GO WITH THE FLOW

Losing a lake: The Laguna de Aculeo in Chile used to be a popular getaway destination for water sports enthusiasts from the country's capital Santiago, which is about a two-hour drive away. But the lake has been dry since 2018 because of an unusually long period of drought and excessive water consumption in the region

More and more often, entire regions are drying out—while other regions are being devastated by catastrophic floods. The uneven distribution of water is facing the human race with problems that were previously unimaginable. Good management and technology adapted to local needs can help in the search for a solution

TEXT **TIM SCHRÖDER**

The grass has dried up. A few ragged straws sway in the wind. The cattle breeders in the Magellan region of southern Chile are desperate. “The wind is getting stronger and drying everything out, and the grass isn’t growing. This is the drama we’re experiencing,” they say. Here the fjords cut deep into the land. Some are covered with ice. The strong winds that are typical of this region are worsening the problem of sparse rainfall. In this region, 2022 was the driest year in more than half a century. There has been practically no rain this year either. Now the farmers no longer know how they can help their animals survive the winter without water.

The southern tip of South America is not the only place where weather anomalies are accumulating. Exceptions are becoming the rule. For example, the island of San Biagio in Lake Garda in Italy is normally completely surrounded by water. But this spring local people and vacationers were able to walk to it without getting their feet wet for the first time in decades. That’s how low the water level had sunk in this lake, which is beloved by tourists, after months of extreme drought. Bodies of water are drying up in France and Spain as well. In May the Emilia Romagna region of northern Italy was suddenly hit by torrential rains. More than 20 rivers overflowed their banks and surged in the form of mudslides through villages and towns.

Similar disasters are happening in Asia and North America. Last year large regions of Pakistan were under water for several weeks after extremely severe monsoon rains. After three years of drought in California, so much rain fell this winter that there were floods in many districts. By contrast, in other regions it was unusually dry. Immense forest fires recently flared up in Canada. Their plumes of smoke could be measured as far away as western Europe. Today many scientists are saying that we have entered the Pyrocene epoch—the age of fire. However, the droughts and fires are basically developing this devastating force only because water is becoming increasingly scarce.

The situation is complicated. In some places there is too much water, in others not enough—and climate change is exacerbating this distribution problem to extremes. According to the Secretary-General of the United Nations, António Guterres, this situation is making the reliable and equitable supply of water an increasingly important task for mankind. “As humanity’s most precious global common good, water unites us all,” he said at the United Nations’ Global Water Conference in March of this year. “That’s why water needs to be at the centre of the global political agenda.”

However, focusing only on water will not be sufficient, emphasizes the hydrologist and UN consultant Johannes Cullmann. “Climate change is always a process of water change as well,” he explains. After pointing to the indissoluble connection between water issues and climate change, the topic that has so far been a stronger focus of public attention, he sounds an alarm: If the decision-makers still want to get the water crisis under control, they cannot wait as long as they did in the case of the measures against greenhouse gases (see the interview starting on page 32).

Power struggles: The Grand Ethiopian Renaissance Dam in Ethiopia, which holds back the Blue Nile, has stirred up conflicts downstream with Sudan and Egypt. The first turbines of the associated power plant went into operation at the beginning of 2022

THE ANOMALY OF WATER

The volume of freshwater decreases down to a temperature of 4°C. That is its point of greatest density. If it is then either heated or cooled, its density decreases. That’s why the temperature at the bottoms of lakes is about 4°C all year long, as a rule. Materials normally reach their greatest degree of density in a solid aggregate state

FRESHWATER IS BECOMING INCREASINGLY SCARCE

But where should we begin? The earth actually has vast reserves of water. Experts estimate that the global volume of water amounts to about 1.5 billion cubic kilometers. However, only about 2.5 percent of that amount is freshwater, and the biggest proportion of it is inaccessible. Just over two thirds of the freshwater is stored in glaciers in Greenland, the Antarctic, and other regions. Most of the remaining third is groundwater that lies so far under the earth’s surface that it would be practically impossible to use it. Ultimately only about 37,000 cubic kilometers of renewable drinking water from rivers, lakes, and natural aquifers near the earth’s surface are available to mankind (see the infographic on page 22).

And this amount is decreasing. That’s because huge quantities of freshwater are lost year after year when they flow into the world’s oceans without being replenished by corresponding reserves in the form of snow, ice or groundwater close to the earth’s surface. Besides, the distribution of freshwater is extremely uneven. The inhabitants of arid zones in Africa and Asia have long been familiar with water scarcity. By contrast, the citizens of most industrialized countries in temperate climate zones have so far not had to deal with the question of where they get their water, as a rule. In these countries people are used to simply turning on the faucet to get a drink of water, take a shower or water the garden. But this situation is changing. A study conducted by the European Environment Agency (EUA) concludes that today 30 percent of Europeans are already directly affected by water stress in an average year.

This finding is obviously connected with climate change and the warming of the earth’s atmosphere. Additional anthropogenic factors are aggravating the situation. At the United Nations’ Global Water Conference, many experts pointed out the bad water management in many regions of the world. Often not enough money is being invested—or the financing flows into exactly those water management measures that ultimately →

Extreme weather: Floods that pose an existential danger to human beings are increasing in frequency all over the world. For example, unusually heavy rainfalls in India in 2019 caused at least 200 deaths and left about a million people homeless

Green fee: Golf players in Las Vegas are still free to play their sport. However, this casino metropolis in the Mojave Desert in the USA recently began to strictly regulate water consumption. Activities that waste water are penalized with fines

The turbines of the associated hydropower plant produce 1,260 megawatts of electricity, covering more than half of Sudan's power supply.

In addition, plans call for water to be channeled into the surrounding region through a canal system several hundred kilometers long so that agriculture can be practiced there. The project led to several thousand people losing their homes without receiving any compensation—but that's not all. Because of the gigantic surface of the reservoir, enormous volumes of water have been lost through evaporation ever since the dam was built. In addition, nutrient-rich sediments that would normally flow downstream and provide the farmers there with natural fertilizer are now accumulating in the reservoir. Structures such as the Merowe Dam and the Grand Ethiopian Renaissance Dam, which is just now going into operation in Ethiopia, always lead to tensions between the countries along the Nile, especially in periods of drought when the water becomes scarce. The situation along the Mekong River in Southeast Asia is similar.

WHEN RIVERS RUN DRY

All too often, the water supply is not comprehended as a system, says Lars Ribbe, a professor of spatial development and infrastructure systems at the Cologne University of Applied Sciences. Even today, in dry regions such as Burkina Faso and Mali people are digging wells without knowing how much groundwater will be replenished. The wells often dry up after a short period of time because the natural aquifers are emptying. Conversely, in some mountainous regions in South America highlands and forests are being overused and destroyed by herds of cattle. The damage affects crucial headwaters of streams and rivers that the inhabitants of villages and cities in the valleys depend on. "We need integrated water management that takes all of these factors into account. Above all, we have to regard water management as part of the overall technical and natural water cycle," Ribbe emphasizes.

Conflicts regarding water are also breaking out more and more frequently in industrialized countries as well. For example, in the state of Brandenburg in Germany, which has very little rain, a dispute over groundwater has been raging between the automaker Tesla and the local population ever since Tesla presented its plans for building a "gigafactory" just outside Berlin. The factory needs so much water that the region's permitted water supply rate is being drastically exceeded. Environmental organizations took legal action against the plan, with partial success. The factory's purified wastewater is also a focus of attention, because it could adversely affect the supply of drinking water in the Berlin metropolitan region. Other German industrial companies with high levels of water consumption are also subject to the criticism that their activities are having a negative effect on the groundwater.

THE SCENT OF RAIN

When rain falls on dry soil, it generates a typical scent that is known as "petrichor." This term was coined by researchers in the 1960s. The scent is carried by oils that are released by plants during dry spells and by geosmin, a substance produced by soil bacteria

harm the overall system. Asit Biswas, a water expert at the Lee Kuan Yew School of Public Policy in Singapore, says that the latter problem is much more serious than scarce financing. "Lack of money, scarcity, and so on—of course all of them are excuses," he says indignantly. "Everywhere, the problem is bad management."

That's because today many countries are still primarily relying on megaprojects involving steel and concrete in order to supply their populations with drinking water and water for agriculture—by means of dams, for example. In the process, the responsible governments often think in terms of very national categories. One example of that is the construction of the Merowe Dam across the Nile in Sudan, which was completed in 2009.

Breakaways: Calving is a normal process for icebergs in the polar regions, like this one in western Greenland. Nonetheless, researchers are concerned, because the total ice mass is continuing to shrink—a process that is gradually causing a rise in sea levels

"Everywhere, the problem is bad management"

ASIT BISWAS, A WATER EXPERT AT THE LEE KUAN YEW SCHOOL OF PUBLIC POLICY, SINGAPORE

In regions where sufficient water was available in the past, water scarcity is leading to problems that were previously unknown. For example, in the summer of 2022 the water level of the Rhine sank so low that many ships could no longer pass through the river's shallowest stretch, which is near the famous Loreley rock. The Rhine is one of Europe's most important trade routes. For many companies, droughts of this kind mean that they can no longer transport their goods—but there's more. When the water level is low, industrial companies along the river must reduce the amount of water they use to cool down production facilities, for example.

Today Germany still does not have nationwide rules regulating how water is to be distributed in times of drought—simply because so far there has always been enough water. The German government has now, for the first time, drafted a "national water strategy," which would establish priorities regarding who may use how much water in the event of a future crisis. That also applies to agriculture, which currently needs much less water than the energy and industrial sector, and to private households, whose consumption of groundwater is rapidly increasing, especially during dry years. "If periods of drought and water scarcity continue to increase in Germany, we will need comprehensive water balances, which will be used to jointly manage the consumption of drinking water and the needs of industry and agriculture," says the Cologne water expert Lars Ribbe. →

CACTUSES INSTEAD OF ROLLED TURF

Examples from all over the world show what can be achieved even in the short term through good water management. For instance, in 2018 the inhabitants of Cape Town in South Africa were facing "Day Zero" after four years of drought. The water reserves in the major reservoirs had been completely used up. For certain periods of time, water consumption was limited to 50 liters per person per day. In addition, Cape Town residents were asked not to get their drinking water directly from the faucet but to fetch it from rivers and springs in the surrounding region. The price of water was also drastically increased in order to encourage private individuals and businesses to conserve water. Thanks to all of these measures, it was ultimately possible to avoid Day Zero.

The city of San Diego in southern California also succeeded in noticeably reducing water consumption by means of incentives and prohibitions. The city pays its residents subsidies if they switch to drought-resistant plants in their gardens. It also promotes water-conserving shower heads. Lawn watering is permitted only on two days per week. Furthermore, the city has set up an advice center that offers information about water management—for example, how to install cisterns for collecting rainwater and why it's worthwhile to switch on the short cycle of a washing machine. The city as a whole now consumes a third less water than it did before. A large seawater desalination plant ensures that the demand for water is reliably covered.

For many countries and regions, desalination plants are the most important technology for providing people with freshwater. In view of the gigantic reserves of seawater on the earth, they represent an obvious solution. At the same time, in many areas they are worsening the climate crisis. One example of that is Dubai. Today it has the world's largest desalination plant, which produces two million liters of drinking water per day—an amount that could cover the requirements of five large cities such as Berlin. However, the plant consumes vast quantities of oil and gas, thus making a huge contribution to CO_2 emissions, which in turn worsen the water problems in the long run. Only a small percentage of these plants worldwide are operated with electricity from renewable sources.

"HARD" OR "SOFT" MEASURES?

Moreover, these plants are extremely expensive. As a result, Singapore in Southeast Asia is relying only partially on seawater desalination. Almost five million people live in this city-state in an area smaller than the city of Berlin. In order to supply them with drinking water, Singapore has taken an unusual approach. In a three-step process called Newater, drinking water is extracted directly from wastewater. First, bacteria are removed from the pre-cleaned water by means of ultrafiltration. Next, reverse osmosis is used to remove tiny impurities such as viruses. In the third step, the water is disinfected with UV radiation.

For poorer countries, high-tech solutions like this one will continue to be prohibitively expensive. And in countries with low population densities, where many people live in small villages, central water treatment plants can be ruled out from the start. These areas have a smaller need for "hard" technology and a much bigger one for "soft" measures that supply people with water. In Ecuador, for example, with support from the environmental protection organization The Nature Conservancy it was possible to protect the catchment areas in the highlands and the mountain forests by organizing a round-table discussion between cattle owners from the mountain villages and residents of the towns in the valley. Together, the discussion participants decided to plant trees in the mountain forests from which the springs and riv- →

DENSE ICE

Researchers in England have created ice at a temperature of about -196° that is almost as dense as water. The water molecules in this ice do not lie in the orderly patterns of crystals, but instead are in a state of disorder, or amorphous. Experts assume that water in space generally occurs in an amorphous form

Switched off: In 2018 the reservoirs that supply water to the metropolis of Cape Town in South Africa were at risk of drying up. The city's residents were asked to use water from springs and rivers in the city's outlying districts

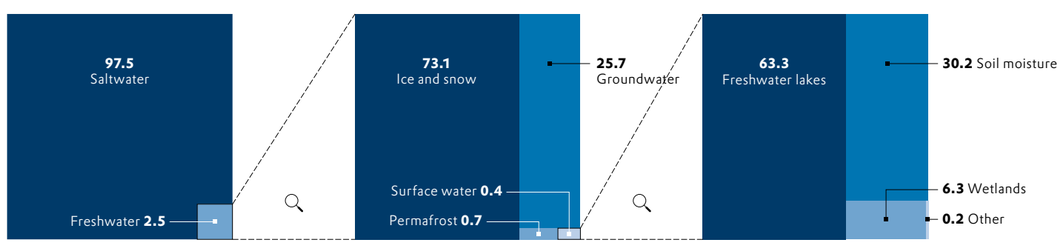
Thirsty work: Agriculture is the sector that consumes the largest amounts of water all over the world. The production of about a kilogram of cotton requires as much as 1,200 liters of water

THE WETTEST PLACE ON EARTH

The place on earth that receives the heaviest rainfall is Mount Wai'ale'ale on the island of Kaua'i in the Hawaiian Archipelago. On the eastern flank of this volcano, it rains on 335 days per year on average. About 12,000 millimeters of precipitation per year fall on every square meter of the mountain—compared to 800 millimeters in Hamburg

A SCARCE COMMODITY

The total volume of water on the earth is estimated to be just over 1.3 billion cubic kilometers. Freshwater that is available to humans is only a tiny fraction of this amount. All figures in percent



Source: USGS

Fire alert: On account of continuing drought, unusually large forest fires raged in British Columbia this summer. Simultaneously, rapid snowmelt caused several rivers in the southern part of this Canadian province to overflow their banks

ers draw their water. In addition, the cattle grazing was spread out more thinly. To compensate for this measure, the villages and towns are imposing a tax to help finance the cattle owners in the mountain region.

PARTICIPATION CREATES RESPONSIBILITY

Many people could benefit from good water management, says Philipp Günter from the German aid organization Misereor, which has already supported many projects in Africa and Latin America. "Over the years we've discovered that water can be a connecting element between people," he reports. When a village community works together to build cisterns for collecting rainwater to use in dry periods, small dams or a well, that strengthens its sense of solidarity. "The challenge consists of keeping the infrastructure going over a period of many years," Günter says, adding that part of the challenge is for the local people to participate in the financing and organization of the water project so that they feel responsible as a community.

Keeping an eye on the environment, technology, and people at the same time—that's still the real challenge facing water projects. And that's the factor that has sometimes been lacking in many countries, says Lars Ribbe. "There are still far too few water experts who are trained in this kind of networked thinking."

It's true that the overarching framework was already defined at the political level for a long time ago. In 2010, the General Assembly of the United Nations declared that "access to safe and clean drinking water" is a fundamental human right. But it won't be until the upcoming global climate conference in Dubai at the end of this year that water security is moved to the center of the global climate protection agenda—more than 40 years after the nations of the world met together for the very first time for a climate conference. —

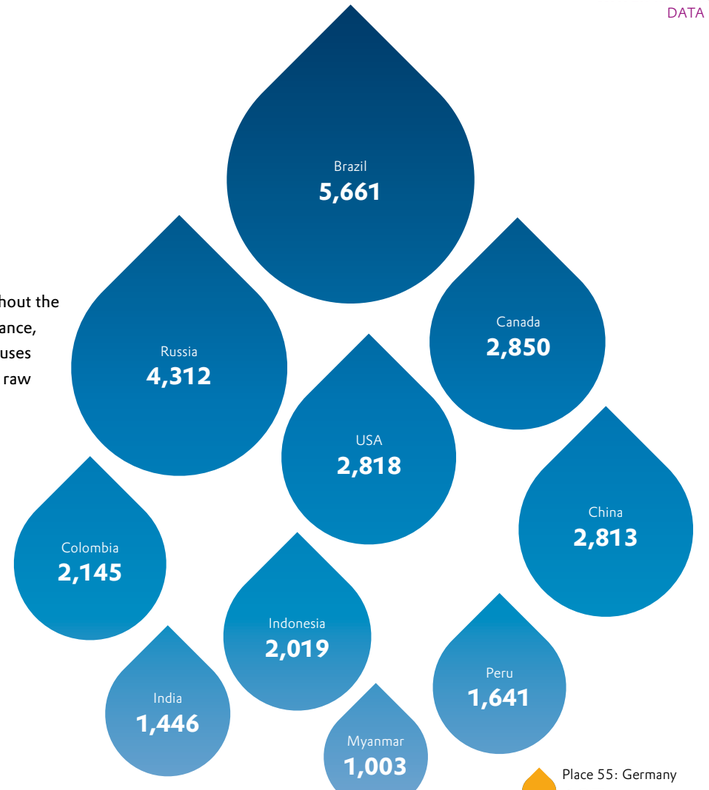
Tim Schröder is a science journalist who lives in Oldenburg

PRECIOUS WATER

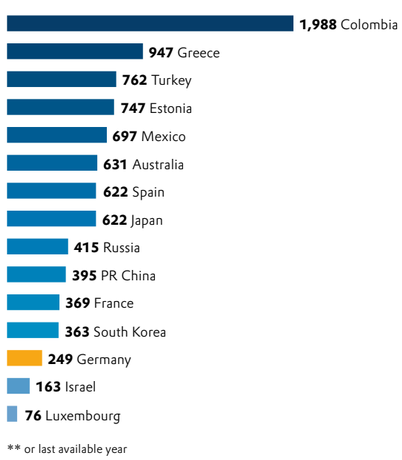
Water is distributed extremely unequally throughout the world. Where is this resource available in abundance, and where is it scarce? Who wastes it, and who uses it sparingly? And how much does this important raw material cost? A numerical overview

INFOGRAPHIC **MAXIMILIAN NERTINGER**

Water in abundance
The ten countries with the biggest reserves of renewable freshwater* in 2020, in billions of cubic meters (compared with Germany)
* Balance of rainfall, evaporation, inflows and outflows

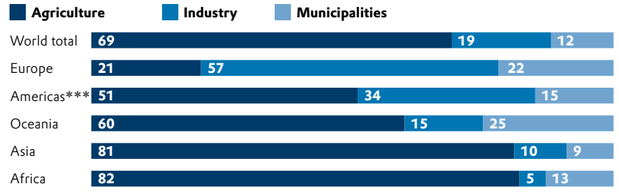


Wasting or saving
Annual per capita water consumption of selected countries in 2021**
in cubic meters



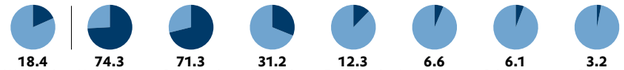
** or last available year

Thirsty agriculture
Water consumption by sector and continent
2015, in percent



*** North and South America

Where the water stress is highest
Proportion of the water abstracted from renewable water sources
2018, in percent



Various calculations
The price of tapwater in selected cities
in 2020, in € per cubic meter

Sources: OECD, FAO, World Bank, holidu.de