WATER ATLAS

Data and facts about the basis of life

2025

HEINRICH BÖLL STIFTUNG

IMPRINT

The **WATER ATLAS 2025** is published by Heinrich-Böll-Stiftung, Berlin, Germany.

Executive editors:
Linda Schneider, Kristin Funke, Heinrich-Böll-Stiftung

Managing editor, graphics research: Martin Eimermacher
Contributing editors: Johanna Sydow, Annette Kraus, Heinrich-Böll-Stiftung, Berlin
Art direction, graphic development: STOCKMAR+WALTER Kommunikationsdesign
Translation and editing: Paul Mundy
Proofreading: Joan Lanfranco, Heinrich-Böll-Stiftung European Union | Global Dialogue

Contributors: Elena Alter, Andrés Ángel, Nidhal Attia, Steffen Bender, Kyle Davis, Inka Dewitz, Petra Dobner, Bapon Fakhruddin, Dieter Gerten, Peter Greve, Daniela Jacob, Annette Jensen, Annette Kraus, Sergiy Moroz, Andreiev Pinzón, Friederike Rohde, Ute Scheub, Susanne Schmeier, Stefan Schwarzer, Nora Stognief, Luis Fernando Sánchez Supelano, Johanna Sydow, Areeya Tivasuradej, Helena Varkkey, Laura von Vittorelli, Anoosh Sophie Werner

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Editorial responsibility (V. i. S. d. P.): Annette Maennel, Heinrich-Böll-Stiftung

1st edition, October 2025

ISBN: 978-9-46494425-9
Legal deposit D/2025/11.850/1

Printed by: MURIEL sprl, Brussels, Belgium

The Water Atlas is the international edition of the Wasseratlas, jointly published by the Heinrich-Böll-Stiftung and Bund für Umwelt und Naturschutz Deutschland (BUND) in early 2025.

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FOREWORD

Water is the basis of all life. It covers more than two-thirds of our planet, comprises most of our bodies, and binds us humans with nature in a unique way. Without water, there would be no plants, no animals, and no people. Water shaped us and the world we live in long before we began to manage and control it. No wonder that it has left its mark on the religions, art, and culture of every civilisation. But today water, that indispensable resource, is threatened more than ever by overuse, by the effects of the climate crisis, and by pollution. The water cycle of our planet is tipping out of balance, and we have already exceeded the limits of sustainable water use. A change of course is urgently needed. Fortunately, such a change is still possible.

In many parts of the world, humanity currently consumes more water than is available. The water table in many countries is falling dramatically, threatening drinking water supplies, food production, and numerous ecosystems. Fuelled by global warming, extreme weather events such as droughts and floods are becoming more common and more severe. Higher temperatures dry out the soil, and heavy rains endanger both people and infrastructure. Our impact on water is visible across the globe, from tiny particles of plastic in remote corners of the Arctic, to traces of industrial chemicals in the water we drink. As a result, our livelihoods are threatened, and our water is becoming scarcer and less safe to drink. Those who are hardest hit are the least able to cope with these problems.

Although many people around the world support the idea of protecting water resources, water conservation is rarely at the forefront of political debates. Other challenges, such as economic needs, are seen as more

> No water, no life. The climate crisis is making every drop even more precious

pressing. This overlooks the fact that manufacturing also needs adequate water supplies. That points to the need for strong and committed communication of the facts by politicians, scientists, and civil society.

For example, we need to explain the connections between the climate crisis and water. Many people are still not aware of how the climate crisis affects the water balance. Research tells us that when people can perceive environmental problems directly with their senses, it is easier for them to assess a crisis. The water crisis with its droughts, floods, parched forests, and rivers full of dead fish can be experienced directly – while greenhouse gases such as carbon dioxide remain invisible. That explains why many people are unaware how closely the climate is linked to the quality and availability of water. Scientists refer to this phenomenon as water blindness. Further uncertainties arise because the climate crisis can lead to seemingly contradictory phenomena when it comes to water: flooding on the one hand, and water shortages on the other.

In addition to the climate, industry and agriculture also put water resources under strain. Rivers, lakes, and groundwater around the world are contaminated by microplastics, chemicals, pharmaceuticals, fertilisers and pesticides. These pollutants threaten the health of both people and nature. Protecting our valuable water resources must finally be given priority over corporate interests. This requires binding policies, financial incentives to promote water-efficiency, and a better labelling of products that save water. Protecting water resources can be successful only if it is thought of in preventative terms. The most effective way to maintain water quality is to stop it from being contaminated in the first place. Instead of allowing toxic substances to enter water, they should be taken out of circulation altogether. Industry and agriculture should be seen more as water stakeholders and should be held more accountable for their effects.

Our growing demand for energy and raw materials must also be examined, as it has a major influence on the quality and availability of water. We need to understand that our consumption of raw materials and land cannot continue to grow indefinitely. Policy measures and innovative technologies can help achieve a shift towards a more careful use of water. Companies should be required to minimise the risks along their supply chains that might limit the availability of water to the local population. In addition, areas that are important for water supplies should remain undisturbed: they should be protected, including from mining activities.

The importance of water goes beyond ecological and technical issues. It also has political and societal dimensions. Water shortages and the climate crisis exacerbate social tensions and inequalities. People in poorer regions are especially vulnerable, suffering greatly from the effects of scarce water and extreme weather. Water shortages threaten food security, trigger migration, and exacerbate existing conflicts. Every year more than 120 cases of conflict over water are registered – and the numbers may well rise in the coming years. That makes it even more important that we work together as a global community.

> ” Water scarcity intensifies existing conflicts and deepens social inequalities

Many institutions are concerned with how water should be used and distributed. Many current laws and action programmes pursue the right approaches to protect water resources – but politicians are often too slow to implement them. Effective international agreements and cross-border cooperation are therefore essential to ensure the sustainable use and protection of our water resources and to avoid conflicts. The United Nations water conferences in the coming years offer an important opportunity to develop measures for improved water management and to negotiate a binding agreement on water.

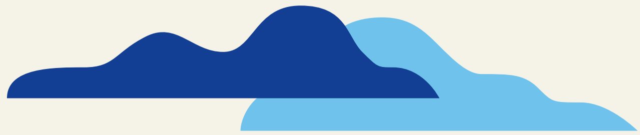
The Water Atlas aims to contribute to raising awareness of the issue of water and throw light on the many facets of this valuable resource. We provide information not only on the urgency of the problem but also show the many opportunities and solutions that exist today.

We face an enormous task: if we act decisively to achieve a sustainable management of water, we can protect the basis for all of life. Let us work together to ensure that water is available for all people, and that it remains a symbol for life, health, and nature.

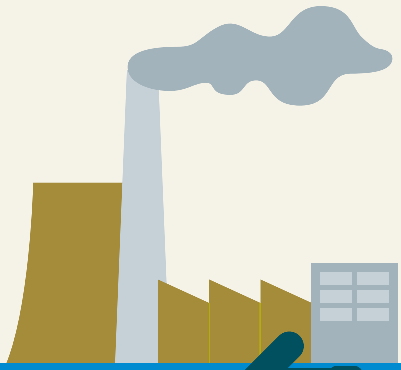
Dr. Imme Scholz
Heinrich-Böll-Stiftung

12 BRIEF LESSONS

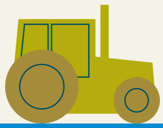
ABOUT WATER

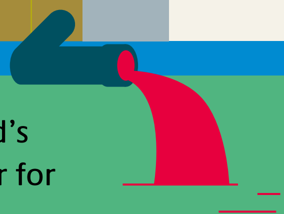


1 Water is the **BASIS OF LIFE.** It covers more than two-thirds of our planet and shapes ecosystems and cultures.



2 Industrialisation, overexploitation, and population growth are driving **WATER SCARCITY, WATER POLLUTION,** and **CONFLICTS.**



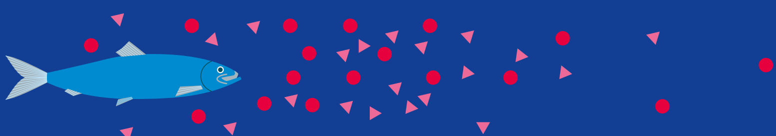


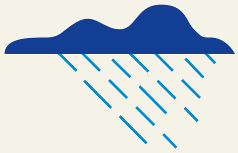
3 The **ENERGY SECTOR, AGRICULTURE**, and **INDUSTRY** are the world's largest **WATER CONSUMERS,** as they require vast amounts of water for cooling, irrigation, and production.

4 Safe access to clean **WATER IS A HUMAN RIGHT.** Yet around 2.2 billion people still lack access to adequate drinking water supply – and the most vulnerable members of society are particularly affected.

5 The **CLIMATE CRISIS** leads to an increase in extreme weather events. **DROUGHTS** are threatening crops and water supplies – while floods endanger many towns and landscapes.

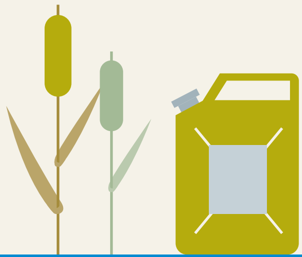
6 Drained **PEATLANDS** must be rewetted and **FLOODPLAINS** restored. In addition to their vital role in supporting **BIODIVERSITY** and maintaining the **LANDSCAPE WATER BALANCE,** they play a key role in **CLIMATE PROTECTION.**





7 Pollution from **CHEMICALS, MICROPLASTICS, PESTICIDES,** and **FERTILISERS** contaminates water bodies, putting ecosystems, biodiversity, and human health at risk.

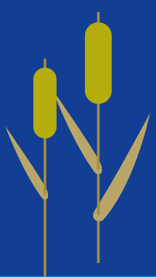
8 Worldwide, many surface waters fail to achieve good **ECOLOGICAL STATUS.** In the European Union, for example, only around 40 percent have a good ecological status.



9 **EXCESS NUTRIENTS** threaten coastal regions worldwide, leading to **OXYGEN-DEPLETED DEAD ZONES** where many marine species cannot survive.

10 **WATER PROTECTION** and the equitable and sufficient use of water can alleviate water stress and injustice. Environmentally friendly materials and production processes can prevent harmful substances from entering water bodies in the first place.

11 To effectively address the challenges of the water and climate crises, we must **DEMOCRATISE WATER GOVERNANCE.** Community-led water management offers an alternative to market-based models.



12 The history of privatisation shows that water is used more responsibly when kept in **PUBLIC HANDS** – rather than being handed over to corporations driven by profit interests. Especially as **ARTIFICIAL INTELLIGENCE (AI)** and other technologies increase water demand.

NO WATER, NO LIFE

Water is vital for life on Earth. But overuse, pollution, and the climate crisis are endangering global water reserves, with far-reaching consequences for ecosystems and humans. To overcome crises, we must manage water sustainably.

More than 70 percent of the Earth's surface is covered in water. But that was not always the case. When it was first formed, the Earth was a huge molten ball of fire. According to the most widely accepted theory, it acquired most of its water later from a bombardment of comets and asteroids about 4 billion years ago. These celestial bodies from distant, cooler parts of the solar system consisted largely of ice, which immediately vaporised in the enormous heat of the atmosphere. As temperatures gradually cooled over time, the water condensed and fell to the ground as a torrential downpour lasting thousands of years. The water flooded the surface, and the depths of the primordial ocean would later become the birthplace of life.

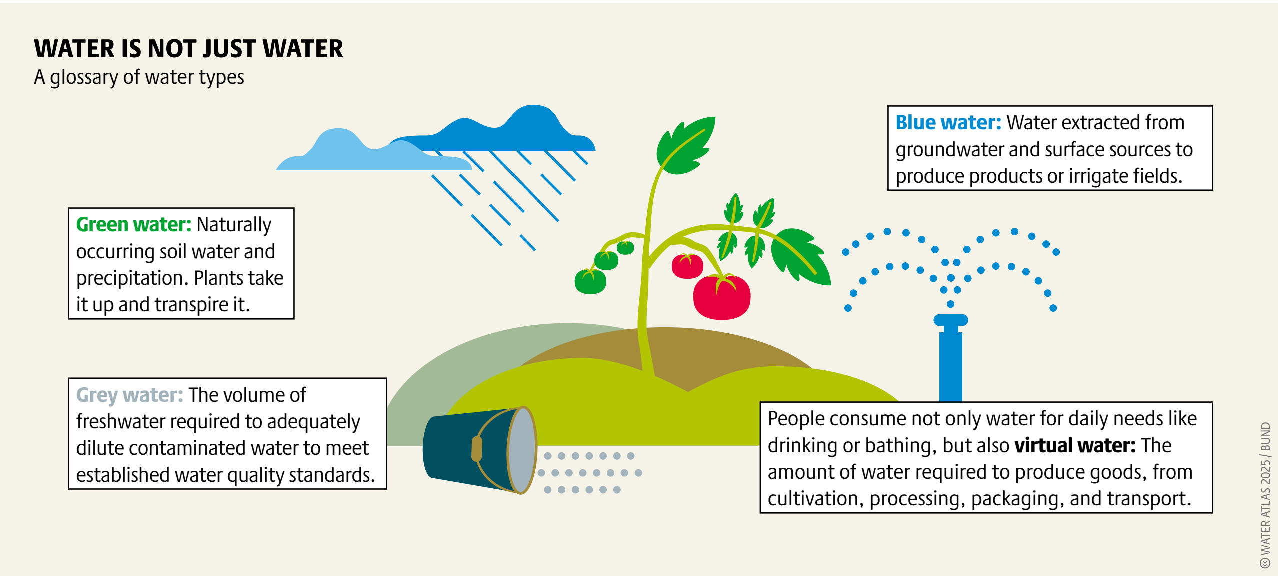
Today, 97.1 percent of the Earth's water is in the form of salt water, mainly in the oceans. The rest is fresh water, and of that, 99.7 is tied up in ice caps or deep beneath the ground. The remaining 0.3 percent of fresh water – around 120,000 cubic kilometres – is in constant circulation between land and sea: above and below the surface, and in solid, liquid or vapour form. This creates a perfect cycle, for the same amount that is carried by the atmosphere onto the land eventually flows back into the sea. The complex patterns of atmospheric circulation are the main reason that freshwater is very unevenly distributed on the land in terms of both space and time. Less fresh water is found in the subtropics and during dry periods, while availability is greater in the tropics.

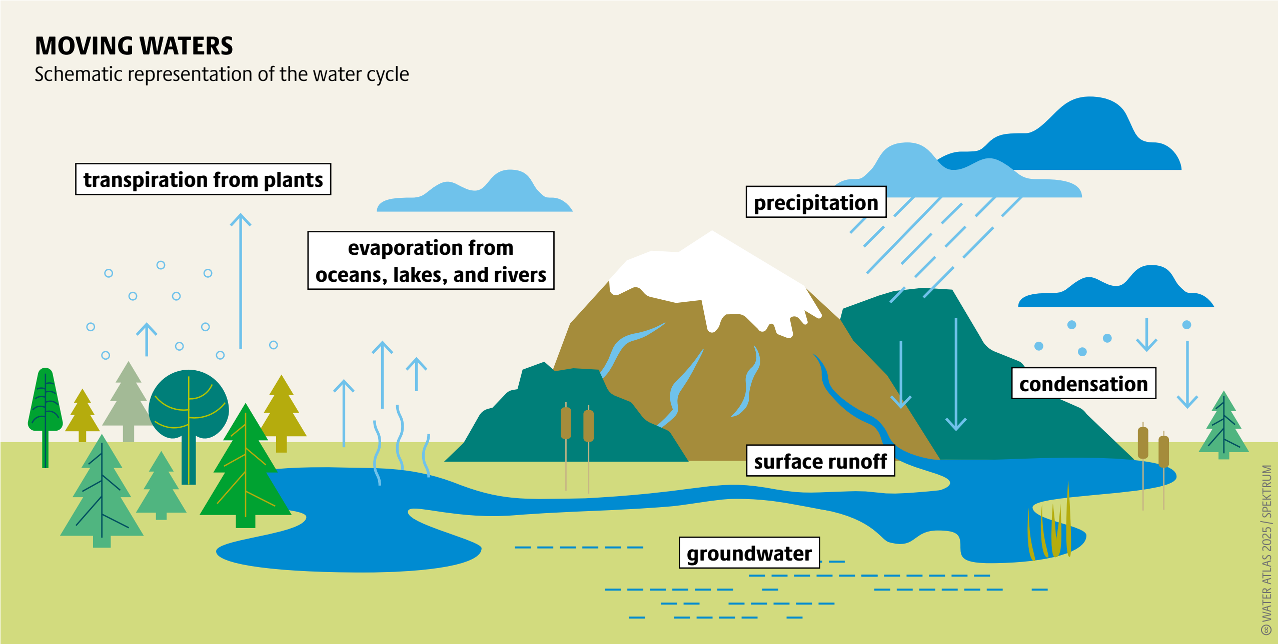
Human interventions are causing profound changes in the water cycle. In many parts of the world, water reserves are being overexploited or polluted. Ecosystems are suffering as a result, as are agriculture, industry, and households. Maintaining a reliable water supply for all is becoming increasingly difficult. Examples of dramatic developments relating to water abound. In Pakistan, northern India, and parts of the USA, groundwater levels have fallen drastically as a result of overexploitation. Glaciers are melting in almost all the world's mountain ranges due to global warming. The consequences are dire for ecosystems and communities downstream, as they are affected by the fluctuating supply of river and meltwater. The biodiversity in and around water bodies is declining so rapidly that one-quarter of all known freshwater fish species are already threatened with extinction. Urban centres such as Mexico City, Beijing, and Cape Town are suffering

Through their imports, wealthy countries draw on virtual water from the Global South, worsening water scarcity in those regions

WATER IS NOT JUST WATER

A glossary of water types





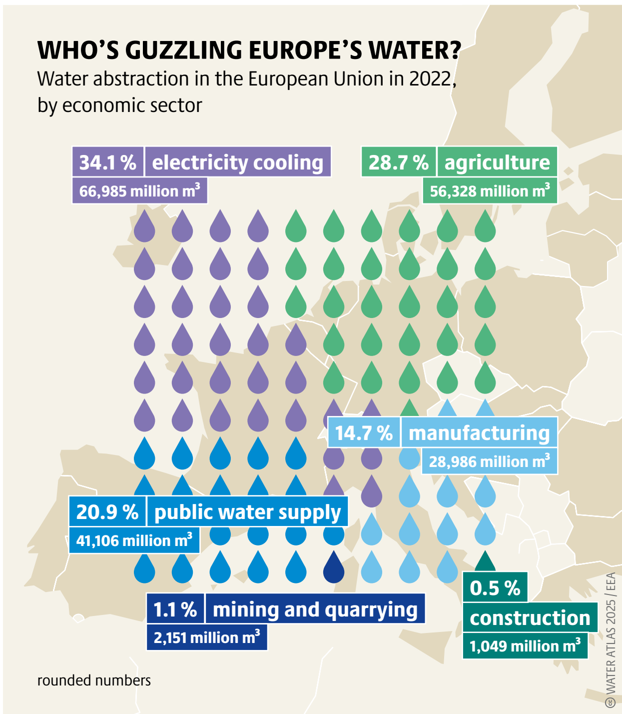
Human interventions alter the water cycle. In the Congo Basin, deforestation of the rainforest could cut local rainfall by 10 percent

from water shortages; 2.2 billion people lack regular access to clean drinking water.

The causes are as many and varied as the problems themselves. For example, river straightening and the sealing of the ground surface increase the extent of flooding. River diversions and dams harm or destroy aquatic ecosystems; spreading pollutants on the soil or into water bodies jeopardises the quality of drinking water. Using too much water for irrigation leads to shortages. The climate crisis causes more frequent and more severe weather extremes such as droughts and floods everywhere.

In order to protect aquatic ecosystems, it is important not to consume all available water. The planetary boundary for freshwater change plays a crucial role here. This is a kind of warning line that shows to what extent nature can cope without being seriously harmed. If water is consumed beyond the planetary boundary, the planet's resilience to other environmental changes, such as the climate crisis, and the loss of ecosystems and their biodiversity, is weakened. According to recent calculations, the freshwater planetary boundary was breached decades ago. Up to 18 percent of the Earth's ice-free surface has either unnaturally low or unnaturally high, water levels in rivers and soils. That is significantly higher than in pre-industrial times.

In the past, it was often assumed that water resources were stable and new reserves could always be tapped. In view of the climate crisis, such a cornucopia approach seems increasingly questionable. Policymakers must therefore increasingly focus on reducing water use and ensuring that water bodies are used more responsibly. A wide range of options are available to industry, and especially to agriculture. These range from collecting rainwater during wet periods, adopting tillage methods that reduce evaporation, and exporting water-intensive goods from water-rich to water-stressed countries. ●



Water use in Europe varies: in the south, agriculture dominates, elsewhere power generation cooling puts the greatest strain on resources

HUMAN RIGHT

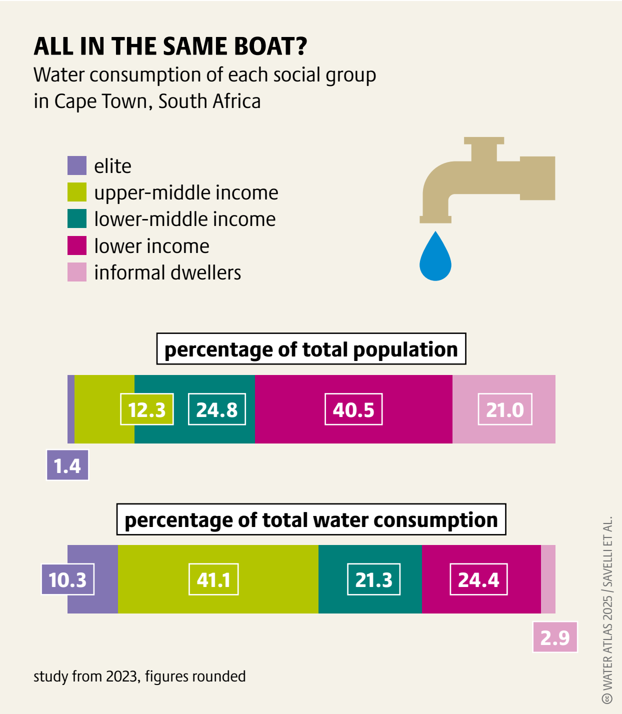
WATER FOR ALL

Over a quarter of the world's population has no safe access to drinking water. To improve this situation, the United Nations has declared water a human right: it must be safe to drink and accessible to all. Decisive political action is required to prevent such well-intentioned efforts from faltering.

The human right to water does not just mean having enough water to drink. It also means having enough water for cooking, cleaning, washing, and personal hygiene. One person needs at least 50 to 100 litres per day to cover all these needs. The right to water is also closely related to the right to basic sanitation. For many people that remains an unattainable reality: some 3.5 billion people still have no functioning toilet in their home. This is often not due to a lack of water, but to its uneven distribution and poverty.

The rights to water and sanitation have increasingly been recognised in recent decades under international law. These rights are derived from Articles 11 and 12 of the United Nations International Covenant on Economic, Social and Cultural Rights (ICESCR). Article 11 addresses the right to an adequate standard of living, and Article 12 recognises the right of all to the highest attainable standard of physical and mental health. The Human Rights Council and the General Assembly of the United Nations (UN) have recognised both these rights; while their decisions are not binding, they carry significant political weight. To help individuals to enforce guaranteed rights, the European Union (EU) has revised its Drinking Water Directive: a right to water has now been explicitly established at the EU level. This is intended to support vulnerable groups, especially homeless people, who often have limited access to toilets and clean water. One example is Germany, where the official number of homeless people in 2022 was around 262,600 – a figure that includes both those without their own place of residence who are staying with friends or in temporary accommodation, and people who live permanently on the streets. The actual number of homeless people in Germany is likely to be higher. One survey found that 20 percent of the homeless had no access to tap water – and for those without any accommodation, it was as high as 37 percent. Providing drinking water in public places would at least be a first step to alleviating this problem. One-third of the survey respondents also stated that they had access to water for drinking but not for washing.

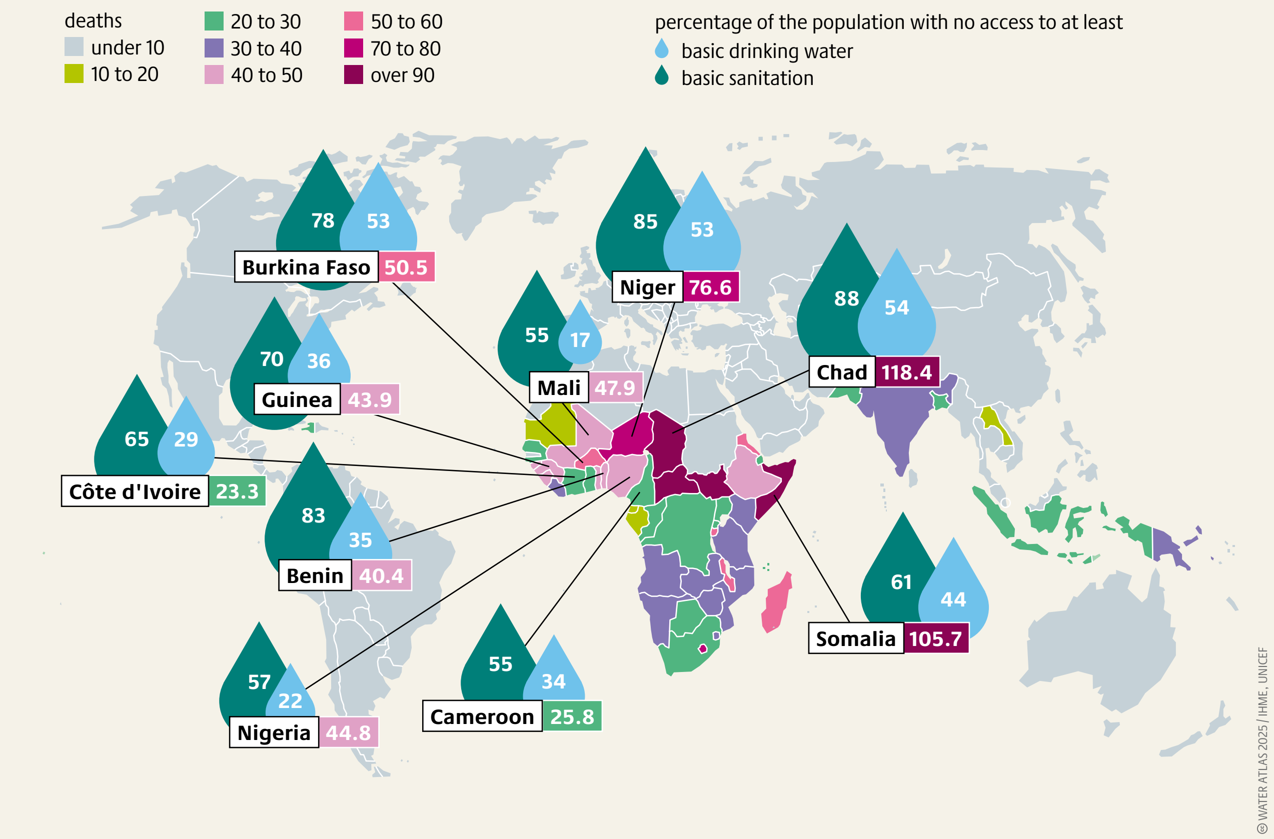
The climate crisis is making it more difficult to ensure a right to water. A recent report by the Intergovernmental Panel on Climate Change (IPCC) clearly shows this: between 2002 and 2021, 1.6 billion people were affected by flooding, while 1.4 billion people suffered from droughts. In the EU, groundwater levels have been declining for years. Annually, approximately 20 percent of the land area and 30 percent of the population face water stress, with droughts causing economic losses of up to nine billion euros per year, in addition to immeasurable damage to ecosystems. Southern Europe is particularly affected. Around 14 percent of the groundwater monitoring stations in the EU report nitrate concentrations exceeding the maximum permissible level of 50 milligrams per litre. This nitrogen compound can harm the health of babies; it enters the groundwater in the form of agricultural fertilisers.



Cape Town provides an extreme example of how water scarcity hits those already economically and politically marginalised the hardest

HOTSPOTS OF WATER INSECURITY

Deaths per 100,000 people related to unsafe water sources in 2021 and the ten countries in the world with the worst access to drinking water and sanitation services



The right to water therefore requires more than guaranteed access to water: its quality must also be protected in the long term. A large part of the world's population still has insufficient access to clean water. At least 3 billion people are reliant on water that is not monitored for quality. More than 2 billion people are exposed to drinking water that may be contaminated with pathogens. That is why water should have a much higher priority on the international agenda. The UN Water Conferences in 2026 and 2028 present an opportunity to initiate a binding global agreement to protect water resources.

The textile industry is responsible for around 20 percent of the global water pollution. Textiles for the global market are often produced in regions where water is already scarce. One example is the extremely water-intensive production of cotton in India. There, it takes 23,000 litres of water to produce just one kilogram of cotton. The European Union's new Supply Chain Law, the Directive on Corporate Sustainability Due Diligence, will require European companies above a certain size to identify and minimise risks such as excessive use of water at the production site. This may force companies to invest in infrastructure to treat water, or to require their suppliers to use more efficient irrigation methods. The law came into force in 2024. It remains to be seen whether it can contribute to strengthening human rights and environmental standards along the value chain.

The WHO estimates that better access to water, sanitation, and hygiene could save more than 1.4 million lives worldwide each year

How new legal approaches can lead to better protection for water can be seen in Panama. In autumn 2023, the country saw the largest protests in decades. Tens of thousands of people demonstrated with strikes and blockades in favour of shutting down the Cobre Panamá, the biggest copper mine in Central America. The protests were boosted by the fact that Panama had shortly before recognised Nature as an independent legal entity – one of the first countries in the world to do so. Nature now enjoys similar rights enshrined in law as humans and legal entities such as firms. After the protests broke out, the Supreme Court of Panama referred to this when ordering the mine to be closed. The Court concluded that the continued operation of the mine would violate the Constitution because it threatened the rainforest and thereby the region's water sources. ●

UNDER PRESSURE

Rising levels of greenhouse gases in the atmosphere warm the oceans, melt icecaps and make extreme weather such as droughts and floods more frequent. Those most severely affected are least able to protect themselves.

Global warming affects the water cycle, with far-reaching consequences. Rising global temperatures cause the oceans to warm. This changes how water circulates, thereby affecting the exchange of heat, and causes the Greenland and Antarctic ice sheets to melt faster than ever.

Dense deep water is an indispensable driver of temperature exchange in the oceans. As the ice melts, smaller quantities of dense, cold water are formed and sink into the depths. That disrupts the natural circulation and negatively affects heat flow at the ocean's surface. The water near the surface is warmed more strongly, causing sea levels to rise because warm water takes up more space than cold. This warming also accelerates the melting of glaciers and ice caps.

Air currents are also affected by global warming. Wind systems and the paths of storms shift, and precipitation patterns change. Weather patterns may increase in intensity. If the surface temperatures of the oceans rise, the warmer air can take up more moisture. Each degree Celsius of warming increases the air's capacity to absorb moisture by 7 percent.

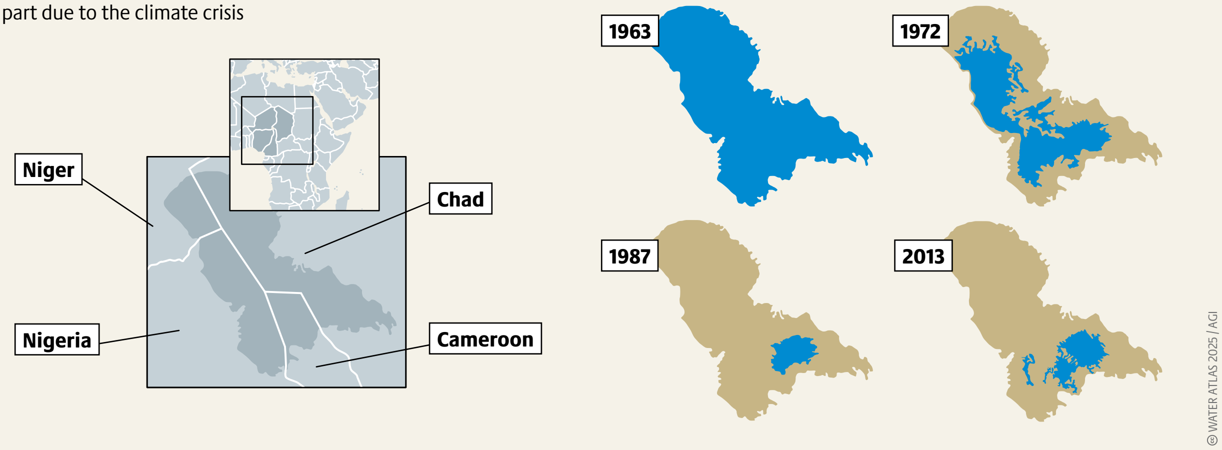
This greater absorption of moisture favours weather extremes and may lead to local dry spells as well as heavy rainfall. Attribution research, which studies the effect of human-caused climate change on extreme weather events, has found that the climate crisis has increased the probability of heavy rain by a factor of 1.2 to 9. If high amounts of rain falls on parched soils, water runs off the surface rather than sinking in. That may result in flooding further downstream.

The climate crisis has an especially profound impact on the water balance in countries of the Global South: Changing rainfall patterns lead to more frequent and intense droughts as well as floods, which in turn undermine the availability of water resources. These shifts threaten the water supply for households, agriculture, and industry, while also increase the risk of conflict over scarce water resources. In Kenya between 1995 and 2019, for example, the proportion of humans living under water stress rose from 15 percent to 33 percent. Wealthy countries in the Global North are also increasingly affected. In the United States, California shows where the trend can lead: in many places, groundwater levels have already fallen by more than 30 metres, and thousands of wells have dried up.

The climate crisis not only reduces the quantity of water available; it also affects its quality. Rising tem-

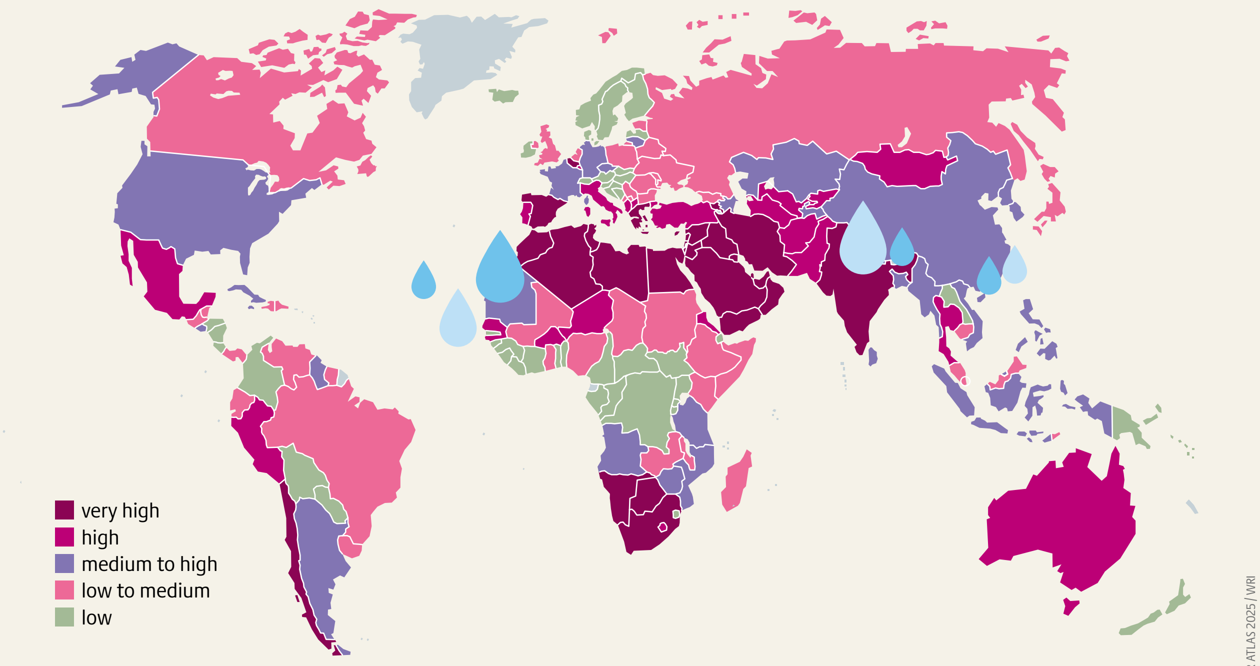
Once huge, the surface area of Lake Chad has now shrunk by 90 percent, endangering the livelihoods of 14 million people

WHO PULLED THE PLUG?
Water loss in Lake Chad in West and Central Africa, in part due to the climate crisis



HEADING FOR A CLIFF

Predicted water stress in 2050 with business-as-usual scenario



Water stress occurs when the balance between water withdrawal and water availability is unfavourable

Unless urgent action is taken, by 2050, 5 billion people could face water scarcity as the population grows and the climate crisis worsens

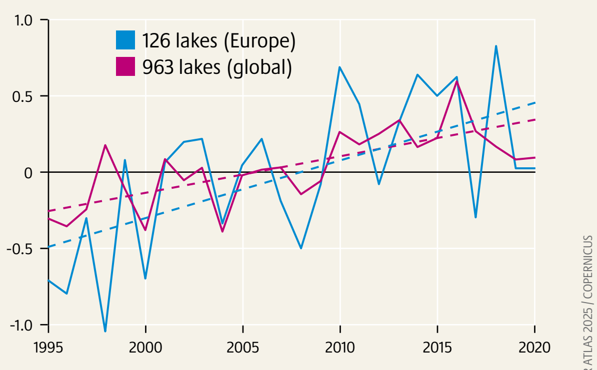
peratures and water shortages in summer favour the growth of dangerous microorganisms such as blue-green algae and vibrios. Oxygen levels in the water also fall, and the dilution effect for harmful substances such as nitrates in the water is reduced.

The global climate crisis mainly affects those who have contributed least to it and who are least able to protect themselves: low-income countries, as well as the poor in high-income countries. The demand for drinking water is supplied mainly by groundwater, but the uncontrolled rise in water consumption leads to land subsidence. Jakarta is an example: the Indonesian capital is sinking by over 20 centimetres per year. Large parts of the city are already below sea level. As a result, large quantities of seawater seep into the groundwater layers, making many wells unusable. In mountainous regions too, water is becoming scarcer because of urban growth and the climate crisis, for example on the western slopes of the Andes. Shrinking glaciers and higher evaporation rates are reducing the usable water resources. Over-extraction and longer dry periods lower the volumes of lakes and rivers. That causes declines in fish stocks and the loss of livelihoods for fisherfolk and their families. These impacts increase political tensions, amplify vulnerability, and often force people to migrate, creating additional social and economic challenges. Urgent, coordinated global action is needed to improve water management and climate adaptation in order to protect vulnerable communities and ecosystems. ●

Rising water temperatures from the climate crisis harm biodiversity, cause algae blooms, and threaten fish stocks and drinking water

IN HOT WATER

Summer water temperature of lakes, Europe and global, compared to mean of period 1996-2016, in degrees Celsius



dashed lines: linear trend

BIODIVERSITY

WET HABITATS

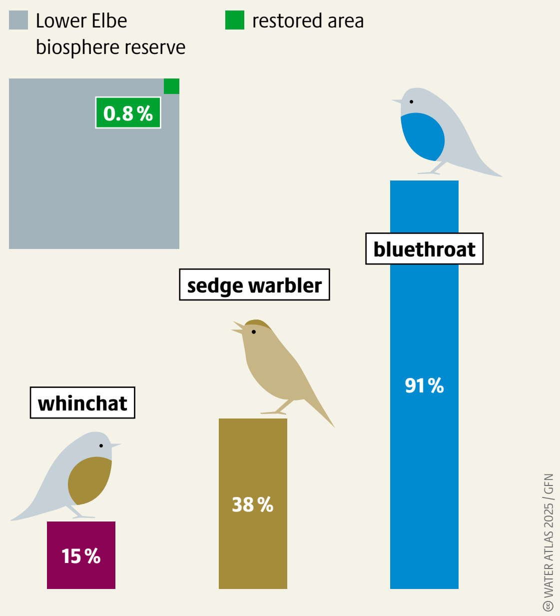
Healthy ecosystems purify water and protect against floods and droughts. However, the climate crisis is disrupting natural cycles and threatening habitats around the world. Protecting peatlands, wetlands, and coastal areas is not only an ecological priority but also a social imperative.

In their search for life on distant planets, scientists look for evidence of water: where there is water, there may be life. On our blue planet, we know that life began in the oceans, later evolving into diverse species that populate the land, seas, and skies.

Water and biodiversity are intimately connected. Different aquatic ecosystems support various types of flora and fauna. Distinct species of catfish inhabit salty oceans, freshwater rivers, and brackish backwaters. Different bird species have evolved to hunt prey in specific types of aquatic habitats. The health of these ecosystems is key to the survival of such specialised species.

BIODIVERSITY THROUGH DIKE RELOCATION

Proportion of the bird population in the restored section of the Lenzener Elbe floodplain (Germany) after 10 years, as a percentage of the total population of the Lower Elbe biosphere reserve, by species



Diversity is essential for a healthy ecosystem. Clean water supports the breeding and growth of species. In turn, diverse communities of flora and fauna work together to cycle and purify water. Species such as cattails, water hyacinth, and certain microbes specialise in removing pollutants, toxins, and heavy metals from water, while shellfish, reeds, and roots act as natural filters. Without such diversity, some ecosystems would gradually become incapable of supporting life.

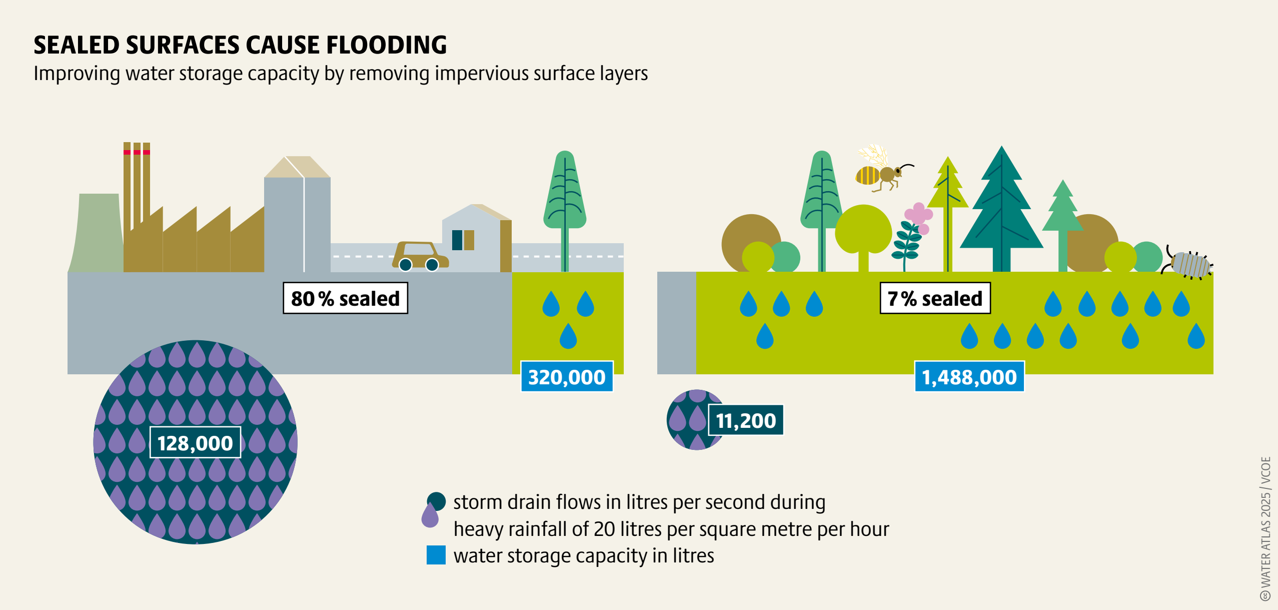
Ecosystems like wetlands, floodplains, moors, and forests contribute to water cycling at the planetary level. Water cycles through these ecosystems in different forms: water vapour rises from the ground and from leaves, condenses into clouds, and falls to the ground again as rain or snow.

Wetlands have porous soils, rich in organic matter, which retains water effectively, like a sponge. In heavy rains, wetlands absorb and store the excess water, preventing floods. As the surrounding areas dry up, the wetlands release their water slowly, mitigating droughts. Floodplains serve a similar role by storing and distributing excess water, reducing the risk of floods and enhancing soil fertility.

The planetary water cycle is severely affected by the climate crisis. Ecosystems may be lost temporarily or permanently; habitats may become fragmented or degraded, and food chains may be disrupted. Species that are unable to adapt may dwindle and become extinct. This is especially problematic if the species in question is a keystone species, one that is crucial for maintaining the structure and function of an ecosystem. Alligators and crocodiles are prime examples of keystone species in wetland environments. As droughts fragment their habitats and breeding sites, this affects their populations, in turn influencing many other species that directly or indirectly depend on them.

The oceans are also suffering from the extreme effects of the climate crisis. Oceans absorb excess carbon dioxide (CO_2), a major greenhouse gas, which helps maintain the global carbon balance. However, absorbing so much CO_2 disrupts the natural pH levels of seawater, making it more acidic and reducing the number of carbonate ions, which corals and shellfish need to build their skeletons and shells. As these organisms are often also keystone species, the rising acidity can

The example from Germany shows that restoration is worthwhile, as floodplains regenerate quickly and provide a refuge for many species



Covering the ground with asphalt and concrete prevents it from absorbing moisture. The result is overflowing drains and flooding

ripple through the entire marine food web. Increasing seawater temperatures also stress corals, causing them to expel the symbiotic algae that provide them with food. This bleaching makes corals more susceptible to disease and starvation. Whole reefs may die if the water temperatures do not return to a safe range.

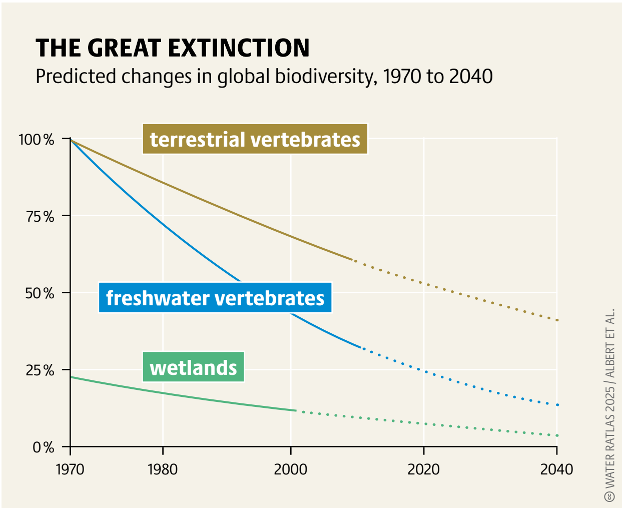
Biodiverse systems are better than low-diversity systems at providing various types of ecosystem services that benefit humans: regulating services for the climate, water, and air; provisioning services for food and medicine; and supporting services like nutrient cycling, photosynthesis, and the formation of fertile soil. Water nourishes human life and well-being, and is essential for industry and progress.

Consequently, a reliable ecosystem-services-based approach is essential to manage water and biodiversity effectively at both national and global levels. The United Nations Convention on Biological Diversity acknowledges the critical link between water and biodiversity. It also recognises the importance of ecosystem-based approaches such as rewetting peatland, restoring river floodplains, and restoring ecologies in maintaining this balance.

Rewetting peatlands is a key strategy used by the Association of Southeast Asian Nations. Restoring water levels to their natural state in such areas helps prevent fires, reduce subsidence, and restore peatland ecosystems. Reintroducing native species can also support biodiversity. Peatlands are naturally flooded, so restoring them to their natural state creates optimal conditions to support biodiversity and mitigate the climate crisis. Organic material that accumulates in the peat decomposes only slowly or not at all, making flooded peatlands ideal carbon sinks.

Rewetting peatlands must involve the communities that live around and depend on them. Introducing paludiculture, or forms of agriculture suited to wetland conditions, can balance biodiversity and socio-economic viability, while sustaining the livelihoods of these communities. The success of such approaches depends on dedicated institutions at both the landscape and drainage-basin levels, supported by strong legislation and political will to preserve biodiversity. The resulting ecosystem benefits, in terms of enhanced water and biodiversity services, can encourage support for such governance frameworks. ●

Europe’s migratory freshwater fish populations have declined by 93 percent since 1970, mainly due to habitat loss, water pollution, and the climate crisis



CONSUMPTION

TAPPED OUT

From farms to factories, from smartphones to kitchen taps, global water consumption and demand are rising, driven by agriculture and industry. At the same time, reserves are shrinking, worsened by the climate crisis, overuse, and unequal access. Efficient, fair, and sustainable management is becoming a critical global priority.

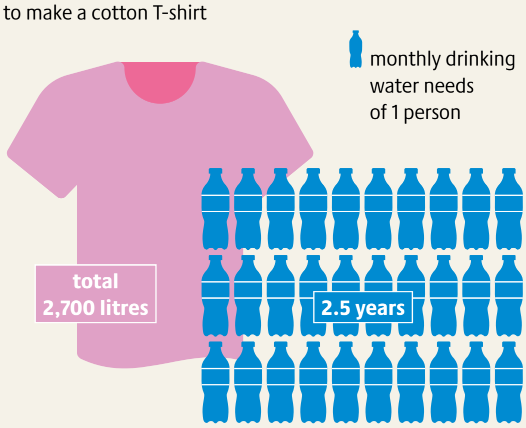
Freshwater is one of the most vital – yet increasingly strained – natural resources on Earth. Today, the total amount of freshwater withdrawn from rivers, lakes, reservoirs, and aquifers exceeds 4,000 cubic kilometres per year. Over the past century global water use has increased sixfold, according to the United Nations, due to a combination of population growth, agricultural expansion, industrialisation, and urbanisation. While water withdrawal has plateaued in high-income countries, largely due to efficiency gains, demand continues to rise in emerging economies. That means global water demand is still projected to grow by an additional 20 to 30 percent by 2050, driven largely by cities, energy production, and manufacturing. The climate crisis, pollution, and over-extraction are reducing the supplies available in many regions. Groundwater reserves often serve as the hidden backbone of water security, and they are being depleted faster than they can replenish, especially in India, China, Pakistan, and the western United States. Unless managed carefully, these trends could push more countries into water stress. The future of freshwater will depend not only on how much we use, but also how we allocate and manage it across competing sectors.

Accounting for nearly 70 percent of all freshwater withdrawals, agriculture dominates the global picture of freshwater use. However, industries also play a major role and can exert intense local pressure. Industry makes up roughly 19 percent of global water withdrawals, and households around 11 percent, though these shares vary significantly by country.

In high-income countries, such as Germany or Canada, industrial use can constitute the majority of national freshwater withdrawals. Depending on the country, water-intensive industries can include thermal power generation (which uses water mainly for cooling), mining, chemicals, metals, and textiles. Making steel, refining oil, and processing pulp and paper all require substantial volumes of water. The electronics and semiconductor industry also uses ultrapure water in its manufacturing processes.

Although industrial water is often reused or recycled more than water used in agriculture, the discharge of heated or polluted water can have serious environmental consequences. While industries may consume less water than farms, they may have a greater impact per unit of water withdrawn, especially where freshwater ecosystems are already under stress. Whereas we often associate water use with drinking, cooking, or farming, vast amounts of water are also embedded in the manufacture of products that we use every day. This so-called hidden or virtual water is embedded in the items we wear, use, and dispose of, often without realizing their environmental impact. Paper, plastics, and electronics all have substantial water footprints. For example, manufacturing a single smartphone may require as much as 12,000 litres of water, used in mining rare metals, assembling components, and cooling during production. Similarly, a laptop can require tens of thousands of litres to make, primarily to make microchips, which requires large amounts of ultrapure water. The textile and fashion industry is another major water user. Producing synthetic fabrics like polyester involves water-intensive chemical processes, while dyeing and finishing garments can cause pollution if the waste water is untreated. A pair of leather shoes uses thousands

THIRSTY FASHION
Average water consumption required to make a cotton T-shirt

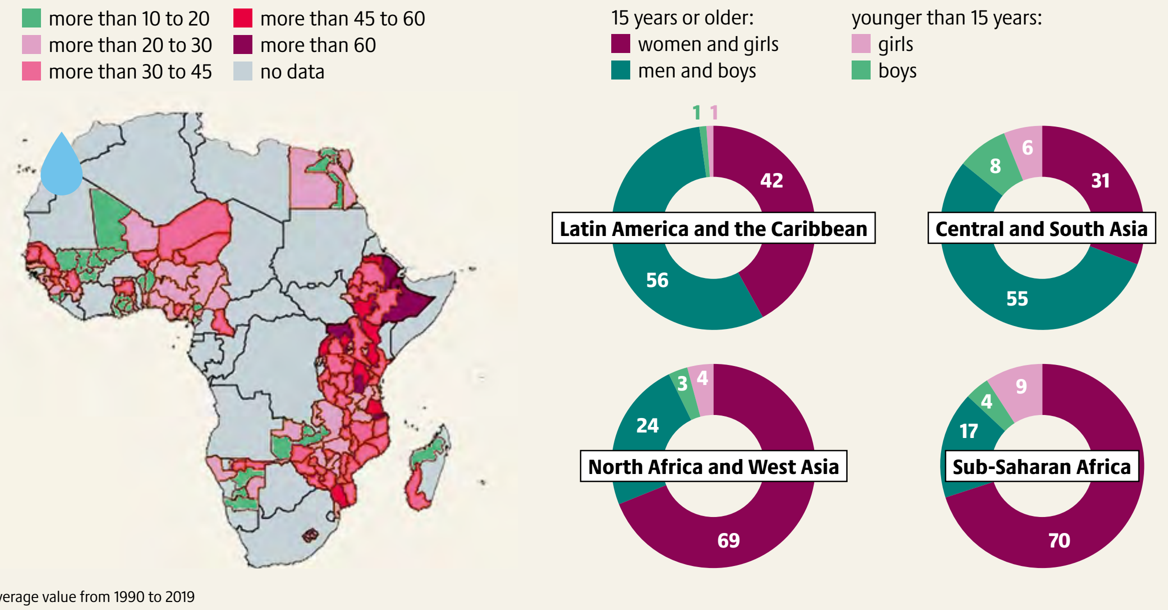


The textile and clothing industry uses 93 billion cubic metres of water each year for cultivation and production, leaving a huge ecological footprint

LONG WALK TO THE WELL

Daily time spent by women on water provision in households without their own connection, in minutes

Main responsibility for water provision in households without their own connection, in percent



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of litres, mostly in tanning and processing the leather. Even producing a sheet of office paper requires around 10 litres of water. All of these water costs often occur far from where products are sold, making conscious consumption and sustainable manufacturing practices essential in a water-scarce world.

As the climate crisis alters rainfall patterns and makes droughts more frequent, conflicts over water allocation are increasing. When water becomes scarce, who gets priority: farms, factories, or families? In most countries, households and essential services (such as hospitals and schools) are generally prioritised. Yet the reality plays out in more complex ways. In India, some regions have diverted water from agriculture to urban centres to meet drinking water demand during droughts. In contrast, parts of California have prioritised high-value crops such as almonds even during periods of severe water shortage, sparking debates over public versus private water rights.

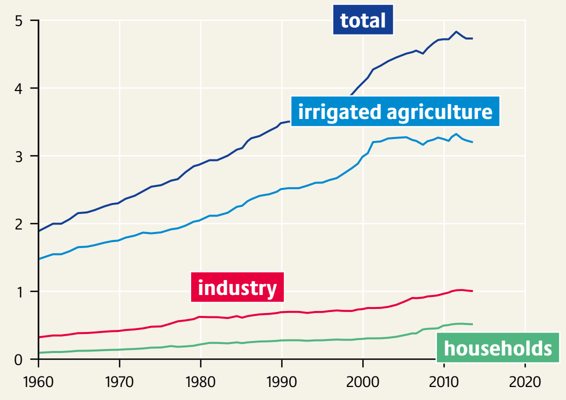
In 2018, drought and mismanagement meant that Cape Town in South Africa only narrowly missed Day Zero, when the city's water reserves would be fully drained. Emergency rationing was imposed, where households were allowed only 50 litres per person per day. Water use by industries and golf courses drew public scrutiny. Similar tensions have emerged in Chile's mining regions, Spain's agricultural valleys, and Jordan's urban–rural divide.

There is no one-size-fits-all answer. The challenge lies in balancing social, economic, and ecological needs, especially as the climate crisis makes the future of water harder to predict. Transparent governance, robust legal frameworks, and inclusive water planning will be critical to making those choices fair and sustainable. ●

In Southern Africa, women spend a total of 16 million hours per day collecting water, while men spend only 6 million

UP, UP, AND AWAY

Global water consumption by sector, in 1,000 cubic kilometres per year



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Global water consumption is expected to double by 2050, mainly due to population growth and the climate crisis

POLLUTION

MURKY DEPTHS

Plastic waste, industrial effluent, chemicals: scarcely a single body of water is safe. They threaten ecosystems, biodiversity, and human health. The solution to the wave of pollutants? A circular economy that conserves resources.

Starting in the mid-19th century, the first modern sewerage systems were built in the rapidly growing metropolises of Europe and North America. Water was used to flush away street grime, human waste, and industrial discharge. But the idea that rivers would clean themselves soon proved to be an illusion: rivers and lakes became stinking, toxic cesspools.

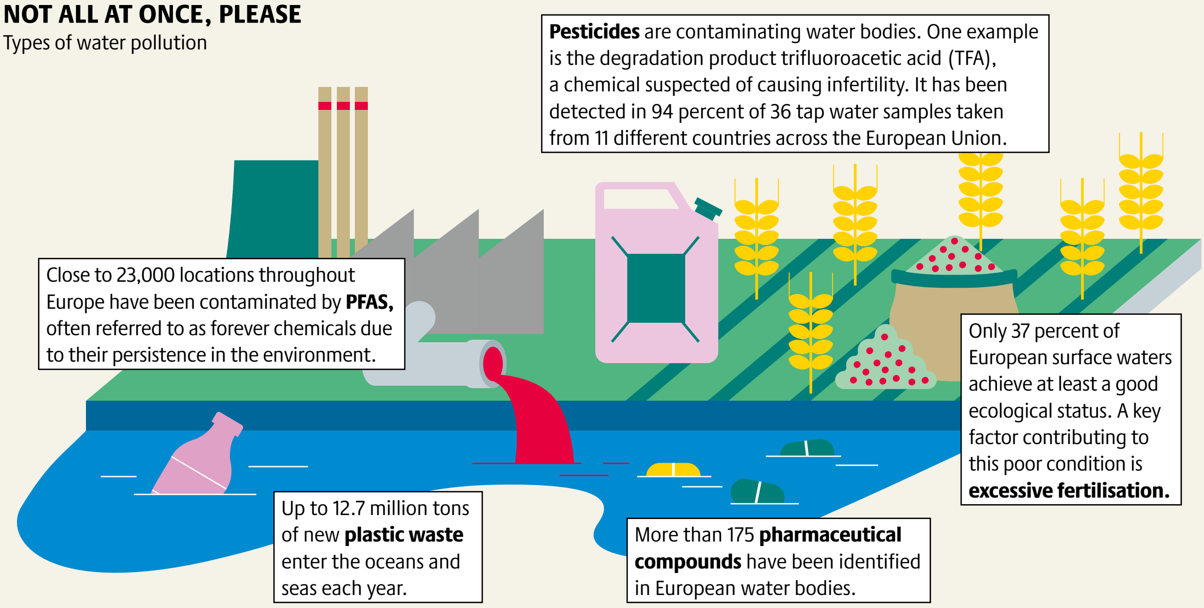
Around 80 percent of all wastewater worldwide enters water bodies without undergoing treatment. An example of the consequences of industrial effluent is the Citarum River in Indonesia, which is regarded as the second most polluted river globally, after the Ganges in India. The industrial effluent from more than 2,000 factories on its banks makes it a life-threatening danger for those with no alternative water source. Studies point to 50,000 deaths every year.

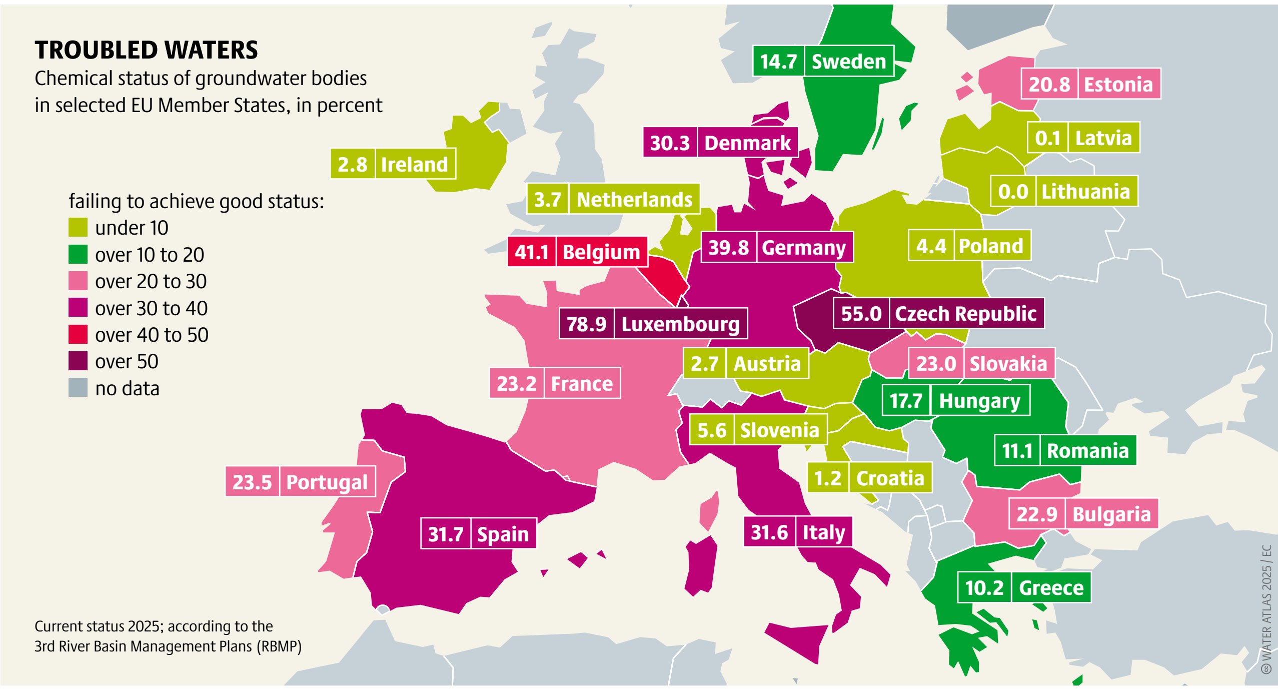
Today, synthetic fertiliser is a major cause of excessive algal growth, oxygen deficiency and fish die-offs in water bodies. In regions dominated by industrial agriculture, far too much fertiliser is released into the environment. Plants absorb only a fraction of the nutrients, while the remainder is washed into groundwater, rivers and ponds by rain and drainage ditches. In 2020, around 859,000 tonnes of nitrogen and 26,000 tonnes of phosphorus were released into the Baltic Sea. The European Union's acceptable limit for nitrate is 50 milligrams per litre; according to the European Commission this value was exceeded at 14.1 percent of Europe's groundwater measuring stations. This results in substantial economic costs. Among other impacts, contamination significantly increases water treatment costs. In Europe, the economic costs of nitrates and other reactive forms of nitrogen are thought to be as high as 320 billion euros per year.

Pesticides also pollute streams, rivers, lakes, the sea and groundwater reservoirs. They are used in agriculture to protect harvests from fungi, weeds and insects. Around 322,000 tonnes of pesticides were sold in the EU in 2022. From farmland and fields they run off or leach into water bodies, where they impair the water quality and harm fish and other aquatic life – and ultimately pose risks to human health. Many pesticides

Ecological farming, landscape restoration, curbs on chemical use, and effective sewage treatment are all essential to safeguarding water resources

NOT ALL AT ONCE, PLEASE
Types of water pollution





The chemical status of groundwater shows whether pollution levels exceed the environmental or health limits set by EU rules

also contain PFAS (perfluorinated and polyfluorinated alkyl compounds), which are sometimes called forever chemicals because of their extraordinary persistence. In the European Union, the number of fruit and vegetable varieties containing residues of at least one PFAS pesticide has tripled in the last 10 years.

PFAS are highly persistent industrial chemicals used across numerous sectors, and they can cause enormous damage to the human body. They are also common in plastic waste, which releases additives such as plasticisers and breaks down into ever-smaller pieces known as microplastics. Even some fertilisers are now wrapped in layers of plastic in order to prolong their effect. Applying such pellets in this way causes plastic to accumulate in fields, from where it ends up in water. Marine animals are defenceless against plastic waste; they ingest it or become entangled in larger plastic debris. Wealthy industrialised nations export large quantities of plastic waste to the Global South, resulting in significant environmental and public health issues in those regions. Plastic pollution is a financial burden especially for low- or middle-income countries. Even though these countries consume only just over one-third of the plastic per person as wealthy industrial nations, the clean-up costs can be up to ten times higher.

Another problem is oil, which finds its way into the sea through shipping, tanker accidents, leaks in oil platforms, illegal disposal or industrial effluents. Globally, oil slicks cover 1.5 million square kilometres of ocean – an area twice the size of Turkey. The oil suffocates marine life, poisons food webs, and causes long-term ecological damage.

To treat wastewater more efficiently, the European Union plans to upgrade larger sewage treatment plants with an additional fourth treatment stage. But such an upgrade is costly and is therefore unlikely to be adopted globally. And even a fourth purification stage cannot completely filter out problematic chemicals such as PFAS.

It is therefore crucial to act proactively, preventing pollution before it occurs. Clean production methods offer the most effective solution for protecting the valuable resource of water as this avoids pollution right from the start. If water is recirculated and used several times during the production process, this reduces both the amount of water consumed and the amount of contaminated wastewater. Some Mediterranean members of the European Union already use treated wastewater in agriculture.

In some cases, it is possible to avoid using water altogether, for example by installing dry toilets. These are increasingly common in festivals and could help save water in everyday life. Since dry toilets do not require water, they eliminate the need for complex chemical and biological wastewater treatment. Human faeces in fact contain valuable nutrients that can be hygienically processed to reduce the use of synthetic fertilisers and to improve soil quality.

However, isolated solutions alone are not sufficient. Real improvements in water protection require both technical innovations and especially political regulation and social change. Fundamental changes in agriculture, industry, and sanitation systems are needed to achieve real improvements in water protection. ●

PRIVATISATION

THE STORY OF A WRONG TURN

Selling public water supply systems to private companies was supposed to make management more efficient, and lower prices. But experience has often shown the opposite. Many municipalities and civil society initiatives now want to bring water back into the public domain.

Until a few decades ago, the supply of water was a self-evident component of public services – along with energy, public transport and social housing. The rise of neoliberalism in economic policy changed that. City governments sold off their municipal housing stock and privatised their power plants; and in the 1990s a wave of privatisations also hit the water supply. Water came to be seen as an economic good that firms could manage more efficiently and provide more cheaply than the state. Private companies held out the prospect of investments in the water infrastructure, which they promised would make drinking water more available in poorer parts of the world, too. In Europe, England and Wales were the first places to privatise their state-owned water utilities. The then-prime minister, Margaret Thatcher, sold them off in 1989.

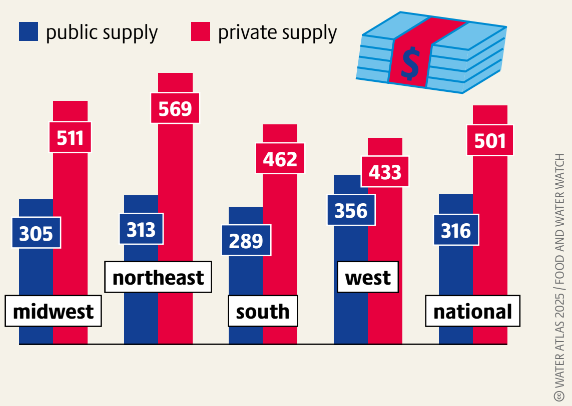
It soon became apparent in many countries that the high hopes for privatisation were not being fulfilled. Around the world, investments in water supplies remained at a low level. Studies have shown that private firms do not generally supply water at lower prices. Privatisations have had particularly drastic consequences in the Global South. In the wave of privatisations in the 1990s implemented as a result of pressure from the World Bank, the smallest, poorest, and most indebted countries in Africa handed over their water supply to private companies. One analysis found that in 2000, the International Monetary Fund tied its loans to the privatisation of water utilities in one-third of cases. In the wake of the euro crisis after 2010, this pressure was also felt in several countries in the European Union, including Greece, Portugal, and Bulgaria. A troika of the European Commission, the International Monetary Fund, and the European Central Bank combined their austerity programmes with proposals to privatise water.

In Chile, water was privatised particularly early on and particularly drastically. In 1981, the dictator Augusto Pinochet introduced the Código de Agua, a law which granted agribusinesses, for example, rights to free water. The military dictatorship ended in 1990, but its neoliberal constitution is still in force in Chile today. Although the land sandwiched between the Pacific and the Andes is rich in water – with 1,250 rivers, 12,780 lakes and 24,110 glaciers – Chile ranks 16th in the list of countries subject to the highest water stress. More than 1 million Chileans generally have no access to clean drinking water, and almost half the population suffers from water shortages. Water scarcity is intensified by an export-driven economy that is not focused on meeting the needs of the local population; for example, more than 50 percent of water-intensive fruit production is exported to the global market.

South Africa shows the possible health consequences of privatisation. After the sale of municipal water utilities in many regions, the hitherto free water supply was switched to a prepaid, metered system. That meant that users have to pay in advance for a certain amount of water. As soon as they have used that quantity, the tap runs dry. In provinces such as KwaZulu-Natal, that has cut off many people's access to clean water, forcing them to turn to polluted streams, rivers, and ponds to survive. In the summer of 2000, that led to a cholera outbreak in which 120,000 people fell ill and hundreds died.

Pollution and water shortages due to privatisation happen in Europe too. After the sale by Margaret

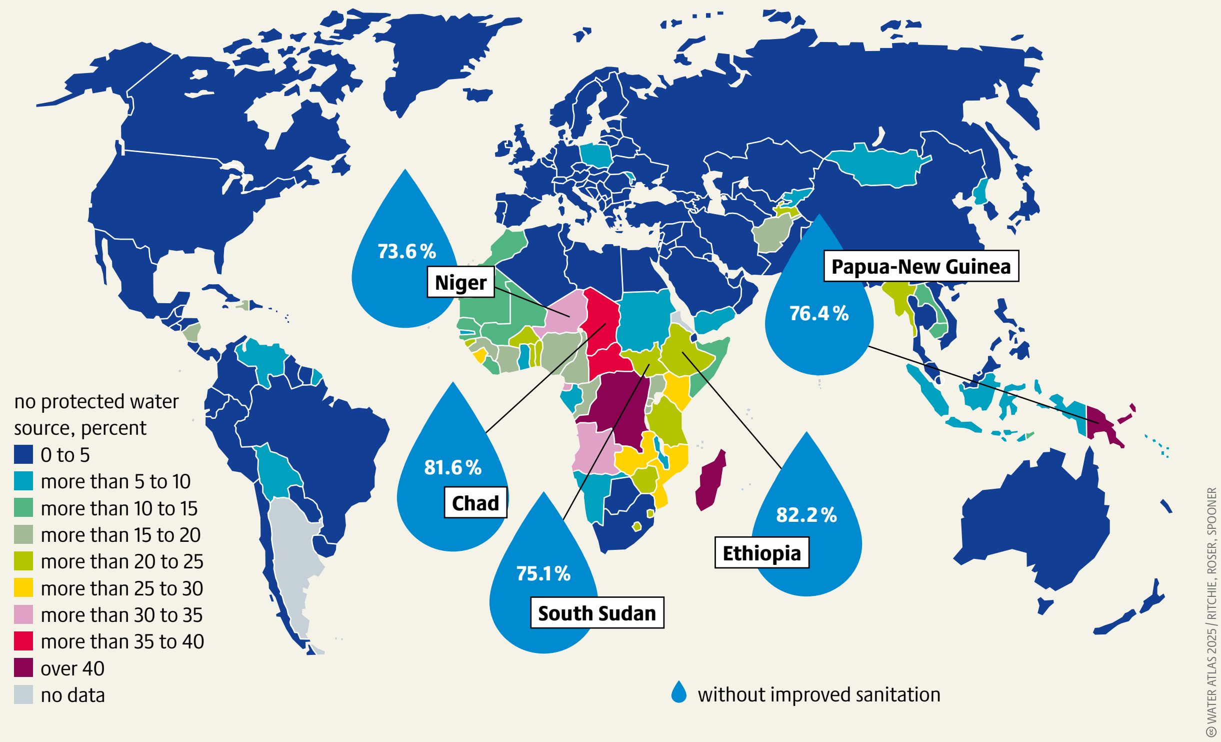
PRICES UP FOR MANY, PROFITS UP FOR FEW
Average annual water bill in the USA,
households using 225,000 litres a year, in US dollars



A 2015 review of the 500 largest US water systems found that private utilities charged households significantly higher rates than state-run systems

DRY WELLS AND MUDDIED WATERS

Proportion of the population in 2022 without access to water sources protected from contamination, and proportion without access to improved sanitation facilities to prevent direct contact with faeces, by country, selected



Thatcher of state-owned water utilities in England and Wales, around half of these utilities' staff lost their jobs. Water prices have since risen by around 40 percent. The profits are rarely reinvested in infrastructure, decent wages or water-quality testing, but stay with the profit-oriented investors in the water company. Dilapidated infrastructure results in massive water losses and has led to the complete failure of the domestic water supply in some places. Nearly 3 billion litres are lost each day in England and Wales through leaky pipes and ageing overflow basins, increasing the risk of contamination. Because millions of cubic metres of untreated sewage are discharged into rivers and the sea, riverscapes are transformed into stinking cesspools. A debate has started on whether to reverse the privatisation and to nationalise Thames Water, Britain's biggest water utility, which is currently owned by a group of private equity companies and pension funds.

Many countries and municipalities in Europe and elsewhere in the world have made a U-turn. Between 2000 and 2015 alone, 235 cases were recorded of water and sewerage utilities being returned to municipal control. Many cities have seen referendums in which the majority of the population has spoken out in favour of buy-backs – for example in the German capital Berlin. In a referendum in Thessaloniki in Greece in 2014, 98 percent of voters chose not to put the water supply into the hands of private investors.

Globally, one in three people has no access to safe water, and over half the world's population lacks safe sanitation

And more and more civil society organisations are advocating for water rights. For instance, the Blue Community movement, founded in 2009, has already brought together 210 communities worldwide, encompassing a total of 25 million people. These communities – including cities, municipalities, and trade unions, as well as universities and schools – commit to the three core principles of the movement: first, the protection of the human right to water and sanitation; second, the preservation or restoration of water as a public good, and third, the promotion of tap water, which is far less ecologically harmful than bottled water. Producing just one litre of bottled water can require up to four litres of water, due to extraction, purification, plastic bottle production, filling, and transportation. Additionally, the production of one litre of bottled water releases 202.7 grams of the greenhouse gas carbon dioxide (CO_2), whereas a litre of tap water results in only 0.4 grams of CO_2 emissions.

The history of privatisation shows that water can be used more responsibly and distributed more fairly when water supply remains in public hands – rather than being handed over to corporations driven by profit interests. ●

DIVIDING THE WATERS

Access to clean water is a human right. But with the climate crisis and population growth, water is becoming an ever-scarcer resource – over which different groups may compete fiercely. International agreements can help promote cooperation rather than conflict.

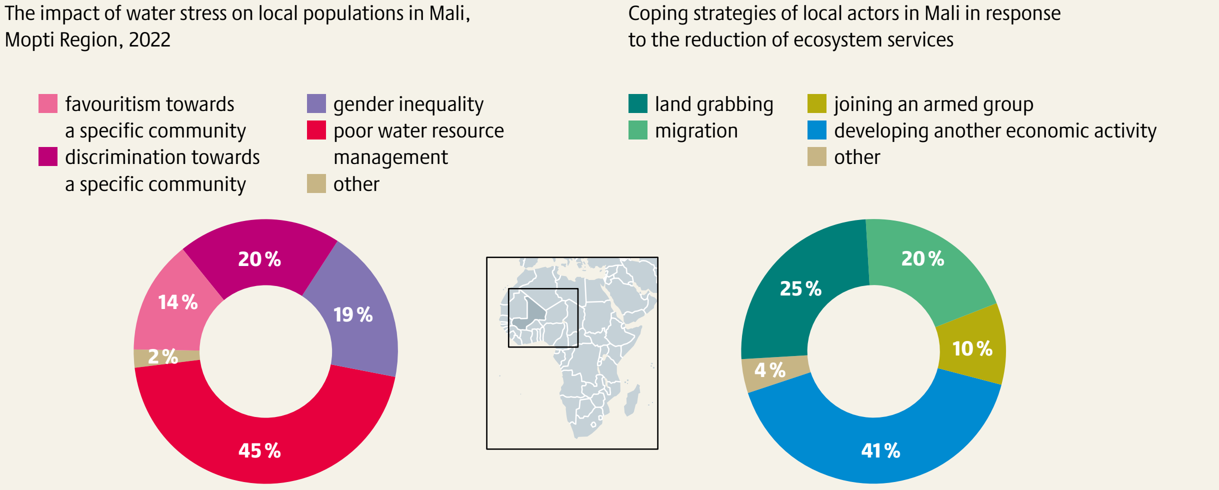
Disputes frequently erupt over the distribution, use, and protection of water resources. Examples abound all over the world. In the Inner Niger Delta in Mali, there have been violent clashes between herders and farmers competing for water, which is becoming scarcer because of the climate crisis and newly built dams on the upper reaches of the river. In Iran, water shortages arise due to the climate crisis and are exacerbated by mismanagement. The result is tensions between people in rural areas and those in the cities. The Iranian police routinely suppress protests against the government. In armed conflicts, water infrastructure often becomes a target: armies and terrorist groups deliberately destroy irrigation canals, desalination plants and dams, as happened in Iraq, Syria, Gaza and Ukraine in recent years.

The situation gets especially complicated if the rivers, lakes or groundwater bodies in question cross international borders. Worldwide, there are in fact 313 such transboundary surface water bodies, almost 600 groundwater reserves, and around 300 wetlands. These cannot be administered by one state alone, and in such cases the economic and security interests of several states may collide. The Nile is an example: in 2011, Ethiopia started building a dam on the upper reaches of the Blue Nile to generate electricity to provide the Ethiopian people with clean power. But far downstream, Egypt sees this as an existential threat to its own water supplies, 97 percent of which depend on the Nile. For years this has given rise to diplomatic tensions between Egypt and Ethiopia, as well as with Sudan, which lies between them.

The dispute over the Syr Darya River in Central Asia also highlights the significant conflict potential of transboundary rivers. The core issue is that the Toktugul dam, controlled by Kyrgyzstan, seeks to release water during winter for hydropower production, while Uzbekistan and Kazakhstan depend on summer water releases for irrigation, particularly for cotton cultivation, which is a major part of Uzbekistan's economy. Disagreements over the timing of these discharges have brought the countries to the brink of conflict following the collapse of the Soviet Union. Tensions escalated as Kyrgyzstan repeatedly reduced water outflows to maintain reservoir levels. Uzbekistan and Kazakh-

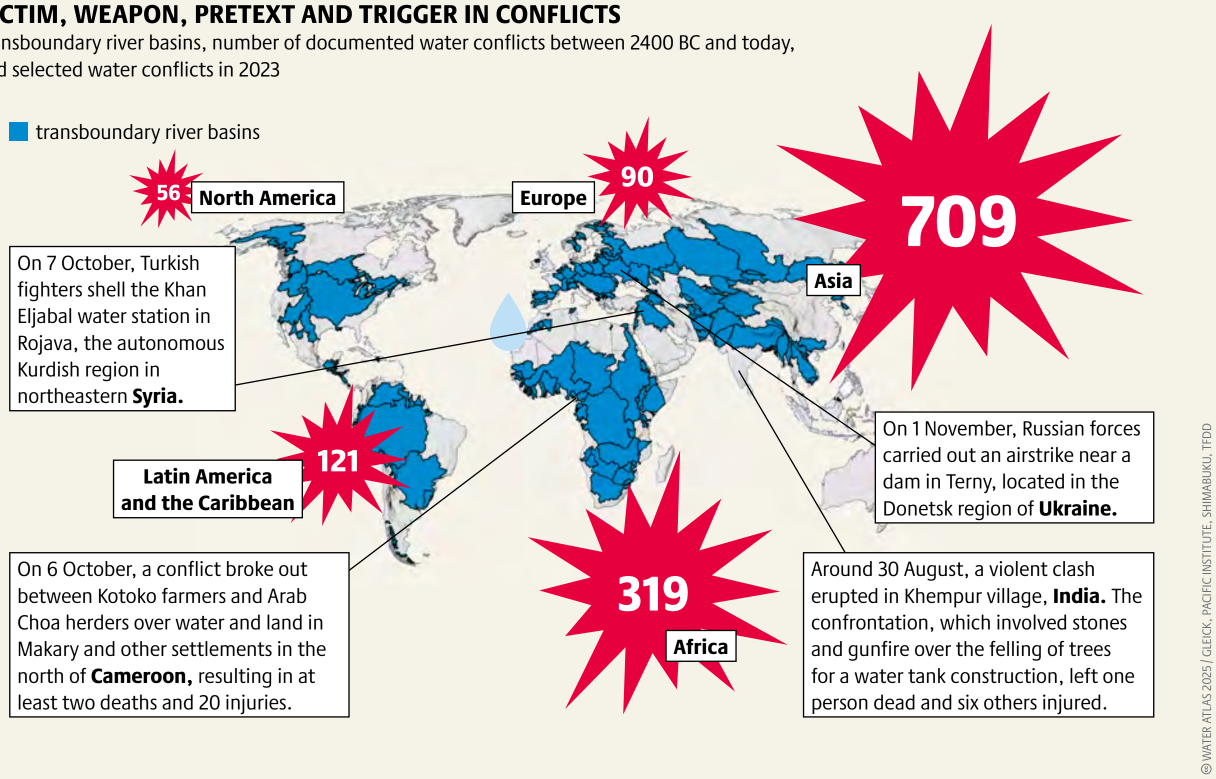
Water scarcity fuels violence and exclusion in countries such as Mali, long troubled by conflict, hunger, and poverty

HOW WATER SCARCITY FUELS CONFLICTS



VICTIM, WEAPON, PRETEXT AND TRIGGER IN CONFLICTS

Transboundary river basins, number of documented water conflicts between 2400 BC and today, and selected water conflicts in 2023



Water often crosses national borders. Cooperation between states and communities can help prevent conflict and ease competition over it

stan accused Kyrgyzstan of using water as a political bargaining tool.

The loss of state institutions can make water management less efficient. In Afghanistan, the gradual loss of power by the previous government meant that ageing infrastructure was no longer maintained and eventually ceased to function. As a result, it was no longer possible to ensure the equitable distribution of water. The Taliban succeeded in taking control of an increasing number of local water-management institutions, such as the so-called mirab system. This also contributed to the Taliban's recruitment success in the later 2010s, which ultimately, and after all, brought them back to power in 2021.

Despite all this, the modern era has not yet experienced an inter-state war directly over water. Research shows that conflicts over water are actually fairly rare, at least when compared with cases of cooperation. A systematic analysis shows that only 28 percent of all interactions between states over water are conflictual in nature. They are even less likely to turn violent.

However, the data also show that conflicts over water have been on the rise in recent years. Water is often one of several different factors that contribute to a conflict, and it can lead to an escalation of the situation. That is the case in the Lake Chad basin in Central and West Africa, where ethnic and religious tensions fuel conflicts between different groups of water users.

States and other institutions have meanwhile created legal and political mechanisms to help organise the distribution and use of water in a peaceful way. Global water agreements set legal standards and offer states a framework to guide their actions. Over 800 intergovernmental agreements regulate the distribution of water, pollution, and fisheries. The International Court of Justice and the Permanent Court of Arbitration in The Hague also serve as places for arbitration. In 1997, for example, they mediated a dispute between Hungary and Czechoslovakia – a country that had ceased to exist – over the Gabčíkovo–Nagymaros dams on the Danube. In 2013 they led negotiations between India and Pakistan over a dam on the Kishenganga, a tributary of the Indus. Both sets of negotiations were able to prevent an escalation and stimulated all parties to work together.

History shows that for both sides, cooperation brings long-term benefits that would be unattainable through the unilateral use of the cross-border water resource. Since the 1970s, cooperation between the countries along the River Senegal in West Africa has permitted the joint construction of two dams that enable year-round irrigated farming, deliver electricity to neighbouring countries, and facilitate navigation. None of the states would have been able to finance these projects alone. This is one of many examples of what is possible if one shares water instead of fighting over it. ●

AGRICULTURE

DRYING OUT

Agriculture is the single largest industrial sector when it comes to consuming water: 72 percent of the world's freshwater consumption is used to produce food. Ensuring a secure supply despite the threats posed by the changing climate will take political will.

Every year, almost 3,000 cubic kilometres of water are extracted for agriculture from the world's groundwater reservoirs, lakes, and rivers. The share of water used by agriculture in total consumption varies depending on the region and income level. In high-income countries, about 40 percent goes to farming; in low-income countries up to 90 percent. Some 3.2 billion people live in predominantly agricultural areas where water is either scarce or very scarce. Many of these people are small-scale farmers, who play a key role in producing food and ensuring food security.

The world's irrigated area has more than doubled since 1961, according to the United Nations. Around 20 percent of the global cropped area is now irrigated, and this area produces 40 percent of the world's food. The increasing demand for irrigation is the result of the rising population. The situation is exacerbated by weather extremes such as long droughts, which are becoming more common because of the climate crisis.

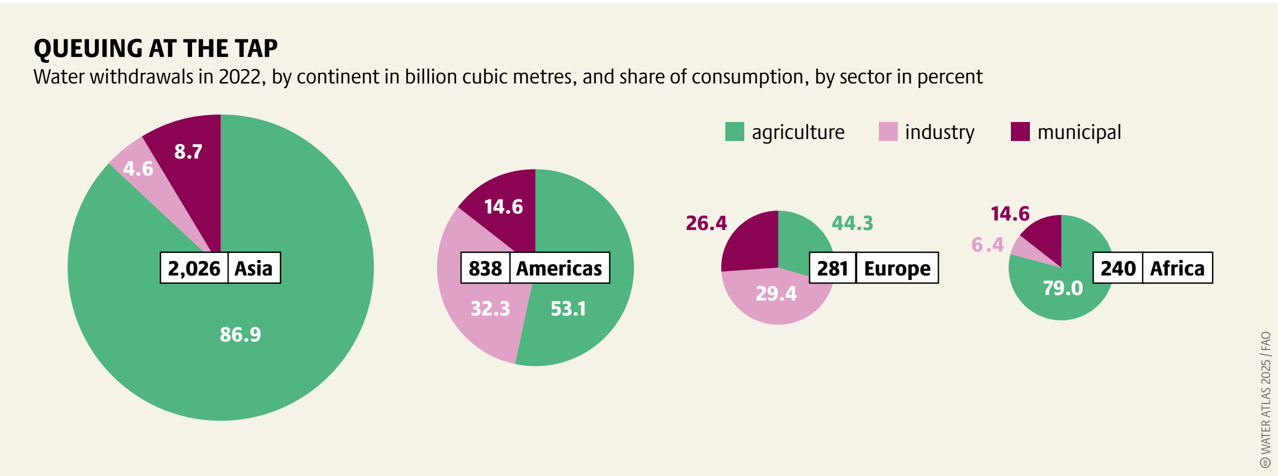
The Middle East, North Africa, India, northern China and the southwestern United States of America are especially hard hit by water scarcity. The Intergovernmental Panel on Climate Change predicts that the demand for water for irrigation could double or triple by the end of this century. Projections show that the rising demand for irrigation, combined with the higher evaporation caused by the climate crisis, will ultimately increasingly deplete groundwater reserves by the turn of the century.

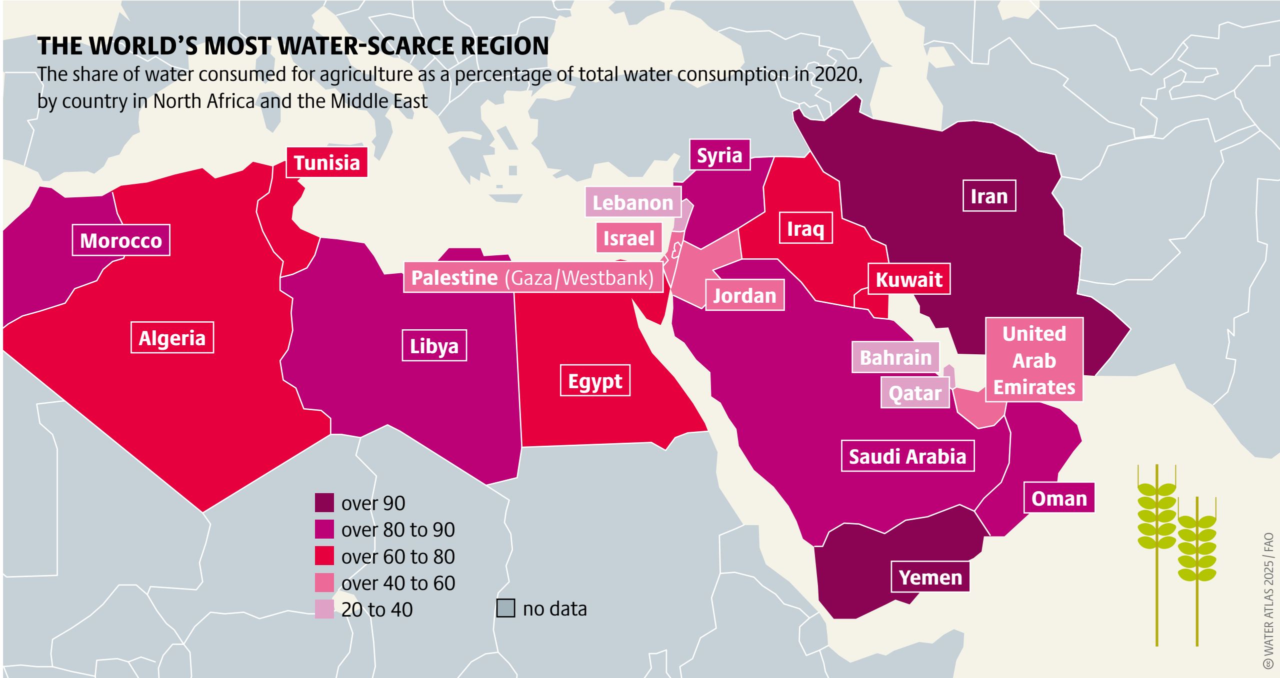
In Punjab, India's breadbasket, the groundwater level has fallen by as much as 40 metres in the last 30 years. Just 1.5 percent of India's total area grows 20 percent of its wheat and 12 percent of its rice. But four-fifths of the usable groundwater is used to irrigate these and other crops. The rising costs of irrigation due to ever-deeper wells drives farmers into debt. According to a study by the Indian Council of Social Science Research, around 86 per cent of farming households in Punjab were in debt in 2017.

The agricultural sector consumes less than one-third of the water used in the European Union. This proportion is much higher in some countries; for example in Spain it is 82 percent. Both surface and groundwater there are especially polluted. The situation in France and Italy is similar. Germany is one of Europe's most water-rich countries, with an average of between 700 and 800 litres of precipitation per square metre each year. But even here, an increasing share of the cultivated area is irrigated, especially for growing vegetables. Between 2009 and 2022, the irrigated area grew by almost 50 percent, from 372,700 to 554,000 hectares.

Virtual water is the amount of water needed to produce the products – and especially the food – that we consume. Many Global North countries have high con-

Global water demand and consumption are increasing, which can endanger supply, especially in arid regions, posing a serious risk to populations





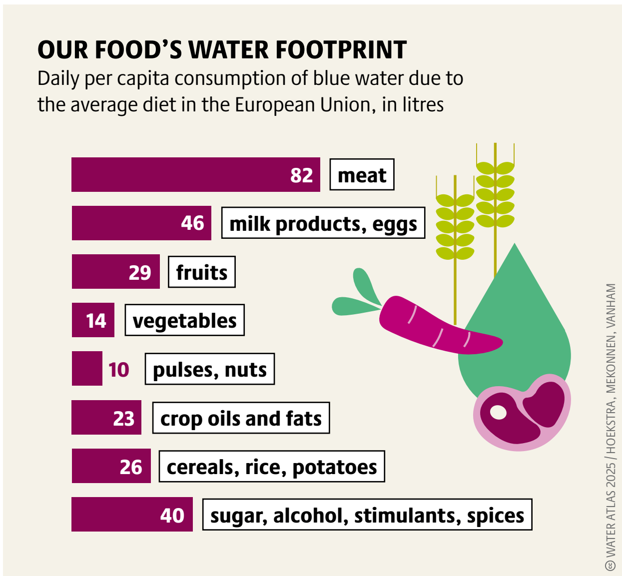
North Africa and the Middle East have 5 percent of the world's population but only 0.7 percent of its freshwater, with 80 percent used for agriculture

sumption levels. For example, Germany consumes 219 billion cubic metres of virtual water per year – almost five times the volume of Lake Constance, Germany's largest lake. But only a small proportion of the virtual water consumed in Germany comes from Germany itself. Around 86 percent is imported in the form of irrigation-intensive agricultural products grown abroad, such as fruit, nuts, rice, and vegetables. Two factors need to be taken into account when scrutinising the water consumption of a food product: the amount of water needed to produce it, and the water availability in the region where it is grown. This combination is used to calculate the item's scarcity-weighted water footprint. The scarcer the water in the growing region, the larger the footprint.

Forecasts show that water stress in the European Union will increase by 2030, meaning that available reserves will be less and less able to meet demand. To provide coming generations with a secure water supply, it is necessary to critically examine how we currently use irrigation for agriculture.

Farms and agricultural businesses play a key role in water management. They can protect water resources and respond to the climate crisis by using rainwater, planting adapted crops, using cultivation methods that limit evaporation, protecting the soil, and combining trees and shrubs with crops in agroforestry systems.

That will require financial incentives, such as water-related agricultural subsidies. The European Union could support resource-conserving measures through its Common Agricultural Policy to a much greater extent than it does now. Instead of the current allocation of funds per hectare, subsidies should honour the protection of water, nature, biodiversity. The European Union's new Corporate Sustainability Due Diligence Directive requires firms to prevent risks of pollution, especially when related to human rights abuses. Information campaigns and a requirement to better label the scarcity-weighted water footprint on food packaging are also steps towards sustainable water protection. ●



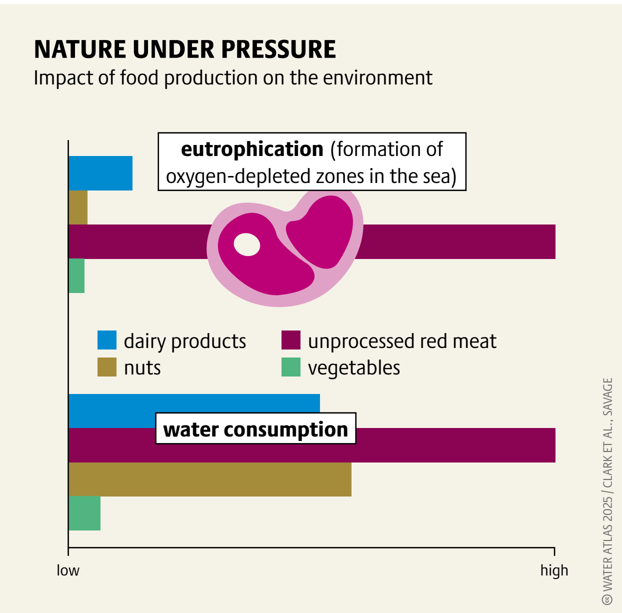
Blue water is surface or groundwater used in irrigation, industry, and manufacturing, vital for agriculture and the economy

VEGETABLE FARMING

THIRSTY TOMATOES IN DRY LANDSCAPES

Spain is Europe's vegetable garden. The country is an example of how export-oriented industrial cultivation methods lead to water shortages and pollution, as well as accelerate the loss of species. To overcome such crises, a sustainable reorganisation of the food system is necessary.

The official figure for Spain's irrigated area is over 4 million hectares. However, the actual figure is probably a lot higher: it is estimated that roughly another 1 million hectares are irrigated illegally. The high levels of water use for agriculture have drastic and far-reaching consequences for ecosystems. The Doñana National Park in Andalusia is a prime example: this famous UNESCO World Heritage Site with its rare waterbirds, flamingos, and herons was once regarded as one of the most important and diverse wetlands in Europe. But the diversion of water for nearby strawberry plantations and expanding tourist facilities has almost completely dried out this fragile area. In recent years, the park has suffered its biggest decline in species ever. Between 2020 and 2021 alone, the number of birds fell from 470,000 to just 87,500.



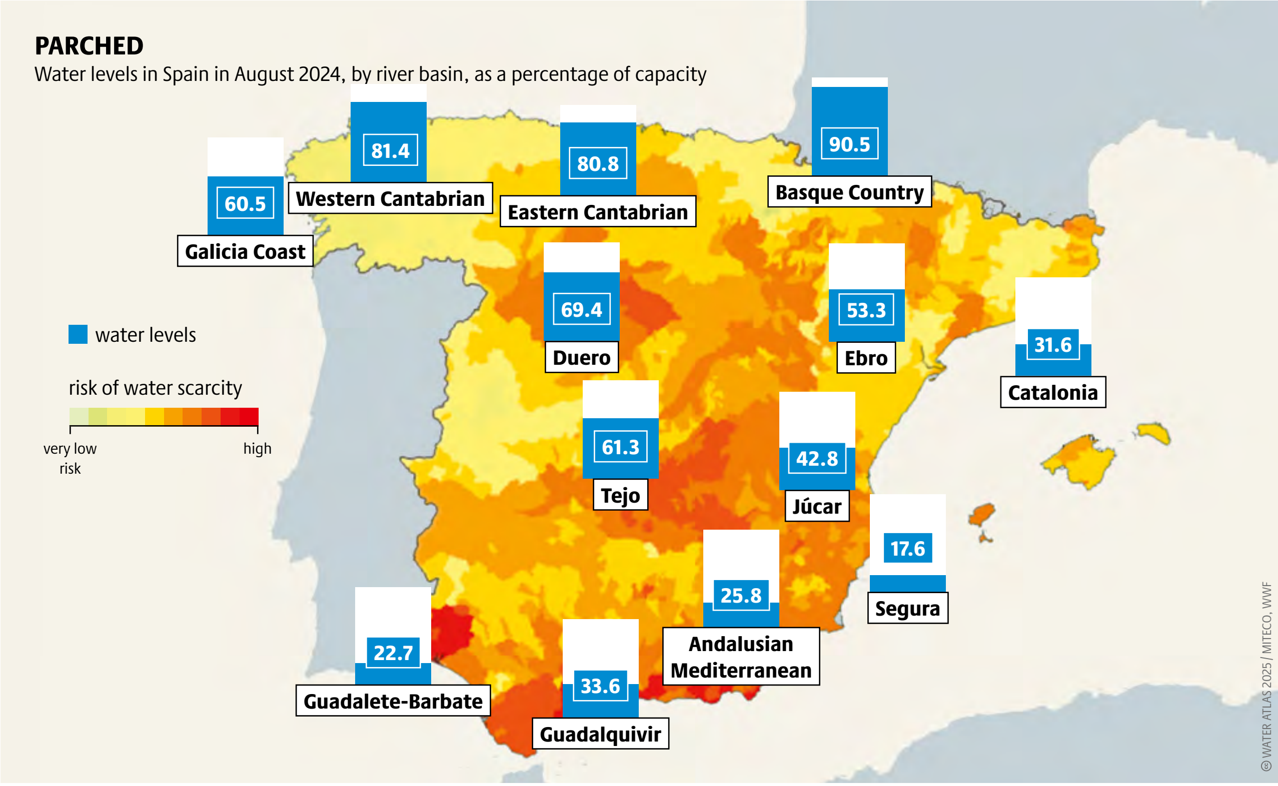
In Almeria, also in Andalusia, greenhouses covering an area of over 30,000 hectares are extensively used to grow vegetables, mainly using groundwater. This extraction results in a water deficit of 170 million cubic metres a year. Because the area is very close to the sea, this unsustainable overuse allows seawater to seep into deeper groundwater layers, making the freshwater saline and unsuitable for both drinking and farming. For such reasons, many Spanish provinces have become dependent on external sources of water or expensive desalination plants. The Carboneras desalination plant in Almeria has a production capacity of 42 million cubic metres of water a year, making it the second largest such plant in Europe. It consumes a great deal of energy and emits enormous amounts of greenhouse gases.

Industrial agriculture not only consumes water but also salinises and pollutes it. In Spain, 11 percent of the surface water and as much as 37 percent of the groundwater have nitrate concentrations above the applicable European environmental quality standards. In 2024, the European Court of Justice ruled against Spain because it had failed to fulfil its obligations to protect water from nitrate pollution from agricultural sources in eight of its autonomous regions.

The best-known case of water pollution is the Mar Menor lagoon in the Murcia region. This is Europe's biggest saltwater lagoon, and its salt-rich and nutrient-poor water makes it a unique ecosystem. But the Mar Menor has for years suffered from repeated environmental crises, mainly because of large quantities of nutrients entering the water through heavy irrigation and excessive fertilisation on nearby farmland. This has led to a massive decline in native species over several years in a row. In 2016 alone, 80 percent of the seagrass meadows disappeared.

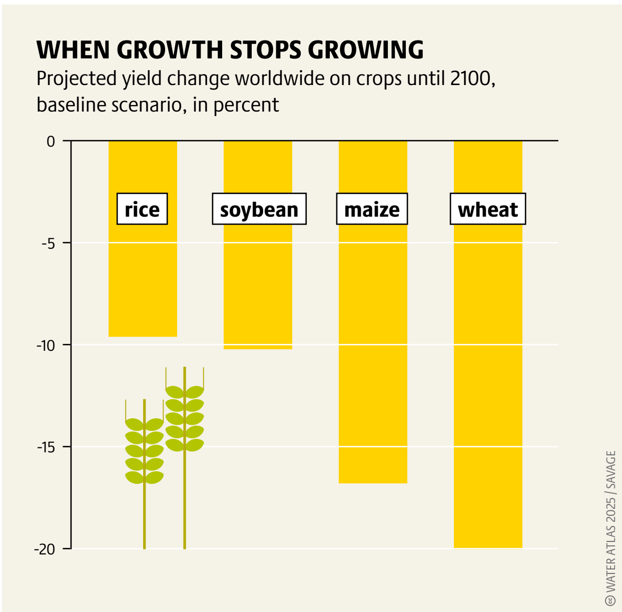
Many water bodies in Spain are also heavily polluted by pesticides. The applicable limits for drinking water were exceeded at 54 percent of the measurement stations for surface water. Analyses show that in three-quarters of the cases, the weedkiller glyphosate and its breakdown product AMPA were responsible for

In many countries, growing crops for export uses large amounts of water, while meat production uses even more, worsening shortages and drought stress



the excessive levels. It is migrant workers who are most likely to come into contact with these poisonous substances in industrial agriculture – and these workers are often paid far less than the minimum wage, while also being subject to precarious working conditions and insufficient health and safety standards. In 2022, some 3,370 people in Almeria's vegetable-growing region were living in shacks without adequate drinking water, and with no connection to the sewerage system or electricity network.

The agricultural hotspots of southern Spain and the devastating state of their surface and groundwater reserves show clearly how industrial agriculture is nearing a breaking point. Despite all the technical measures to improve efficiency over the last decades, be it drip irrigation or the increased use of biological pest control, the belief that technical advances alone can be a solution ignores the fact that the current crises are rooted in agricultural models aiming at quick profits for the few. Solving water crises will require a major rethink. For example, cooperatives that make affordable agricultural land available to small enterprises must be strengthened. It must be made easier for farmers to move away from a purely export-oriented approach. Shorter marketing channels would guarantee fairer prices for agricultural products. Retailers in importing countries also have a responsibility and must be more closely monitored to ensure they comply with European environmental standards. The changes to our food systems are not of interest only to farmers, but to us all, precisely because they are so closely intertwined with the food we eat, the water we drink, the climate, and rural areas. ●



ENERGY

OUR POWER CRAVES WATER

Water and energy are deeply interconnected: producing energy relies on water, while treating water consumes energy. Mining raw materials such as lithium and copper needs lots of water, also in arid regions. The solutions: recycling, water-saving technologies, and switching to renewable energy sources such as wind and solar.

Overcoming water-related challenges is inseparable from tackling energy-related issues. It takes lots of water to generate energy, for example to cool thermal power plants and nuclear reactors. Energy, in turn, is needed for water-related activities such as drilling, transportation, purification, desalination, and wastewater treatment.

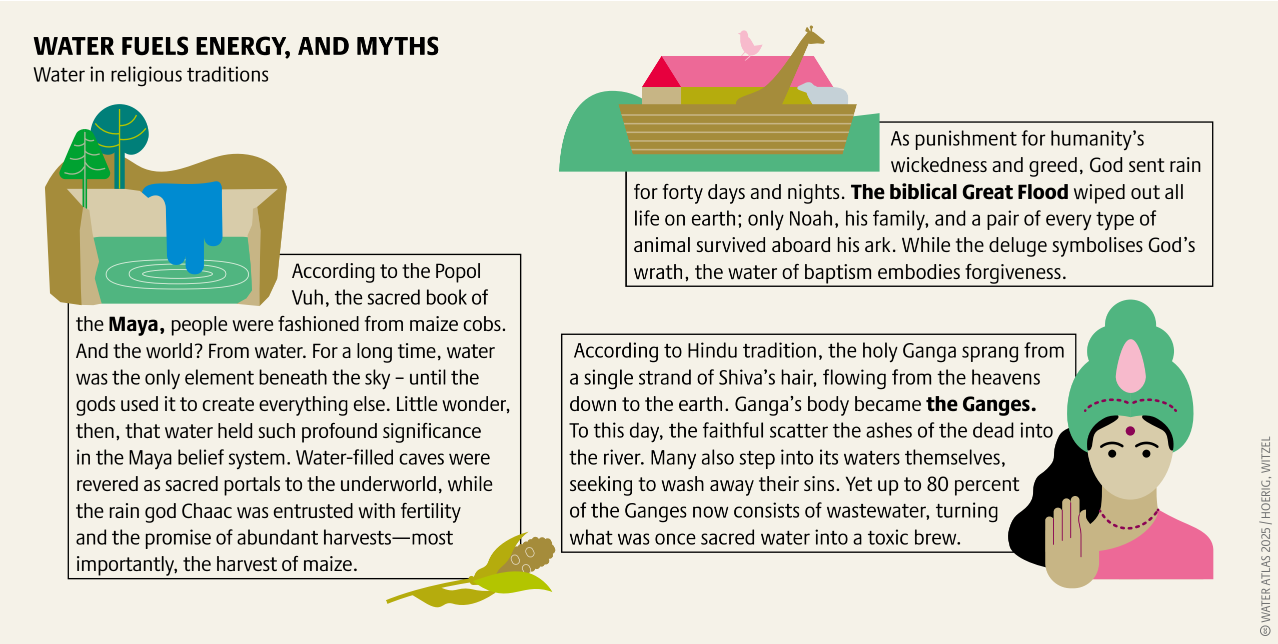
Because the relationship between water and energy is so close and complex, problems such as access, scarcity, or mismanagement of one can significantly affect the other. If water is scarce, this can hamper energy production and hinder efforts to cut carbon emissions. And energy production that ignores water limitations can lead to pollution, as seen in Shell's oil operations in Nigeria, which have caused severe local damage. Likewise, fossil-fuel power plants are major contributors to water pollution, releasing contaminants that threaten public health and ecosystems, including rivers, groundwater, and surrounding communities.

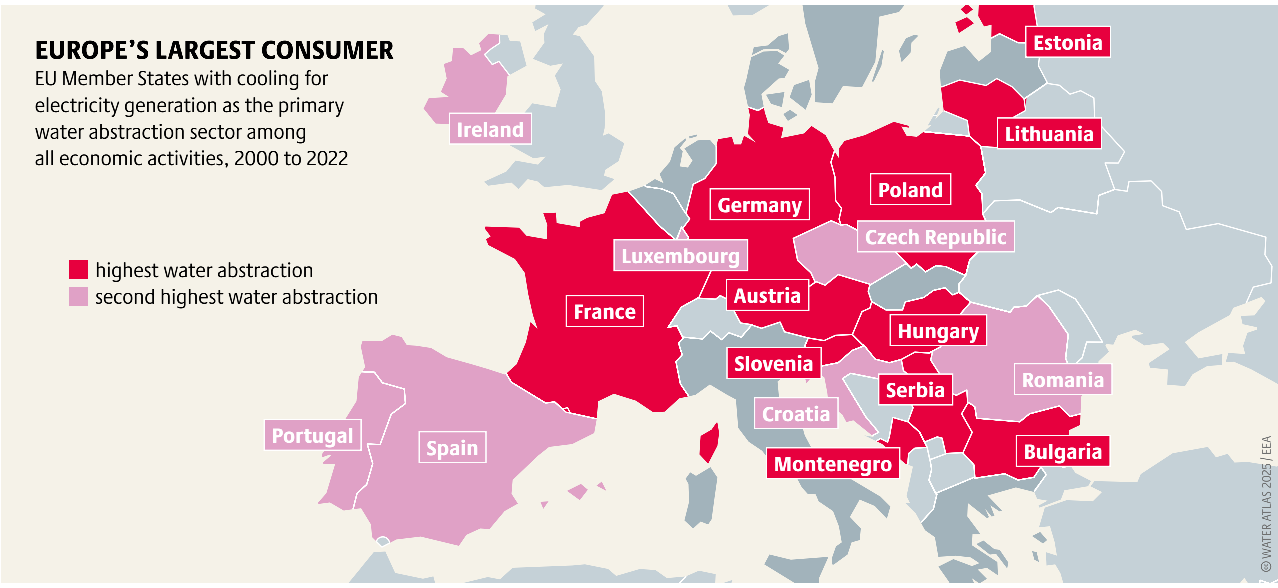
According to the International Energy Agency (IEA), global water withdrawals for electricity and fuel production reached around 370 billion cubic metres in 2021. Most was used for cooling in thermal and nuclear power plants. It is projected that water withdrawals for energy production could rise to 400 billion cubic metres by 2030.

In the energy sector, electricity generation accounts for the largest share of water withdrawals. In 2021, around 54 billion cubic metres of water were used to produce energy. Although in 2021 the global energy system used less water than in 2010, it still accounts for roughly 10 percent of total global freshwater withdrawals.

In 2023, the United Nations Climate Change Conference called for global renewable energy capacity to be tripled by 2030. Achieving this goal will require adding an average of 1,100 gigawatts of renewable capacity per year. This holds out the hope of reducing the exploitation of the world's water resources. Renewable energy sources represent only a small fraction of total water consumption, much smaller than that of fossil fuel-based energy.

Water drives turbines and lights cities – yet it also powers myths and faith, seen as near-omnipotent: able to create, destroy, cleanse, and redeem





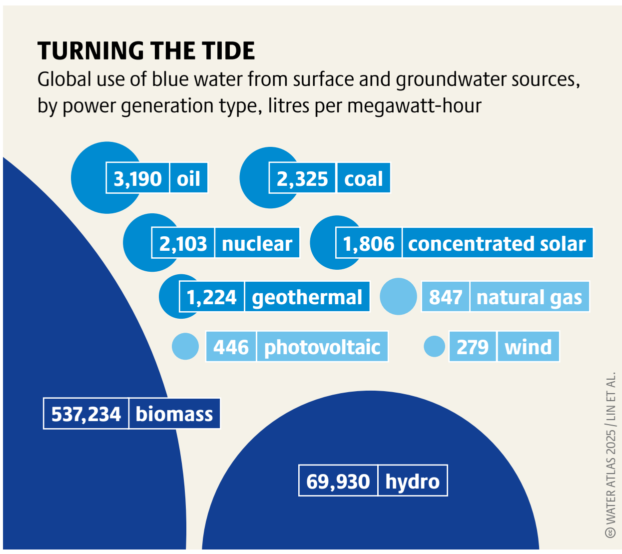
From 2000 to 2022, cooling power plants in the EU used 36 percent of total water abstraction, with shares varying by country

But significant challenges remain. The climate crisis is disrupting the global water cycle. The mining industry is failing to manage its waste and reduce its consumption of water. Social and environmental problems abound. Many critical minerals lie in water-scarce regions, including lithium, nickel, cobalt, and graphite for batteries, and rare earth elements for wind turbines and electric vehicles. Over 50 percent of the world's lithium reserves are located in water-scarce regions. Chile, the world's biggest copper producer, holds around 21 percent of global copper reserves. Mining poses significant environmental risks, particularly to fragile forest ecosystems, as it requires large amounts of water and pollutes both surface water and groundwater. Mineral extraction relies on chemicals that can be hazardous if not properly managed, posing serious threats to human health, biodiversity, and the environment.

So-called green hydrogen, or hydrogen produced by the electrolysis of water using renewable electricity, is often held up as a replacement for fossil fuels. But producing one kilogram of hydrogen consumes between 9 and 13 kilograms of water; actual consumption may be higher, depending on the electrolysis technology and amount of cooling water used. Desalination plants, which remove salt from saline water by filtering or heating, are expanding to meet demand. Most are in the Middle East. But desalination is expensive, takes a lot of energy, and has big environmental impacts. In many countries, only wealthier regions or social groups can afford access to desalinated water due to its high cost, while poorer areas often lack the infrastructure or funding – despite having equal or even greater water needs. It also generates vast amounts of brine waste – 141.5 million cubic metres per day – with 70 percent of that in the Middle East.

Another controversial water-intensive technology is Carbon Capture and Storage (CCS). This involves capturing greenhouse gas emissions from fossil-fuel power plants and storing them underground. This takes a lot of water. The large-scale development of such technologies could nearly double humanity's water footprint.

Reducing energy demand in a coordinated manner is crucial for ensuring a fair, secure, and sustainable future in the face of the climate crisis and water scarcity. A strategy that integrates water-efficient energy technologies is essential for reducing pressure on vital water resources while providing equitable access to energy. ●



Fossil fuels harm the climate and consume much water. Renewables like solar and wind cut CO_2 emissions and use less water

DIGITALISATION

THIRSTY DATA

Digitalisation clearly enables new forms of mobility, living, and working. However, the rising energy consumption and water needs for artificial intelligence and other computing services pose ecological and social challenges.

Crunching data requires physical infrastructure: equipment such as laptops and mobile phones, adaptors and chargers, sensors, transmission networks – and above all, data centres. These centres are where most of the world's data is stored, managed, and very much distributed. While the public has become increasingly aware of the carbon footprint as an indicator of the climate impact of digitalisation, the digital water footprint has been largely overlooked – despite the fact that data centres require large amounts of water to operate.

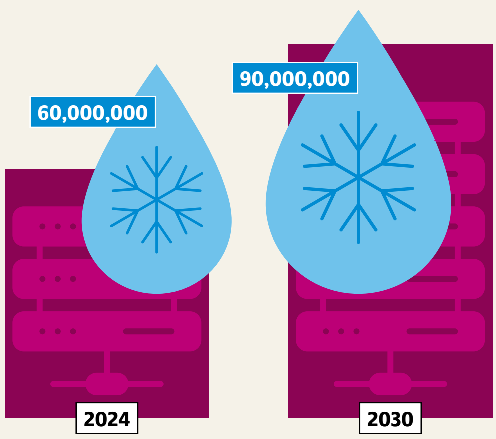
This water footprint actually consists of three main components. First is the water needed to produce the equipment itself; second is the water used to generate electricity to run the digital infrastructure continuously; and third is the water needed to cool the data centres effectively to keep the hardware at an optimal operating temperature. Research show, an average data centre in the United States needs more than a million litres of water a day – as much as three average-sized hospitals combined.

Data centres have to be kept cool to prolong the lifespan of the hardware. In one commonly used method, the water temperature is first lowered in a central cooling tower. The water then circulates through cooling coils that absorb heat from the air in the data centre and then release it outside via the cooling tower. A study by the Chilean water authority found that for cooling processes alone, a data centre requires up to 169 litres of water every second.

Artificial intelligence (AI) systems such as the chatbot ChatGPT have recently spread widely. These are algorithmic systems that make decisions not through traditional programming but via machine learning. They are trained on huge pools of data. Because they need a great deal of computing capacity, they are also responsible for rising water consumption in the data centres. While 20 Google searches use 10 millilitres of water, ChatGPT guzzles half a litre to answer 20 to 50 questions. When training the ChatGPT model GPT-3, for example, 700,000 litres of clean fresh water were evaporated in Microsoft's research centres in the United States. The rising water consumption for artificial intelligence is also reflected in the fact that tech companies are drawing more and more water from the drinking water network: in 2022, Google used 20 percent more water than in the previous year; Microsoft used 34 percent more. By 2027, artificial intelligence worldwide is expected to consume up to six times more water as Denmark does. Cryptocurrencies also have a massive water footprint: the water consumed by a single bitcoin transaction would fill an entire swimming pool.

Many regions have already seen protests against the construction of data centres – especially in those areas that are already severely affected by water shortages. Uruguay is an example. Low rainfall and extreme heat in 2023 meant that the country's most important reservoirs dried up. The authorities were forced to take water from the Rio de la Plata estuary, where seawater and freshwater mix, giving the tap water a salty taste. The protests focused on the planned establishment of a Google data centre, which was feared to worsen the water shortage. The demonstrators accused the government of prioritising water supplies for multinational concerns at the expense of the local population. This

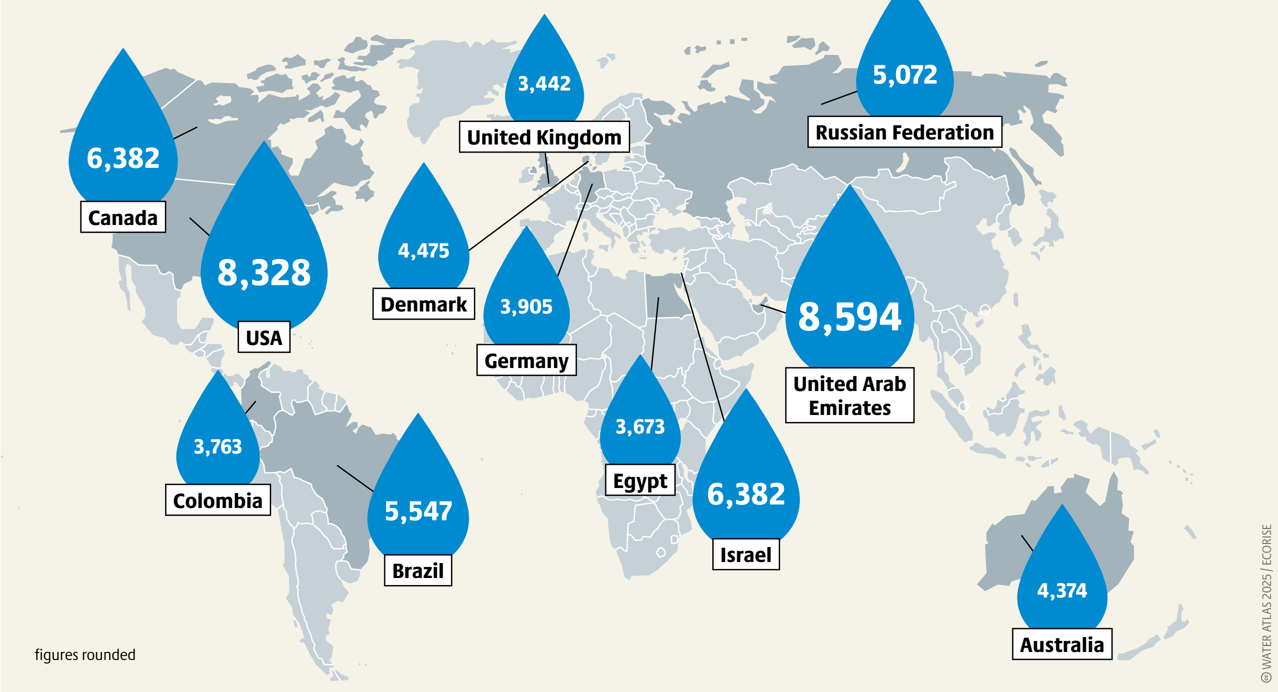
COOLING THE CLOUD
Current and future water demand for data centre water cooling in Europe, in litres



Studies show water-based cooling accounts for about 20 percent of Europe's market. By 2030, its water use could match that of a major city like Munich

GLOBAL FLOW

Volume of virtual water used to produce goods, selected countries, litres per person and day



conflict shows that the ecological consequences of AI are closely linked to issues of distributive justice. In the meantime, the authorities have approved the establishment of the data centre – though with just one-third of the originally planned capacity and a comparatively water-saving air cooling system.

Although companies in the Global North in particular profit from technologies such as artificial intelligence, the ecological and social costs are borne mainly in the Global South. The public and scientific debate on how this can be changed is still in its infancy. In 2024, the European Union passed the so-called AI Act. This is the world's first law to regulate artificial intelligence and obliges the documentation of the energy consumption and computing resources needed to train artificial intelligence models. But it does not require a similar documentation for water consumption because it regulates only the artificial intelligence products and not the technical infrastructure needed to run them. The European Union's Energy Efficiency Directive does at least have reporting requirements for water use by data centres, which improves the transparency at least for data centres in Europe. Tackling the problem worldwide will require much greater investments in measures to reduce water requirements – such as alternative cooling systems or finding ways to use rainwater or seawater.

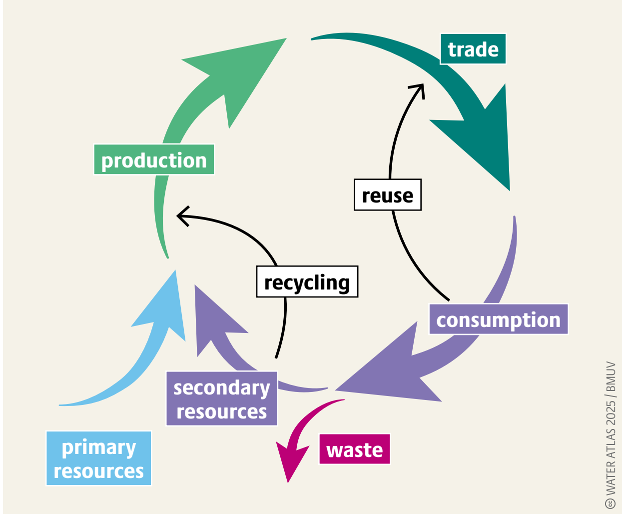
Only through global cooperation, stricter regulations, and a shift toward sustainable digital infrastructures can the environmental burden of digitalisation and AI be equitably addressed and long-term resilience ensured. ●

A circular economy can cut water use through recycling, reuse, and efficient resource management in both production and consumption

Virtual water refers to the unseen water used in the production of goods. The Global North consumes large amounts of it through imports

MOVING FORWARD BY GOING IN CIRCLES

Guiding principles of the circular economy



FOSSIL ENERGY

YESTERDAY'S BURDEN

In many countries, coal companies are not only the main emitters of carbon dioxide – they are also the biggest water users. By importing fossil fuels, the world's wealthiest countries contribute to water shortages in producing countries.

Fossil fuels cause immense damage to the climate. Coal is the biggest driver of the climate crisis: mining and burning it is responsible for more than 30 percent of global warming. Coal mining also has a major impact on the regional water balance. Large quantities of groundwater must be pumped out to expose the deeper layers of rock where coal is found. Coal-fired power stations also need large amounts of cooling water. A 500-megawatt power station with a continuous cooling system requires a flow of water that would fill an Olympic swimming pool every three minutes.

Mining leaves behind consequences that must be dealt with for many generations to come. Sufficient financial resources must be set aside to cover the costs of doing so. In some countries such as Germany, in accordance with the so-called polluter pays principle, the mining companies are obliged to make provisions for mitigation and monitoring activities, but not all the follow-up costs are factored into the price. In particular, the burdens and costs of long-term consequences such as surface-water pollution and damage from rising groundwater have scarcely been analysed or quantified. There is no guarantee that the funds set aside for post-closure mine monitoring will still be available if, for example, the mining company goes bankrupt. And in many countries, the principle does not apply.

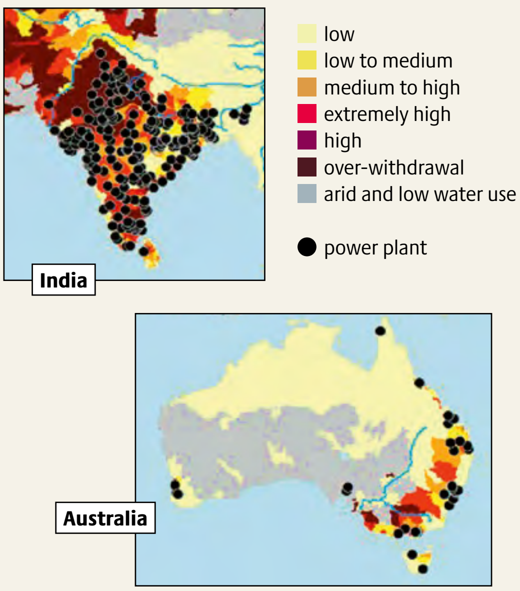
To generate energy, many countries continue to import coal from various producing countries, including the United States, Australia, South Africa, Poland, and Colombia. Colombia mined around 84 million tonnes of coal every year between 2012 and 2022. In northern Colombia, numerous rivers have been diverted and dams constructed to permit coal mining. In mining regions such as the La Guajira semi-desert, water shortages are a major contributor to the high local infant mortality. Economically stronger countries import large amounts from Colombia. Germany, for example, imports some 5 million tonnes of coal yearly from Colombia, and is thus responsible for the consumption of at least 5.5 million cubic metres of water there.

Coal is not the only fossil fuel depleting global water resources. In late 2024, two damaged oil tankers in the Strait of Kerch, between the Black Sea and the Sea of Azov, attracted widespread attention. The ships were carrying around 9,000 tonnes of heavy fuel oil. The subsequent oil spill led to the death of dolphins and the contamination of more than 40 kilometres of beach. It is difficult to estimate the number of birds that had their plumage stuck together by the oil slick, seals whose fur was fouled, or fish whose gills were clogged. Such oil disasters also result in oil entering the marine food chain and damaging the ecosystem over the long term.

Accidents and lax regulations are not the only reasons oil causes water shortages and pollution. This is seen in Canada's synthetic crude oil production: between 2 and 4.5 units of water are required to produce one unit of oil. The industry is permitted to extract

FIRING UP IN THIRSTY TERRAIN

Baseline water stress and coal power plants in India and Australia



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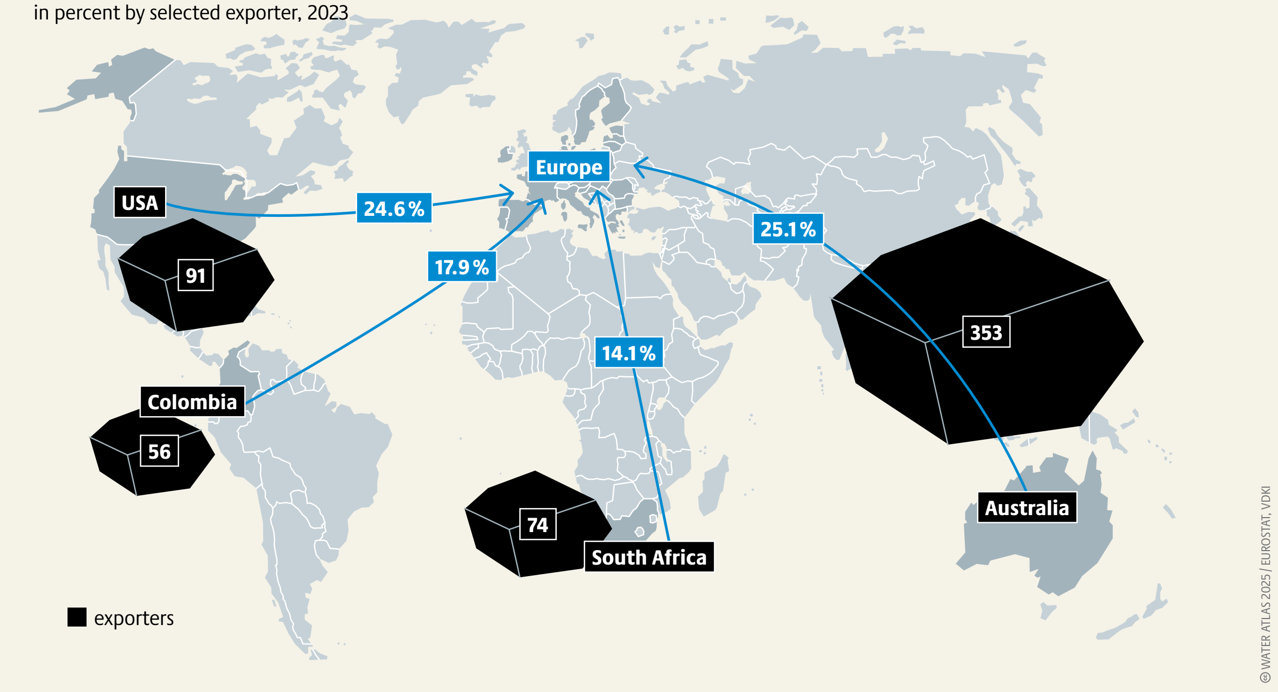
Regions with coal power plants risk water stress, as large volumes of water are used for cooling, reducing availability for people and ecosystems

DEEPLY DUG, WIDELY TRAVELED

Hard coal exports, selected countries, in million tonnes, and net import to the European Union, in percent by selected exporter, 2023



Over 80 percent of the EU's coal imports come from just four countries, where mining drives severe environmental damage

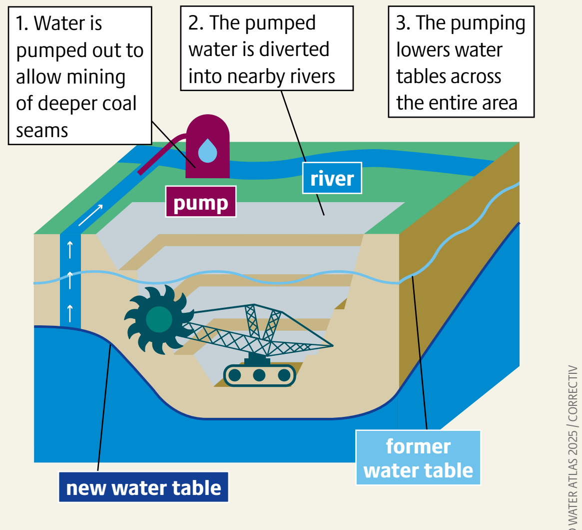
around 349 million cubic metres of water a year from the Athabasca River – about the same volume needed to supply a city of 2 million people. Another problem is the contaminated wastewater discharged by oil refineries. This contains numerous pollutants that end up in rivers and lakes, where they damage ecosystems. Studies show that this wastewater harms both water quality and biodiversity.

Energy companies promote natural gas as a cleaner alternative to coal and oil. But the numbers tell a different story. As a fuel, gas is responsible for one-fifth of global carbon dioxide emissions. Fracking, a technique to extract both fossil gas and oil, involves injecting a mixture of water, sand, and chemicals into deep rock layers using high amounts of pressure. This procedure creates fine cracks and releases the trapped fossil fuels. Groundwater may be contaminated by drilling, storage of chemicals used in fracking, methane release, chemical flowback, and the seepage of contaminated reservoir water. The fracking process itself requires large amounts of water as well. According to the German Environment Ministry, around 170,000 cubic metres of water are needed for a well with six drill strings required to fully develop a gas-bearing reservoir.

A comprehensive and equitable phase-out from coal, oil, and gas is necessary to protect global water resources and the climate. This requires rapid and far-reaching renewable energy expansion and reduced energy consumption. Policies must prevent fossil fuel companies from shirking the follow-up costs of their activities and evading responsibility for perpetual liabilities of fuel extraction. ●

IN THE DEPTHS

Effects of open-cast coal mining on groundwater



Coal mining lowers groundwater levels, causing dry wells, harming ecosystems, and reducing water for farming and local use

METAL MINING

THE GREAT WATER ROBBERY

In Chile and elsewhere, multinational mining companies destroy glaciers and displace Indigenous Peoples. With raising demand for minerals there is an increasing threat of resource conflicts because of mining's thirst for water and its huge impact on water quality. A circular economy is one way to slow down the rush to dig up the ground.

Metals such as copper, aluminium, lithium, rare earths, and gold are a big part of our daily lives. They are found in everything from infrastructure projects, the energy sector, transport and housebuilding. And in our pockets: an average mobile phone may contain up to 66 different metals, according to Germany's Federal Institute for Geosciences and Natural Resources. Precious and specialist metals in particular are vital to make them work.

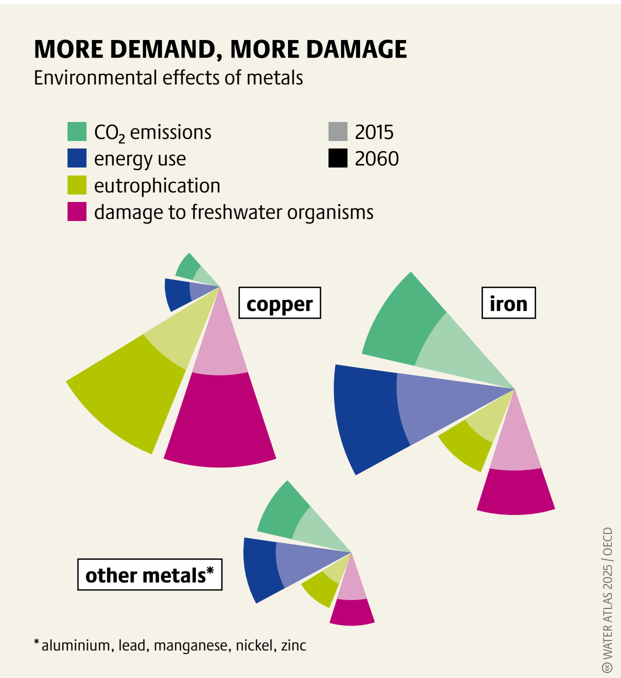
The demand for metals has been steadily on the rise for years. Global demand for rare earths is projected to more than double by 2040, with lithium demand increasing thirteenfold. All that has an impact on the availability and quality of water. Producing one kilogram of the copper that will go into power lines or boilers consumes around 97 litres of water. Thus, the amount of water used for one tonne of copper equals the drinking water requirements of one person in Germany for 177 years. Between 400 and 2,000 litres of water are needed to obtain a kilogram of the lithium needed to make batteries for electric cars.

China and the USA are the largest consumers of minerals and metals, while in Europe, Germany is responsible for the highest consumption. The construction and automotive industries have a particularly high demand as they need large amounts of copper and aluminium.

Over 90 percent of raw materials consumed in Germany are imported, with Chile being a key supplier. That country is the source of almost one-third of the lithium and nearly one-quarter of the copper on the world market.

That has consequences: mines have been encroaching on glaciated areas for years. The glaciers act as reserves of fresh water; their long-term accumulation and melting of ice provide a basic level of water security. Some 70 percent of Chile's population are currently supplied with water from the country's glacier-rich mountains. The climate crisis is already taking its toll on the glaciers – and the mining is damaging them further. It blasts them away, dumps waste rock on them, or covers them with dust, which causes the glaciers to melt even faster. Mining also contaminates local water sources, leaving some villages in the Andes reliant on water deliveries. In the Salar de Atacama, one of Chile's most important mining regions, copper and lithium mining have already used up more than 65 percent of the available water supplies. This disproportionately impacts local communities, as Chile's water resources are privately owned, and the law prioritises industrial use. In many other countries, too, multinationals dominate the extraction of raw materials. Their profits do not benefit local communities in mining areas, where poverty rates are often especially high.

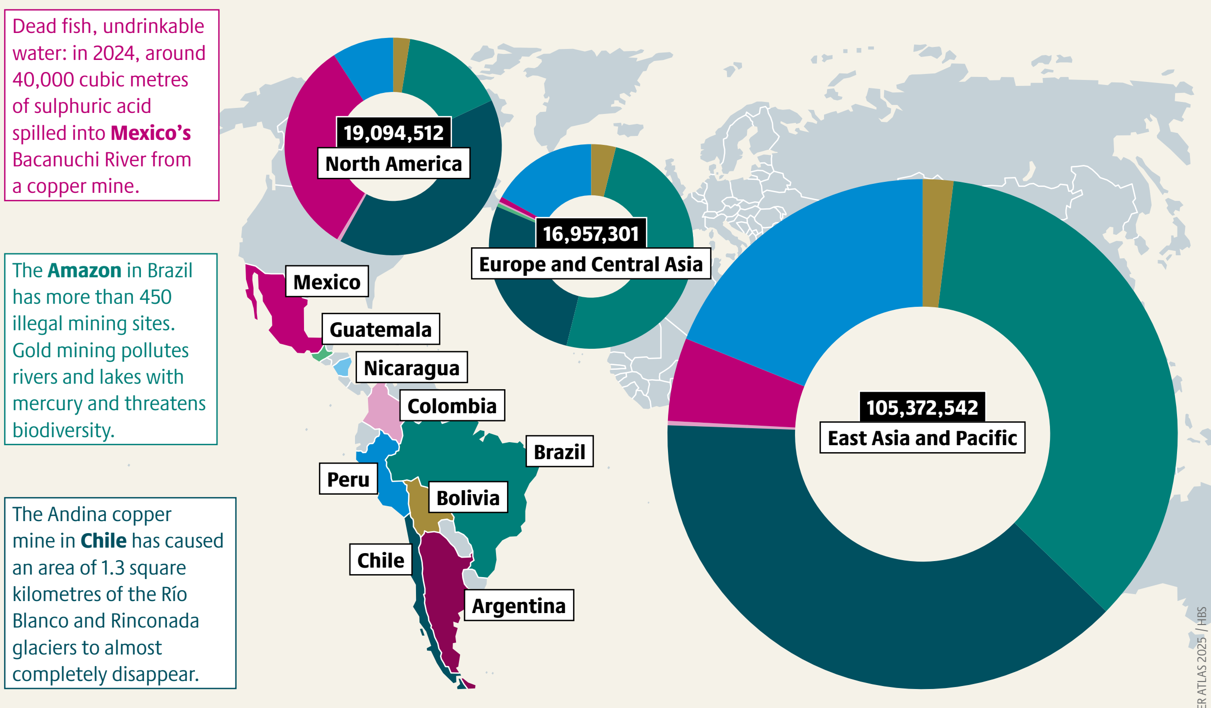
The Global Environmental Justice Atlas currently documents almost 900 mining-related conflicts worldwide. Around 85 percent of these concern the use and contamination of surface water or groundwater. Displacements are common, and in many cases environmental activists and Indigenous People are killed. In some countries, such as the Democratic Republic of Congo, cobalt and coltan mining relies on forced labour.



Raw material demand could double by 2060, accelerating eutrophication and depriving aquatic life of oxygen and vital resources

MINING METALS: ALL THAT GLITTERS IS NOT GOLD

Imports of metals and ores from Latin America, 2021, thousand US dollars, and selected cases of damage caused by mining



Mining strains scarce water resources, sparking violent conflicts between local communities, mining companies, and the authorities

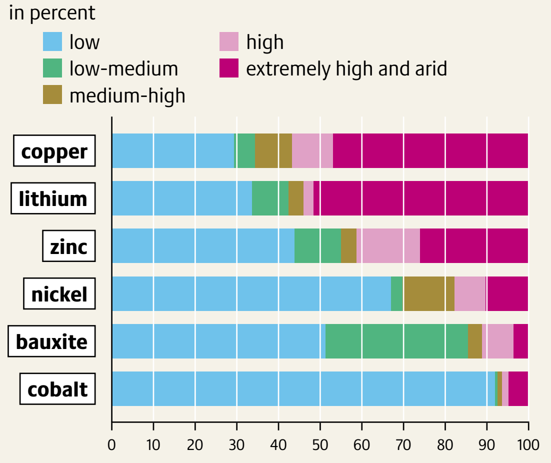
The European Union's Critical Raw Materials Act of 2024 aims to boost Europe's mining sector. Doing so will also bring the problems associated with mining more strongly into focus in the European Union (EU). What is certain is that the only way to mitigate the harm caused by mining is through robust political regulation and effective enforcement. Mining should generally be prohibited in areas with springs and in very dry areas with sensitive ecosystems and glaciers.

In terms of water supplies, the population must have the top priority. Companies must prevent human rights abuses and environmental risks throughout their supply chains, and those affected need access to remedy. But in the long term, the environment can be protected from mining only if policies reduce the demand for raw materials as much as possible. The idea of a circular economy offers some guidance on how to do this. The European Union's Ecodesign Regulation aims to minimise the effects of products on the environment through sustainable design. Because minerals and metals are often used to make solar panels, wind turbines, and electric cars, extending this regulation to cover renewable energy would be a modest but useful step. A shift in the transport and construction sectors is essential to reduce their reliance on raw materials and protect water resources. Basically, this includes a future with fewer cars, more bike lanes, and improved public transportation.

Copper and lithium mining face rising climate risks, with over 50 percent of output in water-stressed areas exposed to heat and floods

DROUGHT AND DIGGING

Global share of production volume by water stress level in 2020, in percent



MEKONG

FLOURISHING A CONTINENT

The Mekong, one of the world's most biodiverse rivers, breathes life into vast ecosystems. Flowing through six countries, it links cultures, livelihoods, and landscapes. But as dams multiply, pollution intensifies, and currents slow, its natural rhythms break down.

Over its nearly 5,000-kilometre course, the Mekong River – known as the Mother of Waters – nurtures riparian ecosystems; from its headwaters on the Tibetan Plateau through China, called the Lancang, to its lower basin. Through Myanmar, Laos, and Thailand, the river threads its way between rocky outcrops, rapids, sediment bars, wetlands. It meanders and broadens into alluvial floodplains in Cambodia, before becoming the Sông Cuu Long as it empties into the South China Sea in Vietnam.

Seasonal rhythms shape the river's ecosystems as the Mekong rises and ebbs. During the flood season, the river, responsible for 70 to 80 percent of the total annual flow, surges, reverses, and expands its tributaries, including Southeast Asia's largest inland freshwater lake, the Tonle Sap in Cambodia. The phenomenon is uniquely known as the flood pulse: a seasonal heartbeat that sustains the river's ecology.

FLOWING LIFELINES
Upper and Lower sections and the surrounding countries to the Mekong River, 2024

© WATER ATLAS 2025 / EYLER, WWF

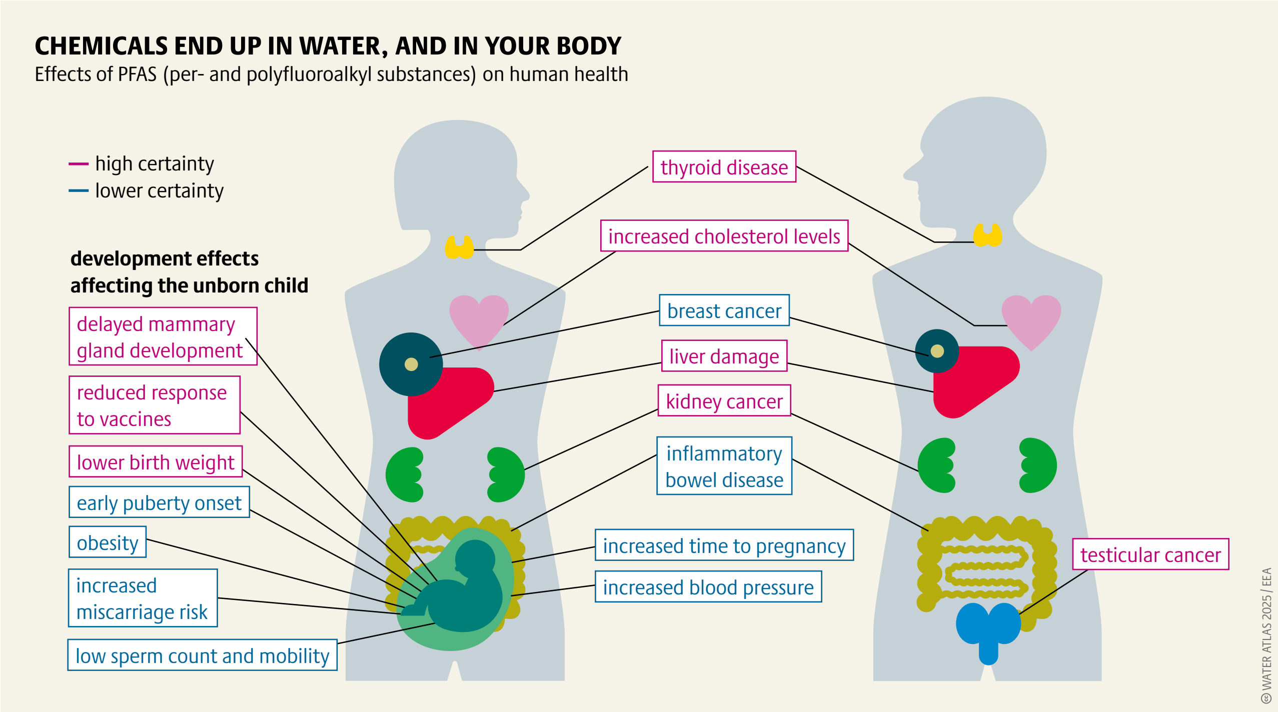
Wetlands correspond to the river's rhythms: they rise and fall with the ebbs and flows. They are vital to fisheries and aquatic life, covering more than 18 million hectares in the lower Mekong basin. Riverine plants' roots anchor themselves against turbulent currents and offer refuge where migratory fish can breed, spawn, and shelter their young. Of over 1,000 identified fish species – and counting – at least one-third migrate seasonally, and 200 are found nowhere else on the Earth. Fishers adapt their gears to the fish, the ecosystems, the seasons, and then they wait. The river's abundance is woven into livelihoods, spirits, and stories. The magnificent Mekong Giant Catfish, one of the world's largest freshwater fish species, is listed as critically endangered on the IUCN Red List yet remains prominent in legends and memories .

As the dry season approaches, fish seek refuge in mainstream deep pools or tributary wetlands. Mid-channel bars and rapids emerge while plants' young leaves bud, fruits ripen, and migratory birds come for food and breeding. Floodwaters replenish the soil with sediments and nutrients. Riverside farmers prepare their land and sow seeds along the retreating waterline. In northern Thailand, freshwater green algae known as kai grow on smooth river stones when the water clears. Although the Mekong has marked the border between Thailand and Laos since French colonial rule in the early 20th century, women still cross boundaries to collect kai for consumption and income. The river's cycle continues as the rains return, ushering in the next flood season.

For millennia, the Mekong has sustained riverine communities and civilisations. Today, more than 65 million people live in the Lower Mekong Basin, representing a great diversity of ethnic groups and Indigenous People. Riverside towns, including the capitals of Laos and Cambodia, rely on the Mekong for transport, trade, tourism, and agriculture. The Mekong's inland fisheries rank among the most productive of the world, supplying nearly 80 percent of local animal protein.

The Mekong forms the backbone of regional economic growth. Its riverbed is dredged for sand, a key ingredient for concrete construction. The velocity of its strong currents attracts hydropower dam projects, turning flow into electricity, and profit, across mainland Southeast Asia. But while rising electricity de-

The Mekong River runs through six countries, supporting over 60 million people and one of the world's most diverse freshwater ecosystems



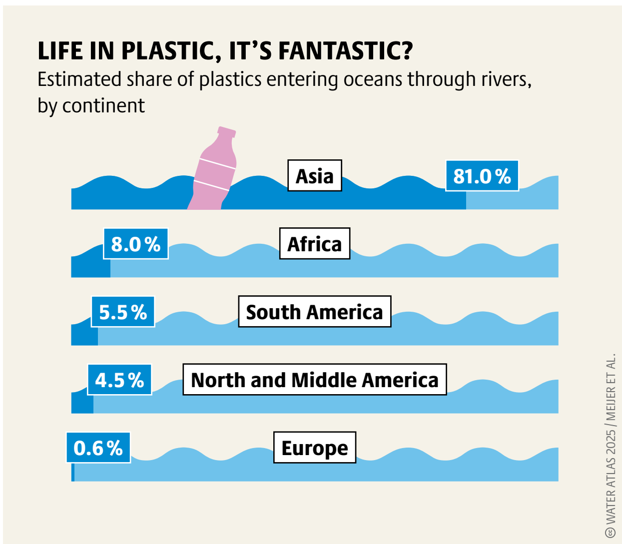
Chemicals such as PFAS contaminate water sources in the long term. They break down slowly, accumulate in nature, and threaten drinking water and human lives

mands drive industry, urban growth, and intensive agriculture, the Mekong also carries tons of debris, microplastic, and effluents ocean. One example comes from the Chi River, a tributary of the Mekong in Thailand, where scientists discovered that 73 percent of 100 sampled fish, belonging to eight species of barbs and catfish, contained microplastics in their stomachs. In March 2025, the Mekong River finds itself in another dire predicament. Kok River, one of its tributaries, is contaminated by arsenic exceeding WHO safety threshold from unregulated rare earth mining operations in Shan State, Myanmar. Fisher folks observed visible abnormalities of fish caught from Kok and Mekong rivers.

Dams and damming disrupt the river's seasonal rhythm and block the natural flow of sediments. Daily water level swings, triggered by cascade dams a thousand kilometres away in China, are felt downstream. Sudden releases during the dry season flood crops, disorient fish and plants, and damage fishing boats and local tourism. Dams block fish migration, forcing fishers to adopt other livelihood strategies. Sediments and organic matter are essential nutrients for soils, plants, fish, and humans, but they are trapped and contaminated. In extreme cases, the rusty-brown Mekong turns blue, starved of sediments and nutrients.

In 2022, Thailand's administrative court dismissed a lawsuit by 37 community representatives opposing the Xayaburi Dam in Laos, built and financed by Thai developers. Local fishers, women, and community leaders, citing the transboundary impacts on ecosystems and livelihoods, demand equal say alongside experts in decision-making. After unusually blistered, red-spotted fish appeared in the Kok River in March 2025, communities sought collaboration with academics and authorities to address cross-border rare earth mining impacts. Through grassroots initiatives – conservation zones, sediment monitoring, youth engagement, and regional advocacy – they defend both the Mekong's right to flow freely and the rights of nature. ●

Rivers transport 1.15 to 2.41 million tonnes of plastic waste from inland areas into the oceans every year, making them key pollution pathways



WHAT REALLY KEEPS US SAFE?

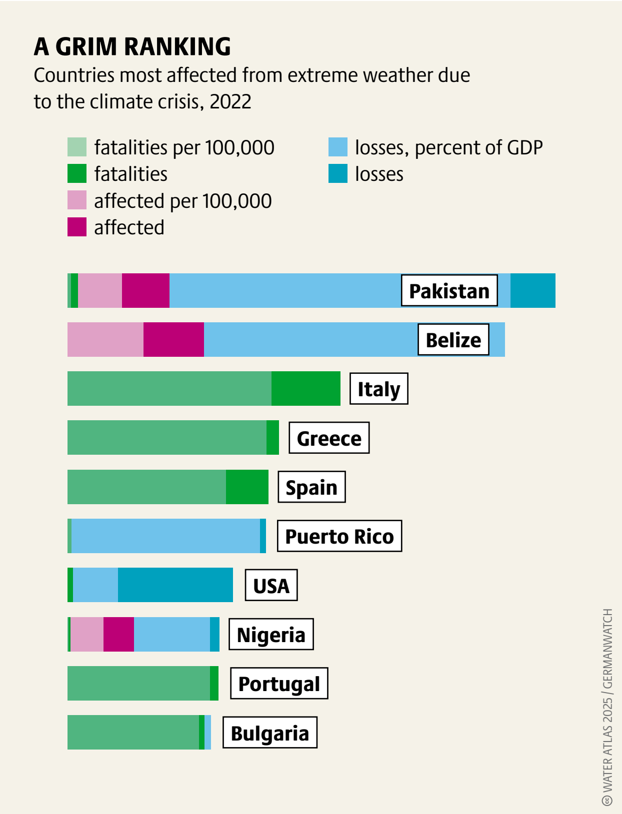
The climate crisis is disrupting the balance of the global water cycle. While rain floods entire regions, others suffer from severe drought. Where water becomes either a threat or a scarcity, the basis of life begins to falter. All the more crucial are solutions like restored wetlands and climate-resilient building in sponge cities, practices that can retain, manage – and safeguard – water and lives.

Scientific research shows that global warming increases the likelihood and intensity of heavy rainfall. Warmer air holds more moisture – approximately 7 percent more for every degree Celsius of warming – which results in more extreme downpours. This leads to flash floods that overwhelm drainage systems, damage homes and infrastructure, and disrupt lives. Such events have become more commonplace. For instance, recent flash floods in Spain 2024 and Texas in 2025 have caused widespread destruction and resulted in numerous fatalities. In July 2021, the catastrophic flooding in Western Europe was attributed to human-caused climate change, which had increased the likelihood of such heavy rainfall up to ninefold. Events like these are particularly devastating to communities already struggling with infrastructure that cannot handle sudden heavy water flow.

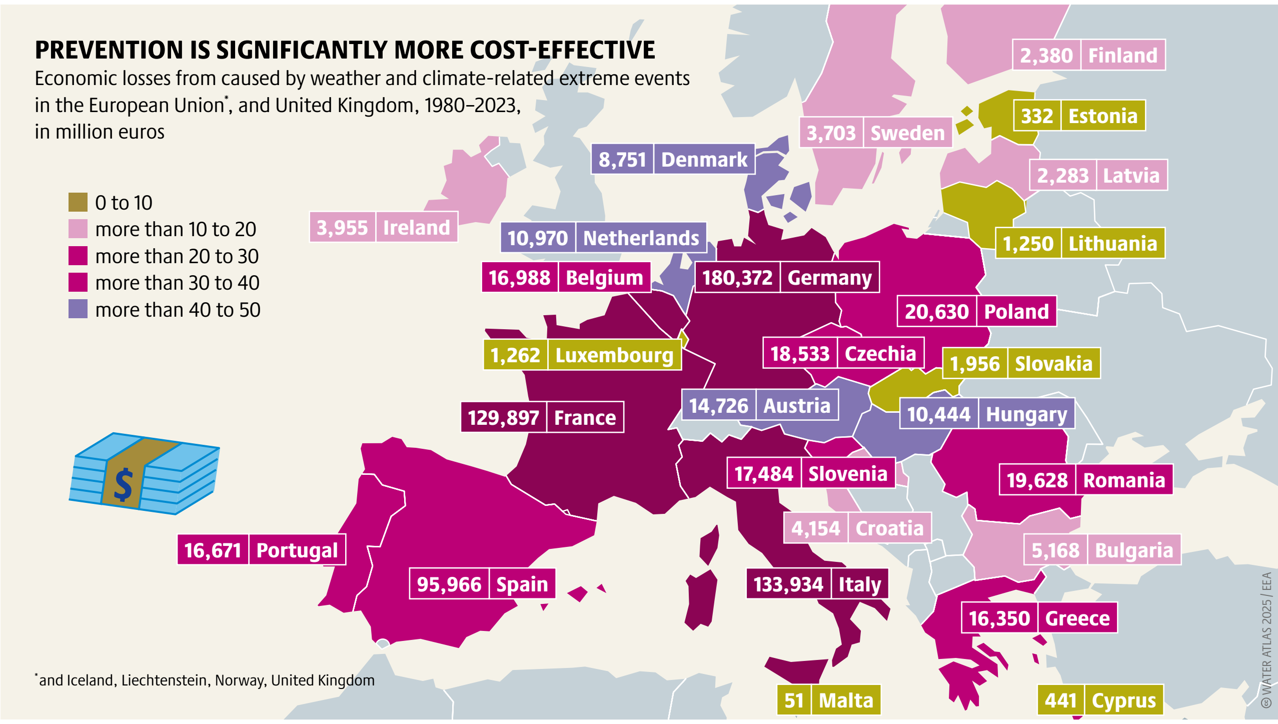
At the same time, other regions face the extreme opposite. Droughts are lasting longer and becoming more severe, especially in regions such as Africa, where rising temperatures and shifting rainfall patterns are depleting water supplies and undermining agriculture. Prolonged dry periods not only reduce crop yields but also threaten livelihoods, increase the cost of living, and strain social and public health systems. In Kenya, for example, millions have been affected by ongoing water scarcity. In Sub-Saharan Africa, safe drinking water remains out of reach for the majority of the population.

What makes the current moment especially concerning is how these climate-driven events increasingly interact. For example, a drought-stricken landscape heavily influenced by prolonged droughts often loses its capacity to absorb heavy rainfall: When rain finally arrives, water runs off swiftly, triggering flash floods and landslides. These cascading and compounding events can rapidly overwhelm already fragile systems, creating a feedback loop of climate-induced extremes. In 2024, prolonged droughts in Madagascar were followed by a powerful tropical cyclone, resulting in widespread flooding and leaving approximately 220,000 people in urgent need of humanitarian support, including around 22,000 who were displaced from their homes. These compounding events led to crop failure, food shortages, displacement, and a worsening humanitarian crisis, highlighting Madagascar's vulnerability to climate extremes.

The climate crisis with its extreme weather events is also a crisis of inequality. Vulnerable groups such as low-income communities, women, and Indigenous populations often face heightened risks due to poor water governance and lack of access to resources, leading to social unrest and potential conflicts over dwindling water supplies. Agriculture, which accounts for about 70 percent of global freshwater usage, is under



The Climate Risk Index ranks countries on a scale summarising impacts of storms, floods, heatwaves and losses, highlighting climate vulnerability



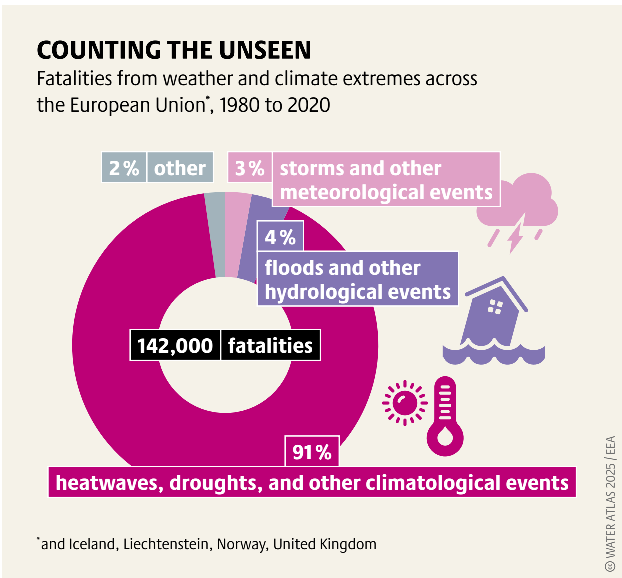
Climate hazards like heat, heavy rain, and drought threaten health and ecosystems. Just 5 percent of events cause 61 percent of economic losses

pressure as demand grows with population increases. Water scarcity thus threatens food security and livelihoods, particularly in regions dependent on climate-sensitive agricultural practices.

Tackling climate-related water challenges takes bold and coordinated action across all levels of society. Cities and regions need practical, forward-looking solutions that protect people and ecosystems from increasingly extreme weather. First of all, effective early warning systems are essential for protecting communities from the impacts of flooding. And urban planning, building regulations, and water management all play a vital role in protection. Updating building codes can make structures more resilient – for example, by requiring flood-proof foundations or materials that reflect heat instead of storing it. The concept of the sponge city offers a powerful approach: it transforms urban areas into landscapes that soak up rainwater like a sponge, filter it naturally, and release it slowly when needed.

To make this work, cities must replace concrete with permeable surfaces that allow water to seep into the ground. Green spaces help refill groundwater and lower the risk of flooding. Parks are essential, but so are green roofs and planted walls. Depending on the design, green roofs can retain up to 90 percent of rainwater. They also cool buildings naturally – on hot summer days, a roof with 10 centimetres of greenery can keep indoor temperatures up to 8 degrees Celsius lower than a bare, sun-heated flat roof.

The more green space a city has, the better it can handle heavy rains and rising heat. But resilience doesn't stop at city limits. Restoring wetlands and protecting watersheds creates natural buffer zones that absorb floods and hold water during droughts. Climate-smart planning must bring these elements together so that cities and landscapes are not just protected but prepared. ●



The climate crisis worsens extreme weather and risks to life. Water cycle disruptions drive floods, droughts, and storms. Adaptation is vital

EUROPEAN UNION

NATURE CAN'T WAIT

Contamination, parched rivers and recurring floods expose the fragility of Europe's water systems. Robust legislation exists, but governments are slow to act. Delivering water resilience requires leadership, investment and real accountability.

Europe's citizens, environment and economy rely fundamentally on water. Yet the rivers, lakes and groundwater aquifers in the European Union (EU) face intense and increasing pressures stemming from pollution and water mismanagement. Take PFAS (per- and polyfluoroalkyl substances), also known as forever chemicals, are widely found in European waters at levels far above safe thresholds in many areas. Other pressures include the alteration of river courses, disruption of natural flow patterns, and excessive water extraction. Europe is warming faster than any other continent, and the impacts on water are felt most acutely: more frequent floods and longer droughts. But the deeper crisis is one of inaction: the EU's water laws exist, but are not properly enforced.

Adopted in 2000, the Water Framework Directive (WFD) is one of Europe's most ambitious environmental laws. It introduced a legally binding, ecological and basin-based approach to water management. By mandating all Member States to achieve a good chemical and ecological status for their waters by 2027 at the latest, and by embedding principles of non-deterioration, transparency and cross-sectoral coherence, the WFD marked a decisive shift from reactive responses to specific water problems such as nitrate pollution.

Yet 25 years after its adoption, the gap between ambition and reality is glaring. The European Commission's 2024 implementation report confirms that the rate of water bodies reaching good status has stagnated, key measures are underfunded, and exemptions are overused. Enforcement remains the exception rather than the rule. The few infringement cases that the European Commission has opened so far regarding breaches of the EU's flagship water law have not led to strengthened implementation. As a result, fewer than 40 percent of surface waters are in good status.

The Commission's proposal to tighten regulatory standards for pollutants of emerging concern – such as PFAS – is still under negotiation. But Member States already have the legal tools to act: They can review industrial discharge permits, enforce stricter pesticide regulations, and impose national bans or restrictions on priority substances – all grounded in existing law, and all possible today.

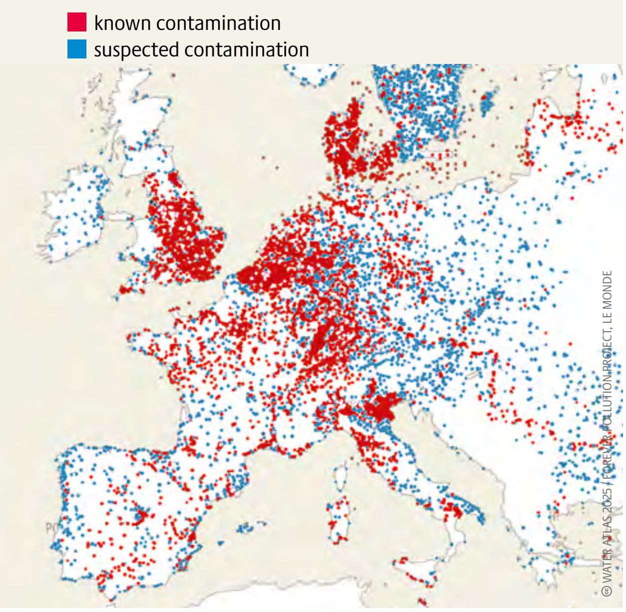
This implementation phase is also the credibility test for the EU's Water Resilience Strategy, put forward in June 2025 to tackle rising water scarcity, flooding, pollution, and ecosystem degradation across the continent. The WFD is what turns the Water Resilience Strategy's targets into enforceable actions.

The cost of implementing the WFD is estimated at 89 billion euros for the period 2022–2027, a fraction of the cost of inaction: 238 billion euros for PFAS clean-up, 9 billion euros per year in drought-related losses, 7.8 billion euros annually in flood damage, and more than 50 billion euros each year in foregone benefits, including those arising from the failure to restore surface water.

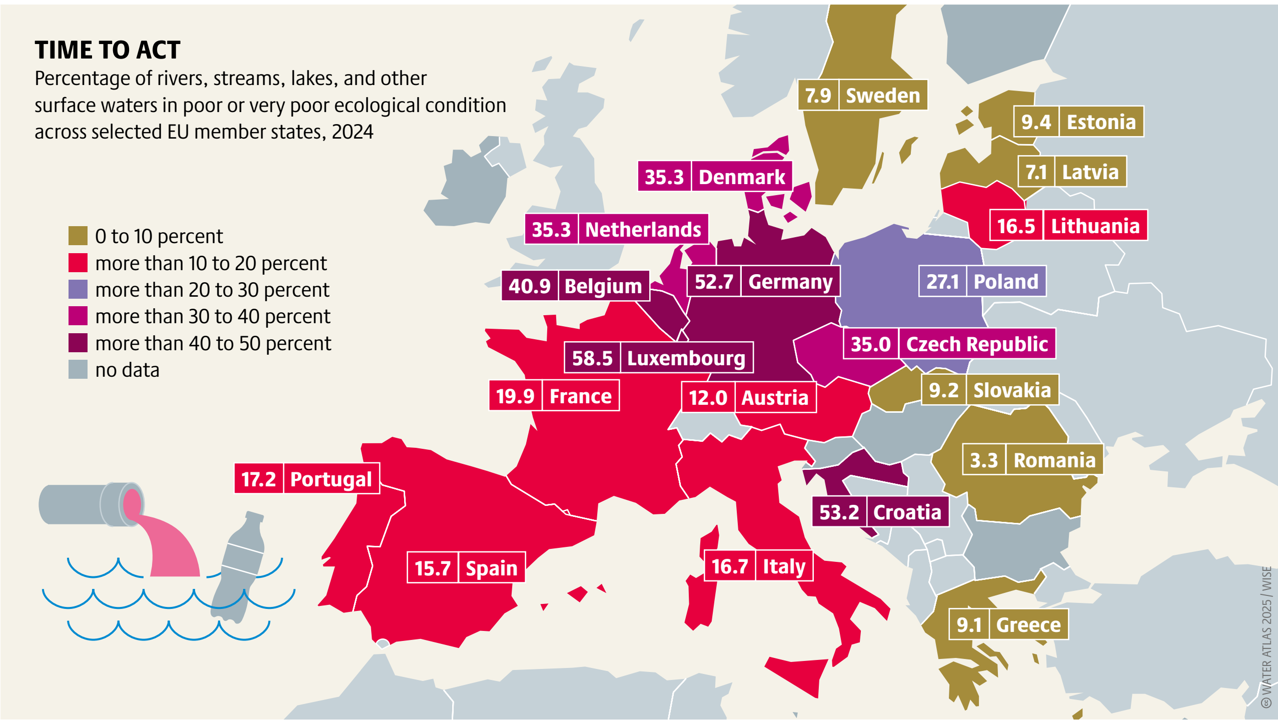
As concluded by the fitness check evaluation of the EU water policy, the WFD does not need to be rewritten – it needs to be implemented and enforced. That is the foundation for water resilience, and for protecting citizens against floods and droughts, to safeguard drinking water, and ensure food security. The tools are already in place.

FOR EVER AND EVER

Contamination in Europe with industrial chemicals from the PFAS (per- and polyfluoroalkyl substances) group, 2023



PFAS contaminate over 17,000 hotspots in Europe: persistent chemicals threaten water, health, and the environment, calling for stricter regulation



Fewer than 40 percent of surface waters in the EU are considered healthy. Policymakers must take active steps to protect them

What is needed now is political will, legal rigour, and sustained investment. This could turn 2027 into a launchpad for a new implementation phase, one focused on delivery, accountability and ecological recovery.

Another opportunity to repair the damage from the past is offered by the recently adopted Nature Restoration Regulation (NRR). This landmark piece of legislation aims to halt and reverse biodiversity loss across the EU and sets legally binding targets for restoring ecosystems – especially wetlands, peatlands, rivers, forests, grasslands, and marine environments. Member States must draw up national plans to restore at least 20 percent of the EU's land and sea areas by 2030, and all degraded ecosystems by 2050. A key element of the law is the restoration of natural processes, such as rewetting peatlands or reconnecting rivers with floodplains, which also contribute to climate mitigation and adaptation. The law reflects a growing recognition: healthy ecosystems underpin food security, water quality, flood protection, and climate resilience. As part of the European Green Deal and EU's Biodiversity Strategy for 2030, the Nature Restoration Law marks a major shift from conserving what remains to actively restoring nature at scale. It must be implemented in concert with the WFD and other nature laws.

New geopolitical and economic pressures are looming – from the EU's industrial competitiveness agenda to the demands of the energy transition – and they may test the strength of Europe's environmental laws. As Member States ramp up investments in hydropower, mining of critical raw materials, and infrastructure, there is a real risk that WFD safeguards may be weakened in the name of flexibility or expediency. Protecting the Directive from such pressures is crucial. Water resilience must remain central to the EU's broader policy direction. This will also influence the EU's standing globally, since both the WFD and NRR serve as models for water governance and nature restoration worldwide. ●

Numerous laws and initiatives exist to protect water resources. What is needed is consistent enforcement

WATER FOR TOMORROW

Selected water protection programmes

- worldwide
- European Union (EU)
- national examples

Australia's **National Water Initiative** uses water trading and limits to ensure fair use, while South Africa's **Water Act** protects ecosystems and ensures equitable access amid scarcity

The United Nations could negotiate a binding **water agreement** at its 2026 and 2028 Water Conferences, covering all aspects of the Sustainable Development Goal "Water and Sanitation for All."

The **EU Water Framework Directive** requires Member States to restore rivers and floodplains and reduce pollutant inputs. The goal: achieving good status for all water bodies by 2027.

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TURNING THE TIDE

Water is becoming scarcer in Colombia, and pollution is rising. Community water management offers a solution: it allows communities to take control of their water, make decisions collectively, and prioritise sustainability and equity. Could this democratic alternative be a chance to manage the world's water challenges?

Thanks to its geographical location, varied topography and range of climatic zones, Colombia is one of the wettest countries in the world. Over 3.2 million Colombians living in rural areas are without access to safe drinking water. Over the past 170 years, Colombia's glaciers have shrunk by 90 per cent, and large areas of the high-altitude paramos have been lost due to the climate crisis and the expansion of mining and energy activities into ecologically rich regions. These declines pose a huge risk because the glaciers and the páramo ecosystem store water and regulate the water cycle, making them very important for the water supply to the population living at lower altitudes.

Water is either scarce or polluted in numerous places across Colombia. The Bogotá River is highly contaminated by wastewater; the Atrato River is polluted by illegal mining; and the Medellín River is fouled by commercial and industrial effluent. The Magdalena – the country's largest river – and the tributaries of the Amazon and Orinoco, which supply water to Colombia's most vulnerable people, are also poorly managed.

The government's approach to water access has largely been business-oriented. Public utilities are required to recover their costs through tariffs and to prioritise profitability. Their relationship with users is treated as a commercial arrangement, rather than water being seen as a right – even though the constitution requires the state to guarantee access to water.

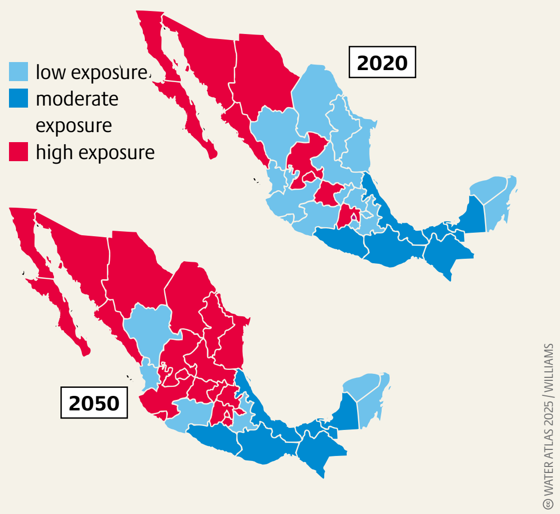
Community water management offers an alternative. In this model, local communities play a central role in water management, making decisions and ensuring water supplies. This work is typically organised through village-level community action boards or user associations, which operate independently of state or private utility providers. The community organisations hold open assemblies where users make decisions collectively. They set priorities, agree on rules for water use, set tariffs based on solidarity principles, and organise the maintenance and protection of infrastructure. This model emphasises local knowledge, trust and accountability. It often includes environmental stewardship as a core principle.

In Usme, a rural district of Bogotá, several community water systems are managed by residential user associations. These associations ensure fair and continuous access to water through voluntary labour, shared responsibilities and democratic governance. Decisions are made in general assemblies, and much of the infrastructure is maintained through collective work efforts known as mingas. Similar community-led initiatives exist throughout Colombia. These networks support each other through knowledge exchange, legal assistance, and advocacy at the national level.

Those who benefit most from this model are rural and peri-urban populations, who are often excluded from conventional water services. Community management guarantees access to water in areas where powerful private actors claim land in pursuit of profit, and where the state has historically failed to provide public services. The community water groups do not just offer access to water; they also empower communities, strengthen their autonomy, foster social cohesion, defend common property against those seeking private gain, and promote sustainable water use.

RUNNING OUT OF WATER

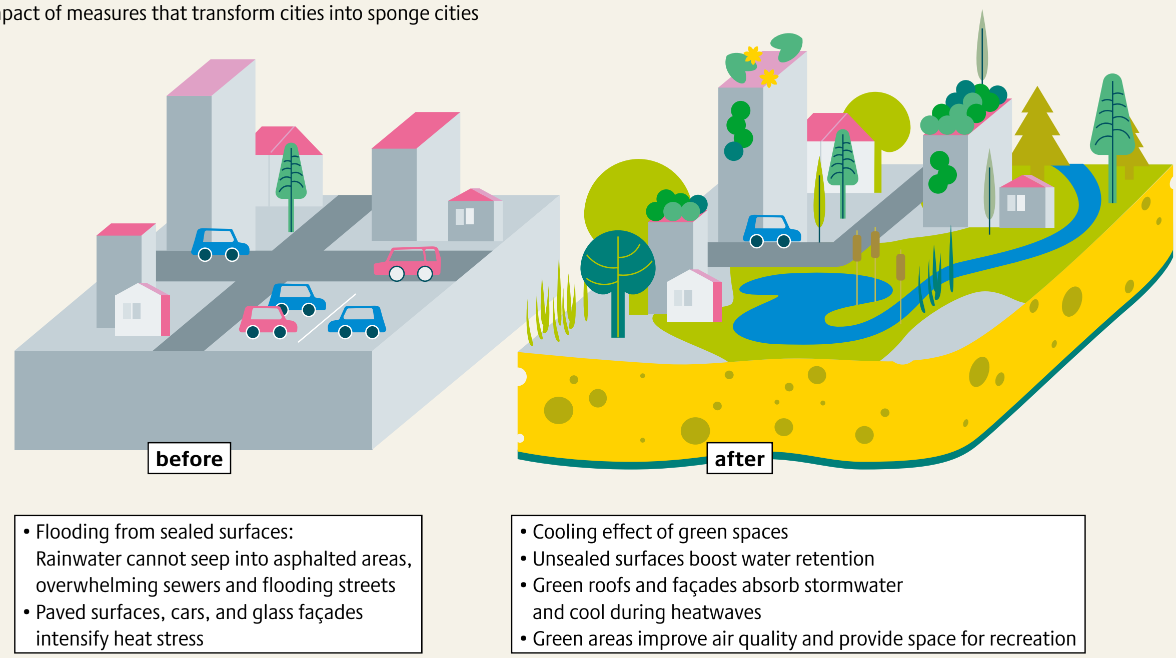
Exposure to water scarcity in Mexico



57 percent of the Mexican population lacks safe supply, 105 of 653 aquifers overused, sparking protests and becoming an election issue

SOAK IT UP

Impact of measures that transform cities into sponge cities



Extreme weather causes over 200 billion US dollars in global financial damage each year. Urgent adaptation measures are needed to protect cities

Many community water managers have taken the lead in defending the environment against extractive industries. In Tasco, a town in the department of Boyacá in central Colombia, community water groups managed to stop the expansion of coal mining. They are now demanding compensation for the environmental damage the mining has caused. The National Network of Community Aqueducts, an organisation with nearly two decades of experience advocating community-based water management, is at the forefront of developing and defending legal and public policy to protect water as a public community good.

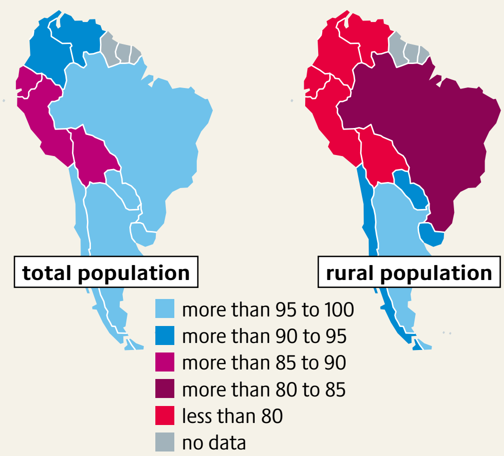
Community water managers have deepened their collaboration and developed a shared strategy. Their Water Mandate is a joint proposal that calls for water to be treated as a common good. It promotes the democratic governance of the commons and supports a holistic, long-term approach to water management. It advocates for the government to recognise the autonomy of communities, support and respect them, and provide investment and technology transfer.

The Water Mandate is based on four key principles. First, it challenges the notion that human rights are neutral or disconnected from the way water is governed. Second, it calls for an end to fragmented, sector-specific approaches to water supply and environmental management. Third, it promotes the re-democratisation of water governance as essential for the realisation of fundamental rights. Finally, it affirms the right of communities to manage water in their own areas and to use it to meet their basic needs. By doing so, community-led water governance stands as a credible alternative to market-based models – one that prioritises equity, participation and long-term sustainability. ●

In South America, access to safe water and sanitation varies by income and region, with millions lacking even basic sanitation facilities

A MATTER OF CLASS AND LOCALITY

Access to healthy drinking water in South America, in percent



SOLUTIONS

CULTIVATING WATER

Returning the land to nature and agriculture that restores the soil can create so-called climate landscapes that are able to soak up carbon and water. That helps against droughts and floods, promotes biodiversity, and cools the climate. It also maintains the local and regional water cycles that sustain life on Earth.

Imagine Earth as an enormous living being, its rivers and the groundwater beneath our feet become its arteries and veins. They regulate the planet's metabolism. The soil is the Earth's skin. Trees and other plants are like sweat glands – they release water through evaporation, which cools the land surface. But these water cycles are threatened by the destruction of intact landscapes. Deforestation, monocultures, soil degradation, river regulation, and the degradation of peatlands lead to the loss of fertile soils and natural vegetation. Climate scientists have long sounded the alarm about global tipping points. The disruption of water cycles by soil degradation and the loss of natural vegetation may constitute a tipping point, one that irreparably damages vital processes that make large parts of the world green and habitable.

Such a tipping point can be averted through decisive action. More vegetation and fertile, humus-rich soils could cool and revitalise entire landscapes. Water can literally be cultivated. Plants consist mainly of water, and their leaves transpire enormous amounts of moisture, which then becomes part of the water cycle again. On a summer's day, a single large tree transpires several hundred litres of water, generating as much evaporative cooling as two air conditioning units.

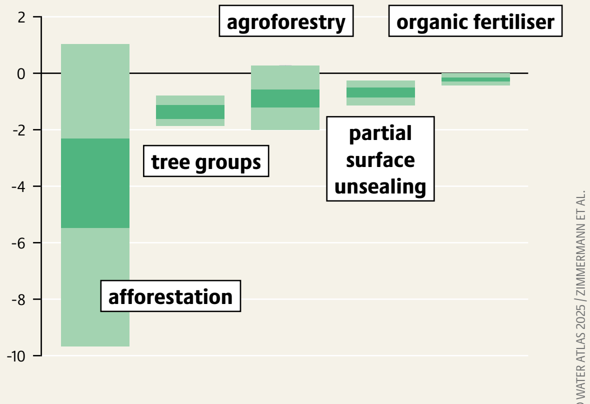
This can work only if the rain that falls can soak into the soil and can stay there for as long as possible. The key to this is slowing down the water cycle. Rivers and streams that have been straightened, obstructed, or canalised must be permitted to meander and overflow their banks once more. In cities, as much of the surface as possible should be freed of concrete and asphalt to let rainwater seep in. The richer the soil is in humus, the better: the more water it can store.

In farming that means keeping the soil surface covered to protect it from evaporation and erosion. One way to do this is by undersowing: sowing a second crop a few weeks after the main crop; this undersown crop will cover the soil after the main crop is harvested. Other possibilities are planting cover crops, avoiding ploughing, and applying compost. Agroforestry, which integrates trees and hedges into fields, can build up the soil, slow down the flow of water, and store it. These measures have huge effects: areas planted with trees can cool their surroundings by several degrees, break the wind, and increase biodiversity by providing habitat for birds and insects. Planting trees and shrubs can even increase the total output by producing wood, berries, and nuts that can be harvested.

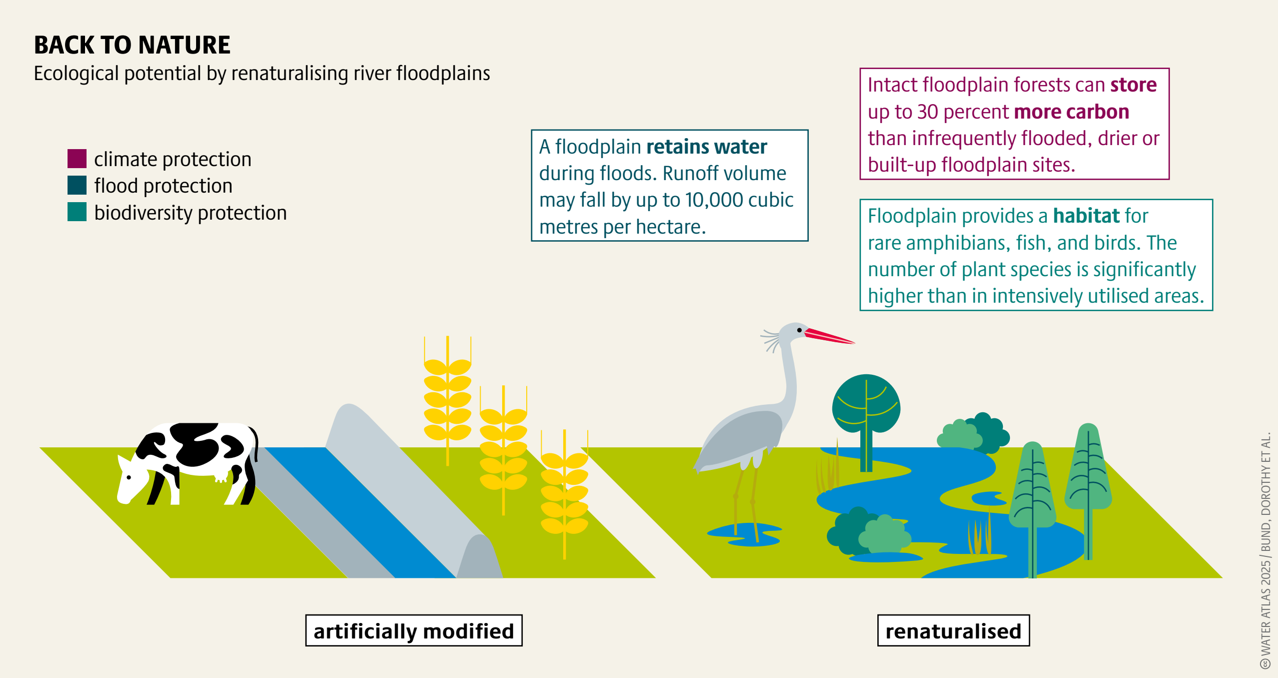
Natural climate protection has huge potential to restore disrupted cycles and reverse environmental damage. The renaturation of just 15 percent of global ecosystems could prevent 60 percent of species extinction as well as help stop around 300 gigatonnes of the greenhouse gas carbon dioxide (CO_2) from being released into the atmosphere. But such measures can only help tackle the climate crisis if other climate actions are also implemented. Carbon storage projects cannot replace the phase-out of fossil fuels.

Protecting and rewetting peatlands should be given priority. Around 95 percent of Germany's peatlands have been artificially drained for agriculture, forestry, and peat extraction. Renaturing the four million hectares of wetlands that have lost their natural functions

NATURAL AIR-CONDITIONING
Effect of climate adaptation measures on ambient temperatures, range, degrees Celsius



The climate crisis is bringing severe heatwaves. Planting trees and greening roofs could lower temperatures and make cities more liveable

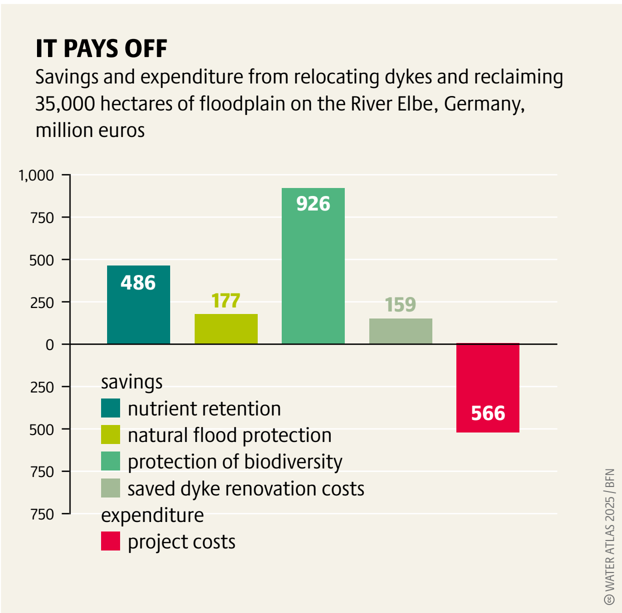


Near-natural floodplain landscapes boost biodiversity, help mitigate climate change, provide natural flood protection, and are popular recreational spots

as a result of human interventions would enable them to store between 100 and 400 gigatonnes of CO_2. The figure of 400 gigatons is roughly ten times the current annual global greenhouse gas emissions. Renaturation also has a positive effect on species protection and water storage. The rewetted peatlands could still be used for agriculture. Paludiculture possibilities include grazing by water buffaloes or growing reeds for use as building materials.

Regenerated water cycles, more vegetation, and fertile soils can revitalise whole landscapes to adapt to the climate crisis. Examples are restored forests, meadows, wetlands, arable land which integrates agroforestry, and rewetted peatlands. And last but not least: sponge cities, where unsealed surfaces absorb rainwater and so prevent flooding, and where greened rooftops cool the microclimate. A 2024 study has revealed that forests in the eastern United States cool the land surface by 1 to 2 degrees Celsius annually, and by 2 to 5 degrees Celsius at midday during the growing season. Young forests between 20 to 40 years old have the strongest effect. This cooling also lowers near-surface air temperatures by up to 1 degree Celsius compared to nearby non-forest areas. Analyses of historical land cover and temperature trends show that areas surrounded by regrowing forests were up to 1 degree Celsius cooler than nearby regions without land cover change.

Developing such climate landscapes requires a clear and reliable political framework. Agricultural businesses that specialise in paludiculture require planning security and financial incentives. At the same time, value chains must be developed that involve the construction industry, for example, and that promote the sale of sustainable products made from peatland plants such as reeds and peat moss. That would restore water cycles, sequester carbon, cool the Earth and allow biodiversity to flourish. In turn that would create valuable spaces for humans, plants, and animals alike. ●



Renaturalised floodplains bind and break down nutrients such as nitrogen. In the long term, this reduces the overall costs of water purification

TO READ AND STUDY

AUTHORS AND SOURCES FOR DATA AND GRAPHICS

All online links were last checked in October 2025. See page 2 for the websites where you can download a clickable PDF of this atlas. Lengthy links have been shortened using the bit.ly web address conversion service.

10–11 BASIS OF LIFE

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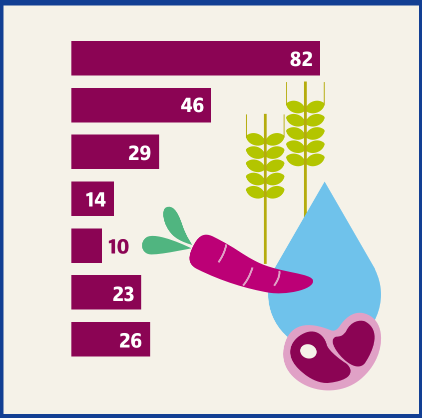

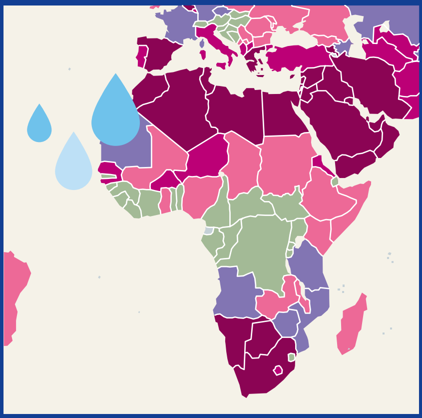

Due to the climate crisis, the oceans are warming and the ice is melting.
Extreme weather events such as droughts and floods are becoming more frequent.
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Over 2 billion people lack access to safe drinking water.
Those most affected are the most socially vulnerable.
from: WATER FOR ALL, page 12

Globally, agriculture accounts for 72 percent of water usage.
Meat has a significantly larger water footprint than a plant-based diet.
from: DRYING OUT, page 26

Action required: Across Europe and the world, most rivers, streams,
lakes, and groundwater are not in a good ecological condition.
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