.[67] Moreover, it also announced USD 18.5 billion of investments in into wastewater treatment systems, especially in rural areas.[66] In late 2020, the Chinese government announced its plan to achieve climate neutrality by 2060, which includes strategies that promote investments in water and wastewater infrastructure.

The European Union has pledged to invest EUR 15 billion to help reach SDG 6. These investments are distributed over the Member States and will mostly be directed towards investments in the construction or upgrading of wastewater treatment plans and sewerage networks, as well as sewage-sludge management.[68]

Infrastructure investments not only provide good financial returns, they also reap social and human welfare rewards. In the US, USD 123 billion worth of investments in the national water infrastructure created an aggregated economic impact of USD 220 billion, alongside 1.3 million jobs and indirect benefits valued at USD 140 billion.[69]

Valuing water, increasing efficiency

Part of the solution to reduce water consumption and increase water use efficiency is to appropriately value water. The most common method used thus far for this are water tariffs. Water tariffs are essential for utilities to cover the cost of providing a service and raise enough funds to expand and upgrade existing water distribution infrastructure.

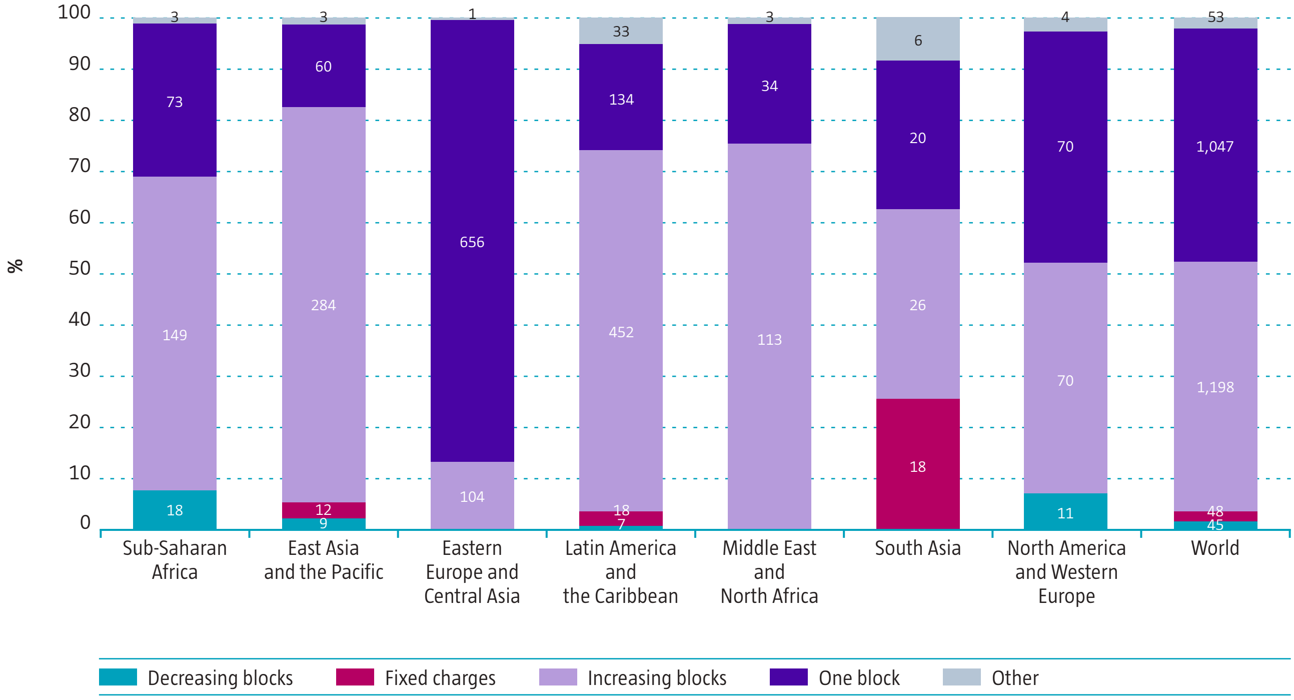
In most regions, governments subsidize utilities due to the importance of water and sanitation services for public health and the environment. This leads to inefficient water use for both suppliers and consumers, and results in an underestimation water's value. The gap between a utilities' distribution costs and what is paid by customers can be significant and leads to excess water consumption that further stresses water supplies. To reduce the gap, utilities rely on tariffs which, in addition to helping control consumption, help utilities recuperate service costs.[12]

About half of global utilities use increasing block tariffs whereby the rate per unit of water increases with consumption. In an increasing block tariff, the first cubic meter of water is much cheaper than the 100th.[12]

As a result, basic water supply costs are covered, but overuse is discouraged by charging users for excessive consumption. In this way, consumers are forced to pay an economic value for water and thus use it more efficiently. Other commonly used tariffs are fixed charges (independent of the total use) and one block (the same price per m³) (Figure 21).

However, for tariffs to be effective, utilities also need efficient metering systems to measure water flows and usage by end customers. Metering systems not only support tariff cost accounting, they also help reduce costs and prevent losses from leaks. [12]

Figure 21 | Break-out of utility tariff structures – worldwide, most regions favor increasing block tariffs



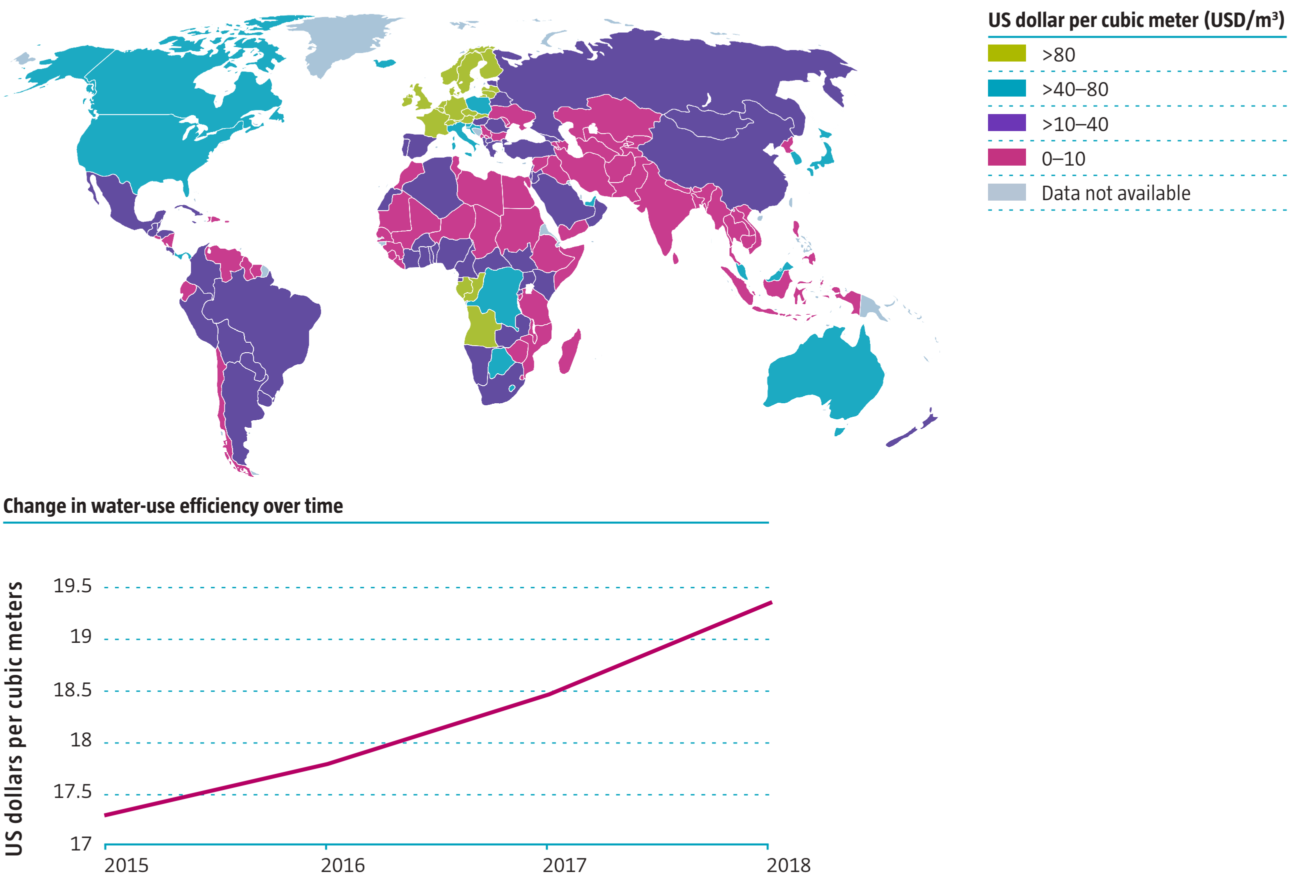
Tariff structures implemented by region. Numbers represent number of water utilities within each region which have implemented the given tariff structure. The Y-axis indicates overall regional percentages.

Source: IBNet Tariffs database (2018) and the Global Water Intelligence (GWI), UN (2021)

Accurate valuations of water in business are crucial for improving water use efficiency and enhancing water supplies. Water use efficiency has risen in recent years, indicating that businesses are valuing water more effectively. Drivers for this trend are stricter global and regional regulations that require companies to integrate natural capital accounting which include water value estimates and water pricing. Moreover, given the rising consumer and investor demand for sustainable products, processes and investments, there is a growing business case for companies to efficiently monitor, manage and report water usage within their operations. In addition to reputational rewards, water usage analysis can result in better decision making, higher revenues, lower future costs, improved risk management and a better reputation.[12]

Global water use efficiency, measured by added USD to GDP per used m³ of water, has risen from 17.3 to 19.4 USD per m³ between 2015 and 2019. Regional differences can be huge. Water stressed regions in developing regions report the lowest scores, whereas developed regions and those with water abundance score comparatively higher (Figure 22).[70]

Figure 22 | Water use efficiency, ratio of dollar value added to volume of water used



Source: FAO, UN, 2020

Added economical value in USD per m³ water used. Regional differences are huge, with more developing regions scoring lower and more developed regions scoring higher value per used m³ of water.

Source: SDG 6 Dataset, United Nations, UN Water, 2020

In addition to cost savings from reduced water use, lower energy bills and avoided expenses related to water scarcity and pollution incidents, companies can tap into new markets for water-smart products or enhanced brand value over the longer-term.[71]

Wastewater as a business case

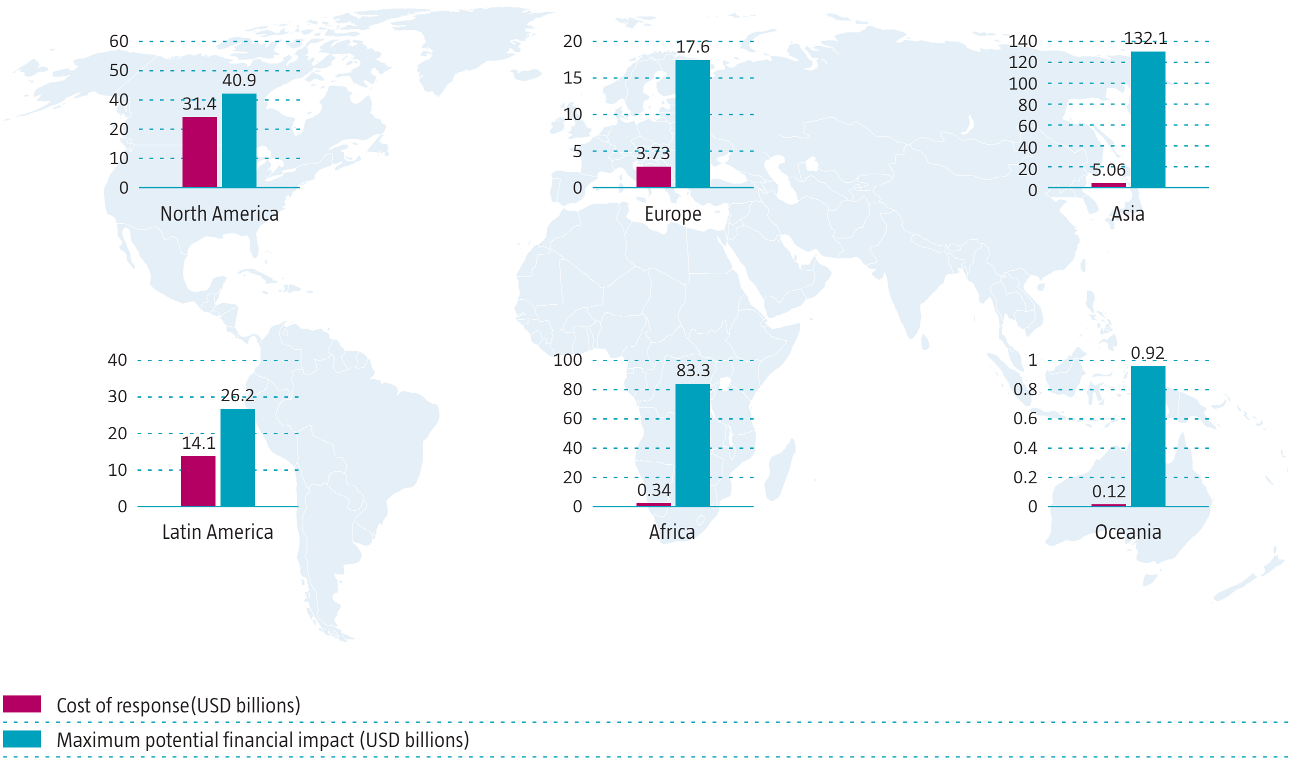
One example of such a new opportunity is the wastewater market. Wastewater contains more energy in the form of biogas and fertilizers than is needed for its treatment, making it an interesting option for utilities to increase energy recovery and sell surplus energy.[4] In addition, extracted metals and fertilizers can be sold, further contributing to the business case. Such new business opportunities deliver higher return rates while simultaneously improving water supply and sanitation.

Private sector action

The role of the private sector in contributing to the solution of water risks is becoming increasingly evident. At the 2019 World Economic Forum, business leaders from around the world stated that water shortage ranks among the risks of most concern.[72] Water shortage threatens a company's reputation, license to operate, financial stability, ability to grow, and the security of supply chains. The market value at risk topped out at USD 425 billion, with companies reporting about 40 % of these risks likely to hit through 2024.[71]

Material financial risks encourage companies to invest in water reduction solutions as well as in green bonds that target sustainable water use and management. The aggregate financial impact for companies if risks are fully realized is estimated to be five times higher (USD 301 billion) than proactive measures to prevent and/or mitigate them (USD 55 billion).[71] This holds globally for both developed and developing economies (Figure 23).

Figure 23 | **Cost of inaction – post-event response costs are far higher than preventative investments**

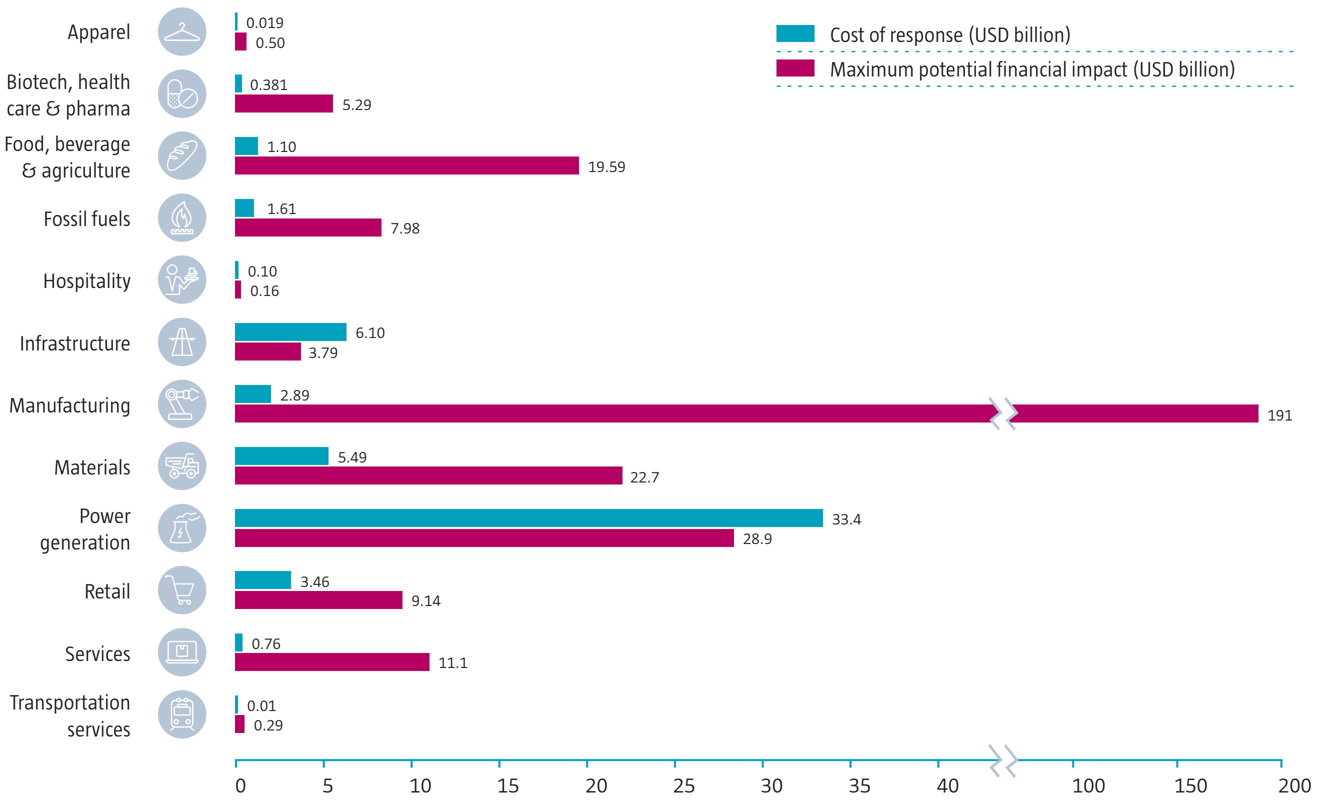


Regional perspective of potential financial impact of water risk and cost of response (in USD billions)

Source: CDP, 2020

The only sectors to have a benefit-cost ratio less than 1 are power generation and infrastructure (Figure 24). For the energy sector, this is explained by the large investments needed to transition electricity generation away from fossil fuels (and hydroelectric dams) to renewable sources. Within infrastructure, it reflects the significant expense needed to maintain and renew existing water utilities and services. Given the low benefit-to-cost ratio, it is no surprise that these two sectors did not take any proactive action to lower their water withdrawal, but instead account for the highest share of companies that increased their water withdrawal between 2019 and 2020.[71]

Figure 24 | **Cost of action against water risk compared to costs of response, per sector**



Industrial sectoral perspective of potential financial impact of water risk and cost of response (in USD billions)

Source: CDP, 2020

While investment in new technologies is one of the top responses to combat water scarcity, only a few companies actually develop new products, highlighting the opportunities in this sector for growth and innovation.[71]

How companies are investing to combat water scarcity

- Increasing capital expenditure (USD 19.7 billion)
- Improving pollution abatement and control (USD 13.2 billion)
- Increasing or reviewing infrastructure investment (USD 11.6 billion)
- Increasing investment in new technology (USD 9.2 billion)
- Complying with local regulatory requirements (USD 4.3 billion)

CPD Global Water Report, 2020

Industrial water use deserves special attention, given that water is a critical factor of production in many sectors. Water scarcity related losses need to be taken into consideration to calculate the true value of financing water infrastructure.

Preventing scarcity risks could reap positive returns on investments by improving current efficiency rates as well as by avoiding future losses. The World Bank estimates that economic growth in some regions has been accelerated as much as 6 % by improving water resource management. Conversely, no action could have the opposite effect, leading to negative growth of up to 6 % in some regions.[73]

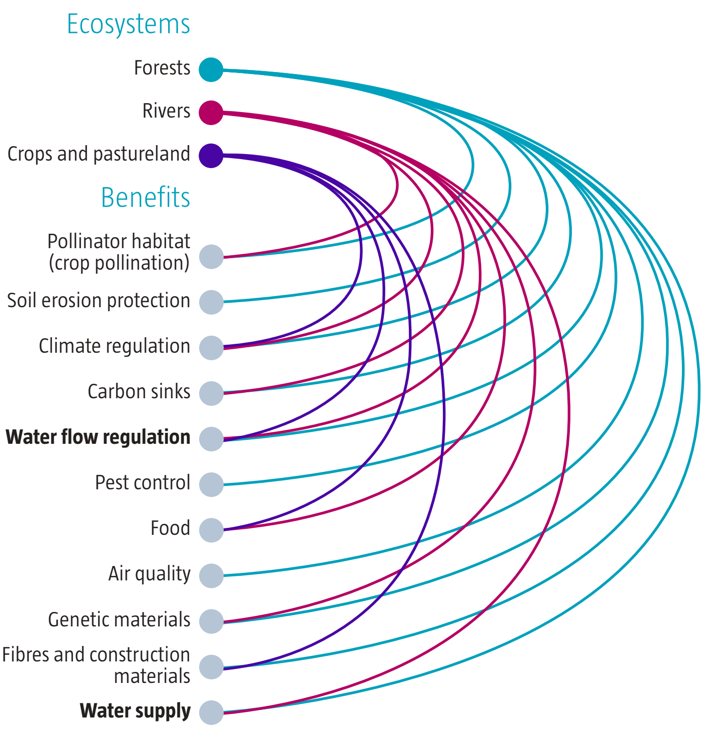
Nature-based solutions (NBS)

Nature-based solutions are projects that address societal challenges effectively and adaptively while simultaneously protecting biodiversity and human health and well-being. They aim to protect, sustainably manage and restore natural and modified ecosystems. [1]

Examples include the use of afforested and managed mangrove forests for storm-related flooding on coastlines. In addition to flood protection, mangroves help prevent soil erosion, as well as provide ecological services that support fish, birds and other marine organisms.

Figure 25 | Bountiful benefits – healthy ecosystems provide a wealth of positive impact

What benefits do ecosystems provide?



Healthy ecosystems provide extensive web of services that protect the environment and human populations.

Source: EU Commission, 2019

Building back better

Water is a central element within the planet's many ecosystems. Like water, ecosystems provide a wealth of essential benefits to human populations and the natural environment. Effective, efficient and sustainable approaches to overcoming the water crisis will also consider the impact of manmade solutions on the surrounding ecosystems as well as the potential synergies of nature-based solutions.

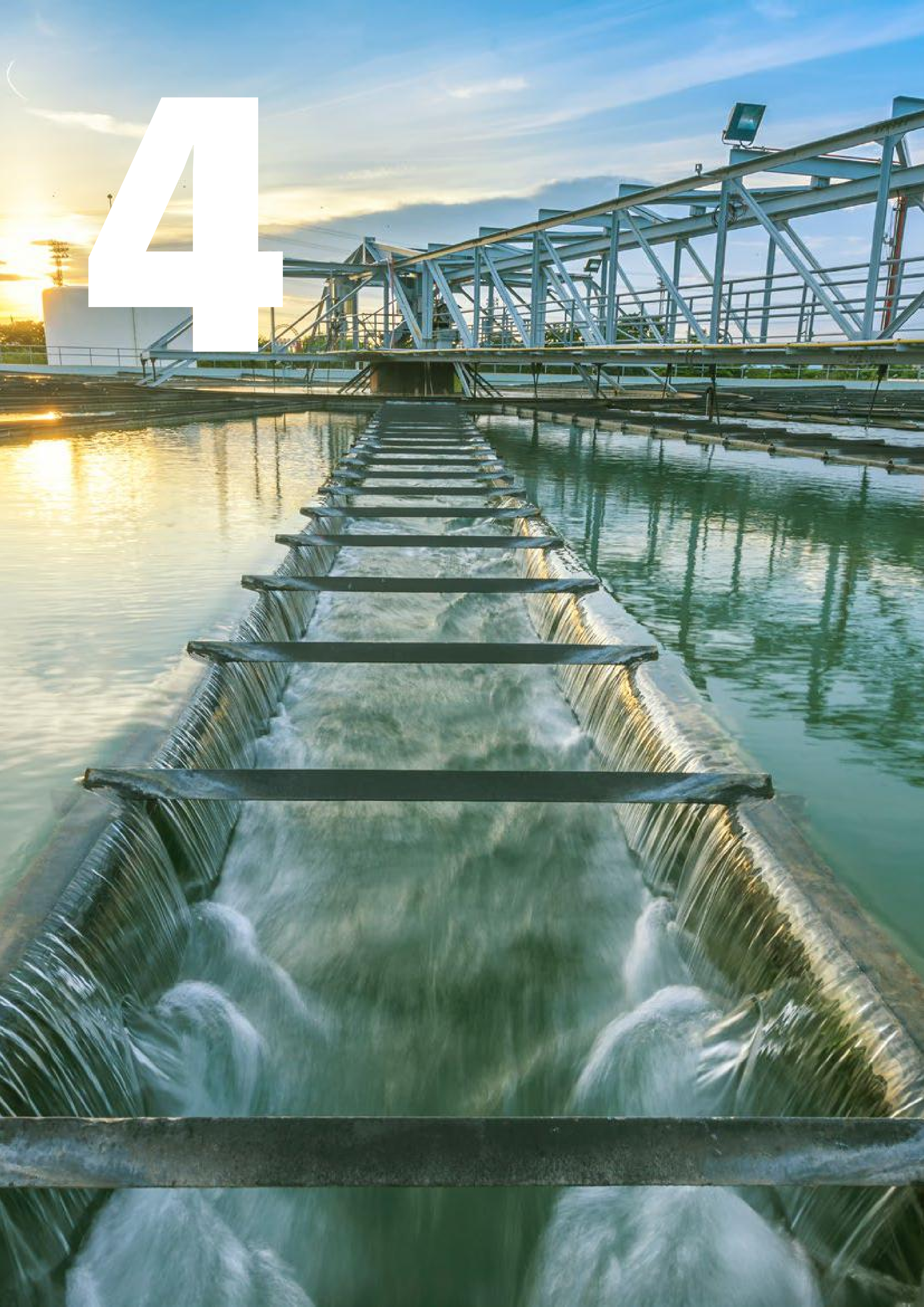
Ecosystem Services

Ecosystems and their services have long been undervalued. Even as far back as 2011, estimates of the notional economic value of nature to people were USD 125 trillion, around two-thirds higher than global GDP at the time. The same study valued water-related services at USD 29 trillion per year. More current studies put losses of ecosystem services through land change and degradation are estimated to be USD 4–20 trillion and USD 6–11 trillion per year respectively.[12, 74] Nature-based solutions (NBS) and their corresponding ecosystem services have thus gained increased attention as valuable approaches to combating both climate change and water scarcity.

NBS are natural, 'green' technologies that use or mimic natural processes. Within the water sector, examples of such ecosystem services are the use of wetlands to naturally treat wastewater, for low or no-energy agricultural irrigation, and maintenance. Moreover, biomass generated through these processes can be used as a renewable fuel source (Figure 25).[3] Further functions are erosion control, disaster risk management and sustainable fisheries. In addition, such NBS-supported ecosystems can reverse years of destruction, create jobs, raise incomes, and enable communities to become more climate and risk resilient for the future.[75]

Researchers estimate that NBS can contribute more than 30 % of solutions needed to adapt to climate change, but until now only 3 % of global climate financing and 1 % of water resource financing has been spent on NBS.[31] Part of the problem is the challenge of translating their benefits and co-benefits into revenue streams.[76, 77]

To overcome these challenges and draw more investment to nature-based projects, a hybrid approach where green' and gray infrastructure projects are combined to address climate change, resource degradation and water scarcity issues. An example of such a hybrid approach is the GrowGreen project in Manchester UK, where a park has been designed to 'drink water' by enlarging surface areas and installing permeable pavement to tackle surface water flooding.[78] Such hybrid approaches can reduce the cost of engineered solutions while improving overall system performance.[76, 79] Moreover, hybrid NBS can be designed to address several risks/challenges simultaneously while providing multiple benefits. According to one study, cost reductions for water utilities implementing NBS in the world's largest cities exceeded USD 890 million annually.[76]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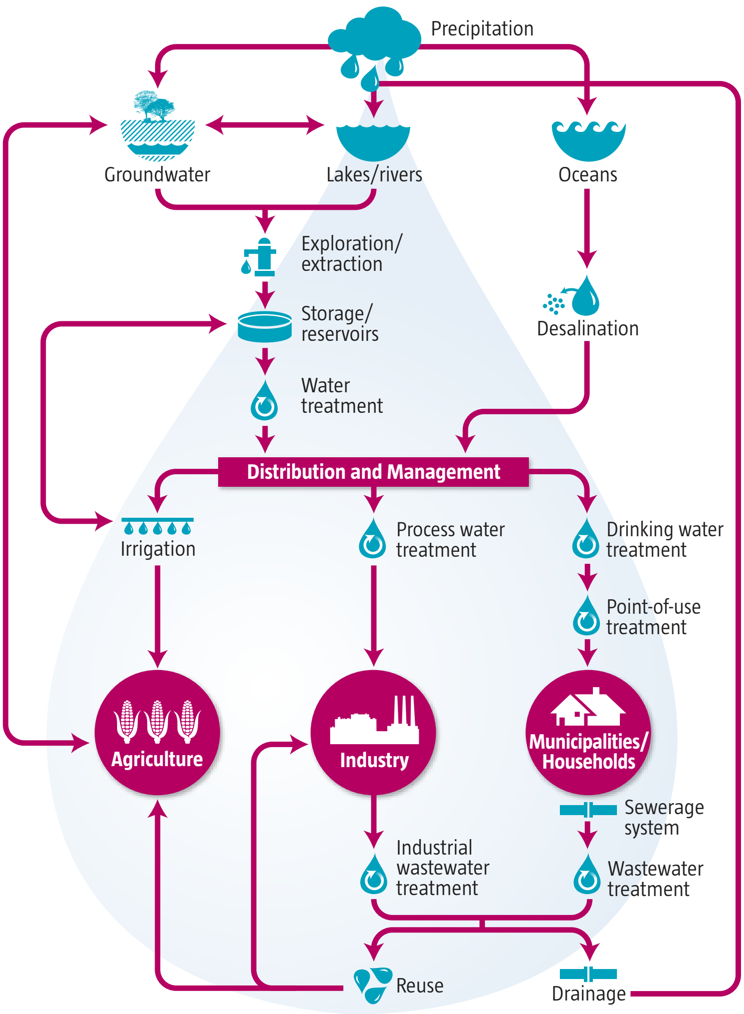
Investment opportunities – the RobecoSAM Sustainable Water Strategy

Climate change, population growth, demographic shifts, and increasing industrialization in both developed and developing markets mean water supplies will continue to face short-term stress and long-term scarcity. Large-scale investments are needed in both emerging and developed markets in order to improve efficient water use, increase water supplies, ensure water quality, and mitigate scarcity in agriculture, energy and industry as well as within urban municipalities and rural communities.

Figure 26 | The water value chain



The water value chain, from precipitation to reuse and drainage

Source: Robeco

For two decades, the RobecoSAM Sustainable Water Strategy has recognized the crucial role of water in supporting life, the environment and economic development, and has focused exclusively on sustainable investments in water markets globally. The strategy is diversified across four investment clusters, each designed to capture the value within the unique market and sub-market segments of the water supply chain. The Utility cluster focuses on companies that provide water and wastewater services, the Capital Goods and Chemicals cluster on companies that manufacture equipment and systems needed throughout the water value chain, the Construction and Materials cluster on companies that plan and build water infrastructure, and the Quality, Analytics & Management cluster on companies that provide services for water quality analytics, point-of-use treatment and resource protection.

Market overview and investment considerations

The water value chain starts upstream with the exploration, extraction, treatment and distribution of water to end consumers, before flowing downstream to the collection, treatment and discharge or reuse of wastewater. Ancillary streams of services include protection against natural disasters, metering municipal water volumes and system flows, and providing waste management solutions to protect water resources (Figure 26).

To evaluate water investments along the supply chain, it is crucial to know the corresponding value of water. This value of water per unit can vary significantly depending on its use – be it by agriculture, communities and municipalities and/or industry. Similar to land, the specific services used and their location affects the value of water and so must be considered when evaluating investment projects. This is of particular importance given the effects of climate change in water-stressed regions such as Asia and Africa. Economic and demographic shifts in these regions will be the most extreme and much of the water infrastructure needed has yet to be built.[80]

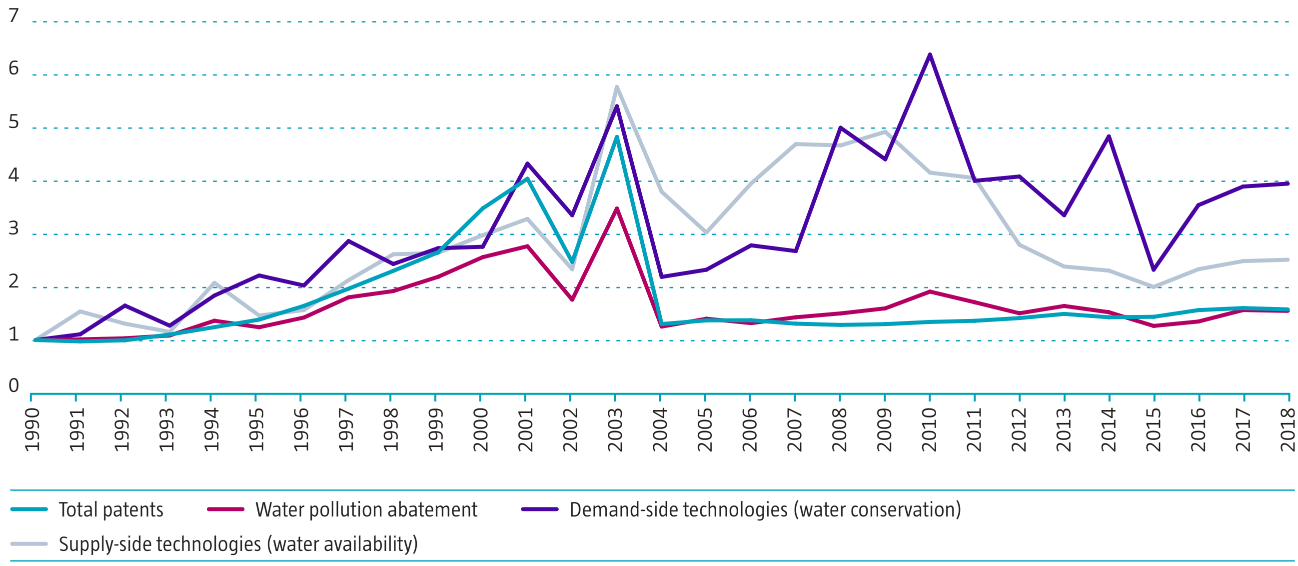
Generally, sustainable investments should be directed towards the most cost-efficient, essential and long-term solutions available for all stakeholders. For example, wastewater reuse in agriculture or nature-based solutions (NBS) are renewable, sustainable solutions for wastewater treatment in communities that also address the water risks of companies.[71]

Water – a wellspring of innovation

The water market relies on innovation to provide solutions for water quality, scarcity and access issues. Fortunately, water-related technological innovation has more than doubled since 1990 and the exacerbating impacts of climate change on water reserves and distribution patterns should further spur innovation and solutions to combat water shortages (Figure 27).[81]

Figure 27 | Innovation in water solutions outstrips global innovation

Relative number of patented inventions by category and by year (1990=1)



Growth in water-related patented inventions by category. For comparison, status of 1990 has been normalized to 1. The y-axis shows the number of patents filed annually compared to the amount filed in 1990. A value of 4 corresponds to an increase of 400% compared to the 1990 value.

Source: Trends in water-related technological innovation, OECD, 2020

Investing in businesses that provide solutions to these long-term water risks provides rewarding returns, especially in regions and in industries where water risks (in terms of environmental, human health, and financial impact) are the greatest. Businesses that invest in water security have a competitive advantage, as it strengthens water supply and system resiliency and can reduce spending on energy generation and treatment chemicals, all critical areas that will be negatively impacted by climate change in the immediate and long term.[75]

Investment clusters – targeted investments across the water value chain

Utilities

Companies in the utilities cluster focus on the provision of water and wastewater (including solid waste) services to residential, commercial and industrial sectors. They operate large and small-scale water and wastewater networks as well as special-use water facilities such as desalination plants near oceans and advanced filtration plants in urban areas. They generate revenue through customer fees as well as through the recovery of nutrients and energy from wastewaters.

Investing in water infrastructure is capital-intensive early on but given the long-life of physical assets, provides stable and enduring returns across multiple business cycles. Furthermore, rising demand in urban areas on every continent suggests that investments in utilities will continue to be a steady source of future income in the decades to come.

In developing countries, urbanization and population growth directs most expenditures towards the creation and expansion of distribution networks. In developed countries, utilities are investing in renewing existing grey infrastructure and increasingly in green infrastructure to provide services. For example, DC Water, responsible for drinking water and sewage treatment for Washington DC, recently invested in green infrastructure to prevent the pollution of rivers through sewage spillage caused by stormwater. Its "Clean Rivers Project" included investments of USD 2.6 billion in three large holding tunnels for sewage and stormwater. Similar projects linked to green bonds have been issued by water-stretched municipalities in San Francisco and Cape Town.[62]

Reverse osmosis (RO) – pressure washing wastewater supplies

Osmosis, where water from one solution is pulled into another solution with higher particle (salt) concentration until a equilibrium is reached, is a natural chemical process used throughout the human body and in nature.

Reverse osmosis pushes that process in the opposite direction. Untreated water saturated in harmful contaminants is forced under high pressure through a semi-permeable membrane that allows water to pass but stops unwanted waste particles, pathogens and other pollutants.

Decreases in the cost of existing technologies such as desalination and reverse osmosis (RO) are making them more interesting for utilities to use for primary water sources. Furthermore, significant progress in water and environmental engineering over the past few decades has led to the development of newer and more efficient water processes such as advanced oxidation, adsorption and nano- and ultra- filtration, which is used to remove regulated contaminants and harmful substances from water supplies.

Advanced water treatments such as these produce cleaner water, at faster rates, using less energy.

Capital Goods & Chemicals

The Capital Goods & Chemicals investment cluster focuses on companies that manufacture equipment and systems that are used throughout the water value chain. This includes capital goods for water supply systems such as original water sources, pump stations and distribution networks as well as wastewater collection, treatment and reuse systems. Furthermore, they provide chemicals for water purification and equipment for irrigation systems.

Drinking water treatment

The provision of safe drinking water is a quintessential function of the water sector. In the developed world, the challenge is not so much a question of water quantity and volumes but water quality and safety. Increasing levels of micro-pollutants, especially in densely populated and industrialized urban areas, is leading to the need for more sophisticated detection and treatment systems and provide extensive growth opportunities for water investments.

Water reuse and industrial treatment

Wastewater reuse offers abundant potential as a solution to water scarcity. Globally, about 360 billion cubic meters (m^3) of wastewater is produced annually, a volume that will further increase to 470 billion m^3 by 2030 and 574 billion m^3 by 2050.[82, 83] Currently, it is estimated that only 11% of all wastewater produced is reused, meaning there is significant potential for treating and reusing wastewater to augment global water supplies.

Global data shows that about 60 % of the global population lives in areas where reuse of treated wastewater is possible (Figure 28).[83] Reuse rates are high in water-scarce countries in the Middle East and North Africa but low in many developed countries. Singapore and Israel provide exemplary models for more advanced markets to follow. Both countries are leaders in the collection and treatment of wastewater for municipal, agricultural and industrial use. Singapore provides 30 % of the nation's annual demand through reuse, and in Israel, 85 % of the sewage collected is reused.[84, 85]

Besides the recovery of water, reuse also recovers nutrients such as nitrogen, phosphorus and potassium, which are important inputs within agriculture. Full recovery of these nutrients would offset 13.4 % of their global demand in agriculture and reduce the eutrophication caused by their release into the environment.[12]

The global market for water recycling and reuse was estimated to be USD 13.88 billion in 2020 and is expected to reach USD 15.42 billion in 2021 and USD 26.61 billion by 2026.[86]

Figure 28 | Wastewater reuse pathways

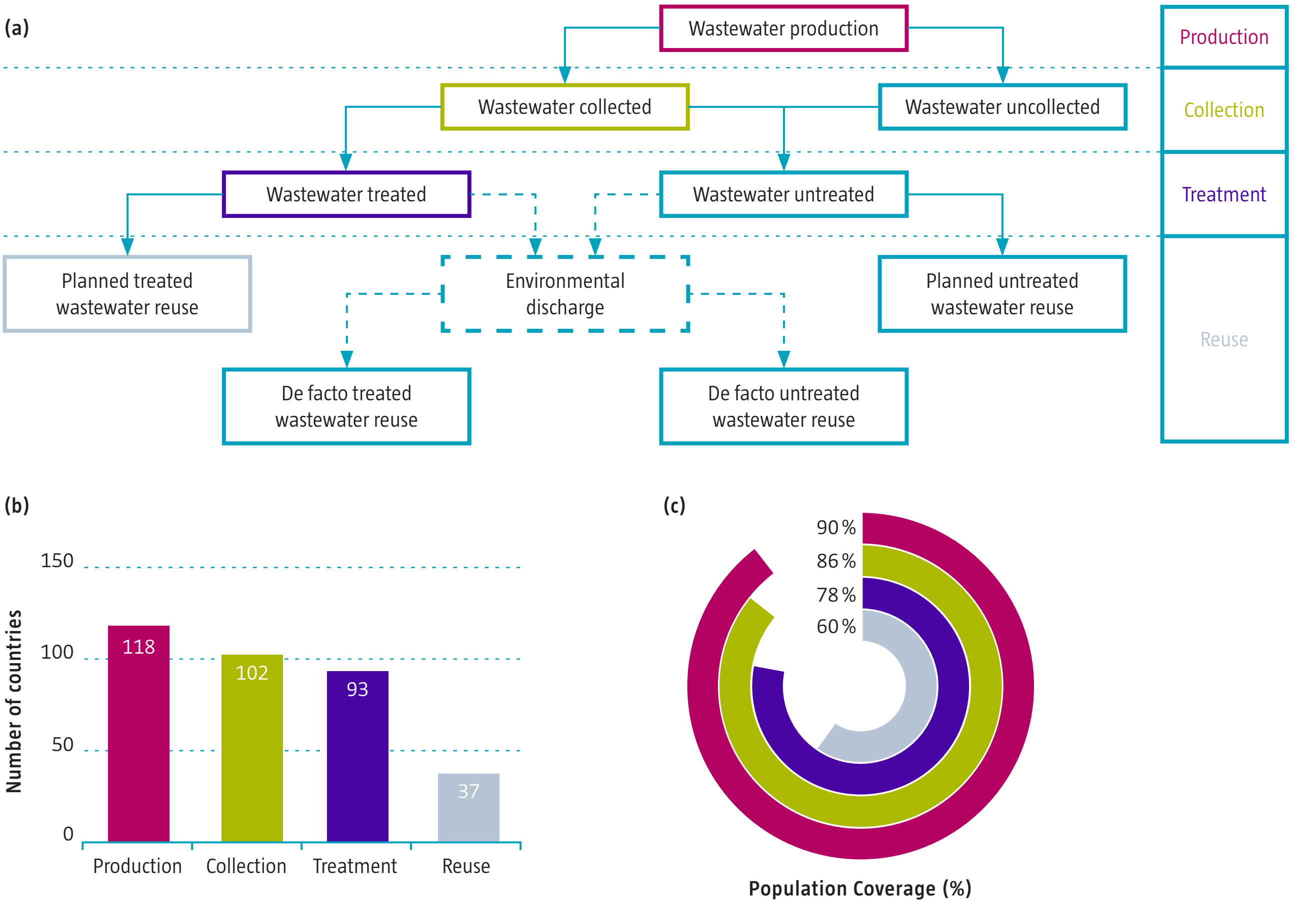


Figure 28 (a): Wastewater treatment and reuse pathways. Wastewater can be reused intentionally or by accident as well as treated or untreated. (b): Within the study, of 118 countries producing wastewater, 102 actively collect it, 93 treat it, while only 37 reuse it. (c): About 60 % of the global population lives in areas where reuse of treated wastewater is possible.

Source: Jones, E. R., van Vliet, M. T. H., Qadir, M., and Bierkens, M. F. P. Earth Syst. Sci. Data, 13, 237–254

Desalination

Desalinated water is an important extension to naturally available water resources, providing high-quality water from oceans and brackish estuaries where seawater meets inland rivers. In water-scarce coastal regions, desalination provides a significant proportion of water supplies. Globally, around 16,000 desalination plants provide 35 billion m³ clean water annually for use in industry, municipalities and agriculture. Almost half (48 %) of total production is in the Middle East, but other markets such as China, the US and Latin America are growing as a result of technological advances that make desalination more cost and energy-efficient compared with conventional water-treatment methods.[87]

Moreover, advances in membrane technologies that extract impurities, making water fit for purpose as drinking water or within industry, are also spurring growth, especially as rising levels of micropollutants such as PFAS[c] gain public and regulatory attention. The global market was estimated to be USD 12.8 billion in 2019, and is expected to grow at a CAGR of 9.0 % between 2020 and 2027.[88]

Irrigation

As the largest consumer of water worldwide, agriculture has the potential for considerable water savings. Conventional methods include irrigation via channels of ditches and/or sprinklers. While economically cheap to install and operate, they are also wasteful, leaving the majority of water unused. Modern micro-irrigation systems could cut water consumption by as much as 70 % without impacting crop yields, while also preventing soil salination and reducing the need for pesticides.[12]

The success and spread of these modern technologies among farmers depend to a large extent on the availability of financing for investments as well as local water pricing systems. Higher water prices drive investments in water-saving technologies. Moreover, increased water efficiency efforts not only positively benefit water availability, they also reduce energy consumption as less electricity is needed for pumping. Furthermore, farmlands will become increasingly more energy and cost-efficient as irrigation machinery is run using renewable energy. Photovoltaic (PV) pumps for large-scale irrigation and solar-powered precision drip systems are prime examples of renewable technologies that can increase crop yields while reducing water consumption, energy use and overall costs for farmers.

Ballast water treatment

Ballast water is essential for stabilizing the weight as well as increasing the maneuverability of empty or unequally loaded cargo ships in long-distance freight transport and is one of the fastest-growing markets in the water sector. Ballast water from ocean or port waters is pumped into large cargo ships and dumped into the ports and waters of other regions when ships are loaded with freight.

Ballast water represents a serious biological and ecological threat as waters filled with marine species, bacteria, parasites and other pathogens native to one region are introduced into another. In addition to the biological threat, it also has economic consequences for fisheries and other local business when invasive species kill off indigenous varieties of marketable seafood.

Stricter enforcement of international maritime regulations is accelerating growth in ballast water management solutions. Current treatment technologies employed include chemical disinfection, ultra-violet light irradiation and filtration.

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c PFAS (per- and polyfluoroalkyl substances) is an umbrella classification that includes thousands (more than 4,700) of man-made chemicals with similar molecular structures. PFAS pose a threat to human and environmental health.

Construction & Materials

The Construction & Materials investment cluster includes companies that design, build or distribute large water infrastructure as well as small-scale solutions that relate to the transmission, management, maintenance and the conservation of water.

Engineering & Construction

In developed countries, investment growth will focus on upgrading and replacing aging distribution networks.[89] In major urban centers, pipes and mains are outdated and in need of replacement. The value of non-revenue water (water lost before it reaches the customer) losses due to main breaks and leaks totaled USD 39 billion per year globally.[90]

In most developing countries the infrastructure needs to be newly built granting access to drinking water and sanitation for all citizens. To meet SDG 6, Clean Water and Sanitation for All, annual water investments must triple in the next decade (around USD 114 billion per year).[12]

Most upgrades will be classified as grey infrastructure improvements; however, green infrastructure is gaining importance. For example, "smart" urban planning policies can help decrease flood risks by providing spaces to collect and store floodwater within the built environment. Meanwhile, the same flood run-off can be channeled to recharge municipal groundwater reservoirs. In this way, cities act as sponges, soaking up water in times of surplus for later release when needed.

Building Materials & Fixtures

Most of the growth in this cluster is expected from the upgrade and expansion of distribution networks to end users such as residential communities and commercial buildings. From plumbing pipes, toilets and faucets to heating and cooling systems, building materials, fittings and fixtures are key to effectively and efficiently delivering water services to end point users. Given energy is used for water pumping, treating and heating, efforts to efficiently manage end-point consumption will also help facilitate the transition to a low carbon economy.

In addition to the building and construction sector, manufacturers across diverse sectors such as chemicals, textiles and semiconductors will need to invest in water-efficient building materials in order to manage natural resources, improve environmental footprints and reduce overall operational costs.

Water and Environmental topics remain a key focus in many countries such as China, thus, a number of programs have been launched related to water supply, heating and drainage. More stringent regulations require further investment into supply upgrades for better quality, efficiency, and reliability in piping systems which focuses on system solutions for safe transport and regulation of water, air pollution and gas flows. Here, water-related technologies offer environmental benefits by improving the efficiency of energy consumption and, in turn, the quality of life.

Smart Metering

Public and private utilities rely on specialty industrial suppliers to build new and update existing water infrastructure. An example of such an update are smart water meters to detect water leakage and manage water and wastewater efficiently. Further applications are re-channeling and re-distribution of floodwaters in order to mitigate damage and recharge aquifers and artificial storage capacity.

Quality, Analytics & Management

Quality, Analytics and Management focuses on companies that develop and sell products and services for water quality monitoring and testing, systems to treat water at its point of use as well as solutions to protect water quality and reduce water use.

Without water-testing it is impossible to provide safe drinking water to municipalities, ensure environmental discharges meet regulatory requirements or provide processed/treated water to industries that meet mineral content, PH level and chemical dosing criteria.

Quality monitoring and water-testing will be key for managing water discharge into the environment, ensuring drinking water safety and providing fit-for-purpose water supplies for industrial applications. As a result, water analytic services will play an increasing role in the water value chain and provide excellent opportunities for revenues and future growth.

Precision purification

Pharmaceuticals and biotech companies in developed markets around the world are growing thanks to scientific breakthroughs, technological advances, and the accelerated pace of clinical trials. Water testing and purification are critical services needed by R&D laboratories, hospitals and healthcare facilities to eliminate impurities and contaminants that could alter the outcomes of experiments as well as harm patient health.

In addition, highly purified water is needed in several industrial processes such as hydrogen production or semiconductor manufacturing.

Analyzing and monitoring contaminants – smart water sensing

Increasing amounts of contaminants and micropollutants raise the need for stringent monitoring of water resources. Advances in sensor technologies are helping utilities improve water quality. Smart sensors can detect and remediate chemical leakages and/or pollution early, helping reduce overall damage and costs for utilities and customers.

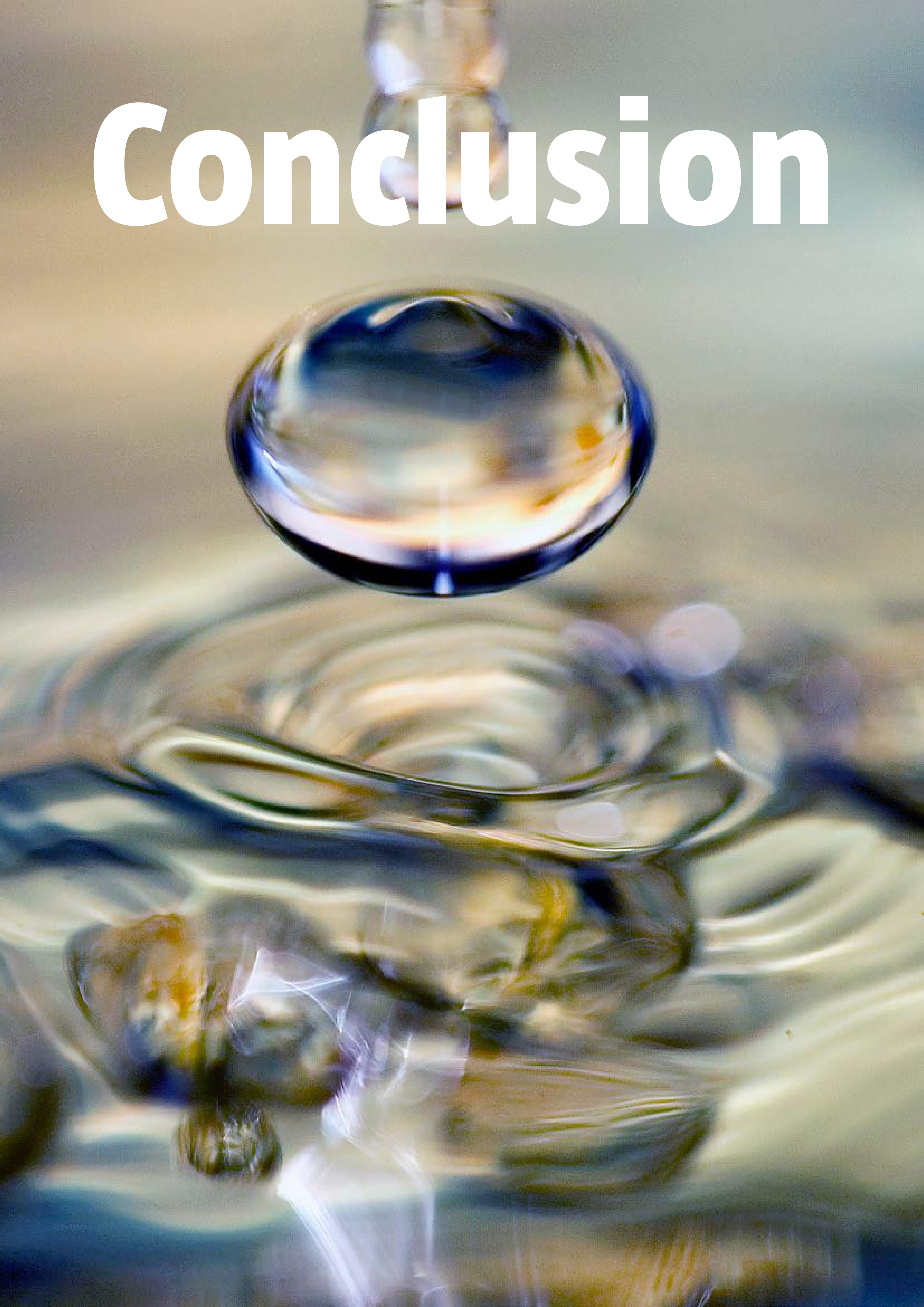
Point-of-use treatments

Point-of-use water treatment systems are used in private homes as well as commercial establishments to improve water quality on site. They are often used in countries with poor water quality or access, demonstrating the need for large-scale systems that can purify water at affordable prices. Growth in the point-of-use market is supported by an increasing awareness of water-related health concerns, rapid urbanization rates in cities with inadequate infrastructure, and rising GDP in emerging countries.

Resource Protection

Sustainable waste management is crucial for the protection of both surface and groundwater. In particular, wastewater management solutions in the mining and oil & gas sectors will grow significantly to comply with stricter environmental regulations. Damages to and pollution of aquifers as a result of fracking is an example of where water treatment and management technologies are urgently needed.

Conclusion



Water is an essential element for biological, environmental, social and economic growth. Yet, global water consumption over the last century has endangered water supplies and led to a water crisis that will worsen as a result of climate change, population increases, demographic shifts and industrialization. Limited supply combined with unsatiable thirst, wasteful consumption and increasing pollution highlight the need for more sustainable and long-term solutions to deal with exacerbating shortages around the globe. Solutions will differ based on local market characteristics such as sector consumption patterns, existing infrastructure, urban trends, as well as topography and geography.

For example, water consumption in many developing regions is dominated by agriculture making investments in more efficient irrigation systems appropriate for addressing scarcity issues. And although increasing urbanization is a worldwide phenomenon, the pace and pressure on local infrastructure will be particularly difficult for emerging market cities to maintain in a sustainable way, given the lack of existing infrastructure on which to build. In contrast, investments in developed cities will be mostly for upgrades and the 'greening' of existing infrastructure. National and local government spending will also positively impact water markets especially in the EU, US and China

Moreover, geography plays an important role in determining suitable investments to mitigate not only water scarcity but also the negative effects of climate change. Desalination is an important technology that can help reduce water scarcity in regions with access to seawater. Coastal cities and regions with direct exposure to hurricanes, monsoons and typhoons will directly benefit from investments in climate adaption and the strengthening of existing infrastructures.

Finally, advances in wastewater treatment will help climate-stressed regions, cities and communities throughout advanced and developing markets to reduce water shortages and restore natural and artificial water capacities for future needs. Solutions such as these are being provided by innovative companies across the water value chain, which is estimated to reach USD 900 billion by 2023.

Market indicators and economic estimates are helpful, but the value of water for many vulnerable groups such as women and girls extends beyond health. Access to sustainable water gives them time to participate in education, advance socially and achieve greater financial security. That means the positive impact of investments in water extend far beyond SDG 6 – Clean Water and Sanitation for All to include SDGs that combat education and gender inequality in addition to global hunger, good health, decent work and economic growth.

The challenges are substantial but so too are the opportunities for generating financial returns and positive impact. Companies that recognize the need and provide sustainable solutions suitable to the diverse segments of the global water market will be ideally positioned to ride the growing wave of interest and investment.

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Additional Information for investors with residence or seat in Germany
This information is solely intended for professional investors or eligible counterparties in the meaning of the German Securities Trading Act.

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The Management Company is not making any representation with respect to the eligibility of any recipients of the Prospectus to acquire the Shares therein under the laws of South Korea, including but not limited to the Foreign Exchange Transaction Act and Regulations thereunder. The Shares have not been registered under the Financial Investment Services and Capital Markets Act of Korea, and none of the Shares may be offered, sold or delivered, or offered or sold to any person for re-offering or resale, directly or indirectly, in South Korea or to any resident of South Korea except pursuant to applicable laws and regulations of South Korea.

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Additional Information for investors with residence or seat in Malaysia
Generally, no offer or sale of the Shares is permitted in Malaysia unless where a Recognition Exemption or the Prospectus Exemption applies: NO ACTION HAS BEEN, OR WILL BE, TAKEN TO COMPLY WITH MALAYSIAN LAWS FOR MAKING AVAILABLE, OFFERING FOR SUBSCRIPTION OR PURCHASE, OR ISSUING ANY INVITATION TO SUBSCRIBE FOR OR PURCHASE OR SALE OF THE SHARES IN MALAYSIA OR TO PERSONS IN MALAYSIA AS THE SHARES ARE NOT INTENDED BY THE ISSUER TO BE MADE AVAILABLE, OR MADE THE SUBJECT OF ANY OFFER OR INVITATION TO SUBSCRIBE OR PURCHASE, IN MALAYSIA. NEITHER THIS DOCUMENT NOR ANY DOCUMENT OR OTHER MATERIAL IN CONNECTION WITH THE SHARES SHOULD BE DISTRIBUTED, CAUSED TO BE DISTRIBUTED OR CIRCULATED IN MALAYSIA. NO PERSON SHOULD MAKE AVAILABLE OR MAKE ANY INVITATION OR OFFER OR INVITATION TO SELL OR PURCHASE THE SHARES IN MALAYSIA UNLESS SUCH PERSON TAKES THE NECESSARY ACTION TO COMPLY WITH MALAYSIAN LAWS.

Additional Information for investors with residence or seat in Mexico
The funds have not been and will not be registered with the National Registry of Securities, maintained by the Mexican National Banking and Securities Commission and, as a result, may not be offered or sold publicly in Mexico. Robeco and any underwriter or purchaser may offer and sell the funds in Mexico on a private placement basis to Institutional and Accredited Investors, pursuant to Article 8 of the Mexican Securities Market Law.

Additional Information for investors with residence or seat in Peru
The Fund has not been registered with the Superintendencia del Mercado de Valores (SMV) and is being placed by means of a private offer. SMV has not reviewed the information provided to the investor. This document is only for the exclusive use of institutional investors in Peru and is not for public distribution.

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of the Fund is not a prospectus as defined in the SFA. Accordingly, statutory liability under the SFA in relation to the content of prospectuses does not apply. The Sub-Funds may only be promoted exclusively to persons who are sufficiently experienced and sophisticated to understand the risks involved in investing in such schemes, and who satisfy certain other criteria provided under Section 304, Section 305 or any other applicable provision of the SFA and the subsidiary legislation enacted thereunder. You should consider carefully whether the investment is suitable for you. Robeco Singapore Private Limited holds a capital markets services license for fund management issued by the MAS and is subject to certain clientele restrictions under such license.

Additional Information for investors with residence or seat in Spain
Robeco Institutional Asset Management B.V., Sucursal en España with identification number W0032687F and having its registered office in Madrid at Calle Serrano 47-14º, is registered with the Spanish Commercial Registry in Madrid, in volume 19.957, page 190, section 8, sheet M-351927 and with the National Securities Market Commission (CNMV) in the Official Register of branches of European investment services companies, under number 24. The investment funds or SICAV mentioned in this document are regulated by the corresponding authorities of their country of origin and are registered in the Special Registry of the CNMV of Foreign Collective Investment Institutions marketed in Spain.

Additional Information for investors with residence or seat in South Africa
Robeco Institutional Asset Management B.V. is registered and regulated by the Financial Sector Conduct Authority in South Africa.

Additional Information for investors with residence or seat in Switzerland
The Fund(s) are domiciled in Luxembourg. This document is exclusively distributed in Switzerland to qualified investors as defined in the Swiss Collective Investment Schemes Act (CISA). This material is distributed by Robeco Switzerland Ltd, postal address: Josefstrasse 218, 8005 Zurich. ACOLIN Fund Services AG, postal address: Affolternstrasse 56, 8050 Zürich, acts as the Swiss representative of the Fund(s). UBS Switzerland AG, Bahnhofstrasse 45, 8001 Zurich, postal address: Europastrasse 2, P.O. Box, CH-8152 Opfikon, acts as the Swiss paying agent. The prospectus, the Key Investor Information Documents (KIIDs), the articles of association, the annual and semi-annual reports of the Fund(s), as well as the list of the purchases and sales which the Fund(s) has undertaken during the financial year, may be obtained, on simple request and free of charge, at the office of the Swiss representative ACOLIN Fund Services AG. The prospectuses are also available via the website.

Additional Information relating to RobecoSAM-branded funds/services
Robeco Switzerland Ltd, postal address Josefstrasse 218, 8005 Zurich, Switzerland has a license as asset manager of collective assets from the Swiss Financial Market Supervisory Authority FINMA. RobecoSAM-branded financial instruments and investment strategies referring to such financial instruments are generally managed by Robeco Switzerland Ltd. The RobecoSAM brand is a registered trademark of Robeco Holding B.V. The brand RobecoSAM is used to market services and products which entail Robeco's expertise on Sustainable Investing (SI). The brand RobecoSAM is not to be considered as a separate legal entity.

Additional Information for investors with residence or seat in Thailand
The Prospectus has not been approved by the Securities and Exchange Commission which takes no responsibility for its contents. No offer to the public to purchase the Shares will be made in Thailand and the Prospectus is intended to be read by the addressee only and must not be passed to, issued to, or shown to the public generally.

Additional Information for investors with residence or seat in the United Arab Emirates
Some Funds referred to in this marketing material have been registered with the UAE Securities and Commodities Authority (the Authority). Details of all Registered Funds can be found on the Authority's website. The Authority assumes no liability for the accuracy of the information set out in this material/document, nor for the failure of any persons engaged in the investment Fund in performing their duties and responsibilities.

Additional Information for investors with residence or seat in the United Kingdom
Robeco is subject to limited regulation in the UK by the Financial Conduct Authority. Details about the extent of our regulation by the Financial Conduct Authority are available from us on request.

Additional Information for investors with residence or seat in Uruguay
The sale of the Fund qualifies as a private placement pursuant to section 2 of Uruguayan law 18,627. The Fund must not be offered or sold to the public in Uruguay, except under circumstances which do not constitute a public offering or distribution under Uruguayan laws and regulations. The Fund is not and will not be registered with the Financial Services Superintendency of the Central Bank of Uruguay. The Fund corresponds to investment funds that are not investment funds regulated by Uruguayan law 16,774 dated September 27, 1996, as amended.

The Investment Engineers

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