# TROUBLED WATER

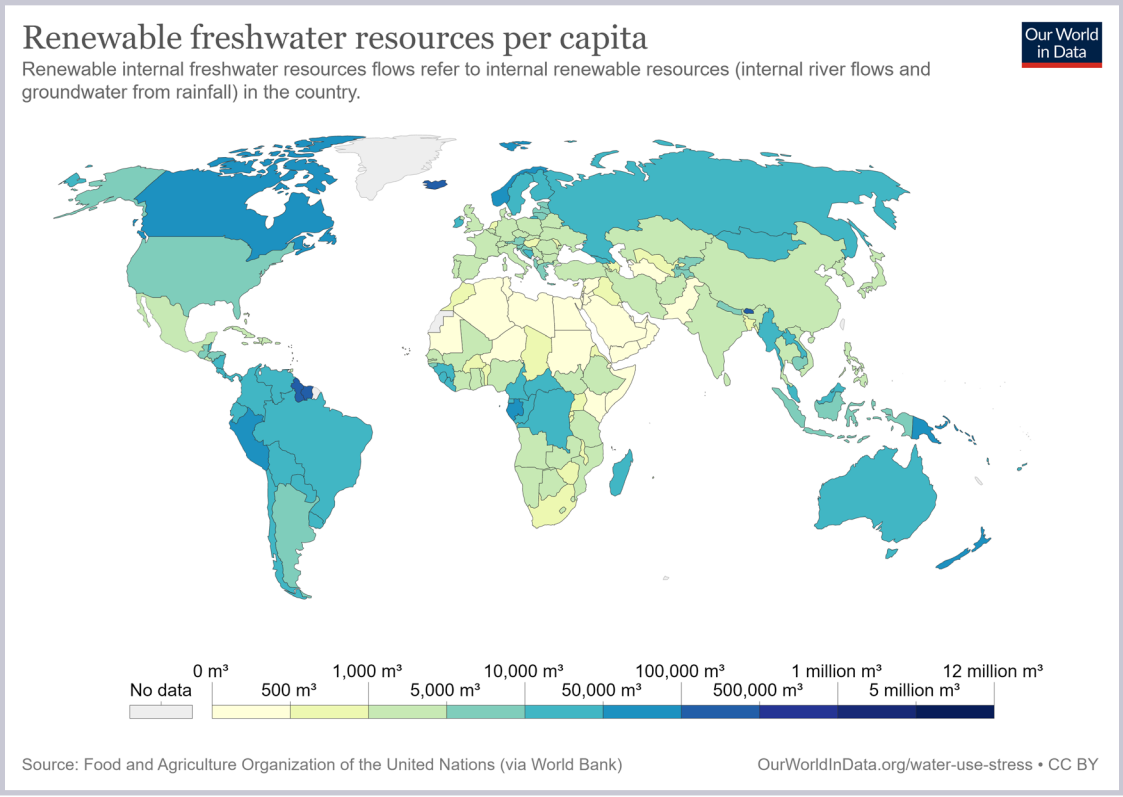
**background reading | water resources unit**

EARTH matters
Studies For Our Global Future

Many people take for granted that a clean, plentiful water supply will always be available. Unfortunately, over-consumption and pollution pose dire threats to this critical life support system. While having clean water is one of the most basic human rights, 1 in 10 people still do not have access to safe drinking water and half the world's population live in water-stressed areas. According to the UN Environmental Program, "In almost every region, population growth, rapid urbanization, rising levels of consumption, desertification, land degradation, and climate change have combined to leave countries suffering from severe water scarcity."[1]

## An unquenchable thirst

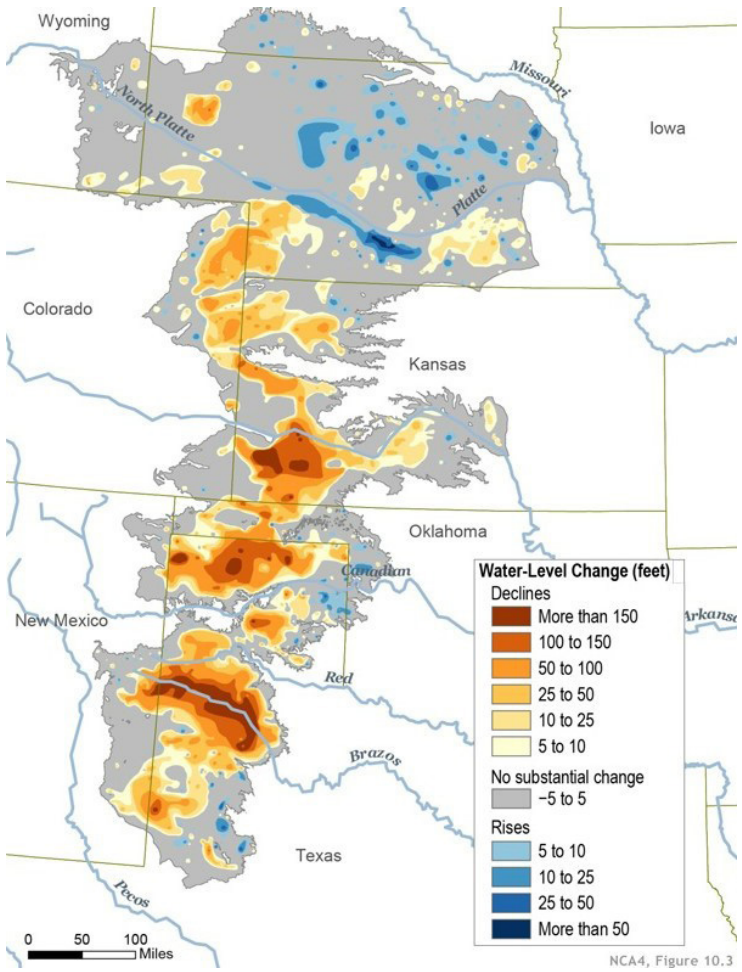
As the world's population grows, so does the demand for water. Over the past century, the world's population has quadrupled and use of water has grown by a factor of six.[2] Because many people live in arid regions, we have developed the ability to transport water and satisfy demands for water in many different ways. However, we have not developed adequate methods of insuring the best and most efficient use of this limited resource. According to the United Nations, 2.3 billion people lived in water-stressed countries in 2018.[3]




Why has water use been growing faster that population growth? Agriculture accounts for 70 percent of freshwater withdrawals.[4] Economic growth in many parts of the world has contributed to shifting diets away from predominantly starch-based foods to more meat and dairy, which require more water. Producing one pound of rice requires 420 gallons of water, while producing one pound of beef requires 1,800 gallons of water – four times as much. It is estimated that we'll need 60 percent more food to feed the expected global population in 2050.[5]

At the same time that demand for water is increasing, our supplies are diminishing. Most of the freshwater in the world (about 69 percent) is locked away in glaciers and icecaps.[6] The rest is found in **surface water** (streams, lakes, rivers, and wetlands) and in underground aquifers. **Aquifers** – underground layers of rock saturated with water that can be brought to the surface through natural springs or by pumping – supply over one-third of the water used by humans worldwide. They can take thousands of years to fill up and only slowly replenish with water from snowmelt and rain. NASA satellites show that more than half of the Earth's 37 largest aquifers are being depleted with more water being withdrawn than replaced over the past decade.[7]

**Great Plains' Ogallala Aquifer Drying Out**




Source: U.S. Global Change Research Program, Fourth National Climate Assessment (NCA4), 2018.

This map shows changes in Ogallala water levels from the period before the aquifer was tapped (about 1950) to 2015. Well outputs in the central and southern parts of the aquifer are declining due to excessive pumping and prolonged droughts, which are expected to worsen as a result of climate change.

In locations from India and China to the U.S. and France, aquifers have passed their **sustainable yield**. Beijing is home to over 20 million people and now gets much of its water from a reservoir 900 miles away. The Chinese government embarked on an ambitious project to divert rivers from other parts of the country to deal with a falling water table in the Beijing area. The Ogallala Aquifer, a vast **groundwater** reservoir under the Great Plains of the United States, supplies almost one-third of the U.S.'s agricultural groundwater and more than 1.8 million people rely on it for drinking water. The aquifer recharges far slower than water is withdrawn. In some areas the water table is dropping as much as two feet a year but recharge in the aquifer only averages about three inches annually.[8]

Surface water, too, is being depleted. One example of a strained surface water resource in the United States is the Colorado River. The amount of river water allotted by treaty to the seven U.S. states that draw upon this water supply (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming) and Mexico actually adds up to more water than flows in the river. Lake Mead, the huge reservoir on the Colorado River in Nevada, reached its lowest point recently from when it was initially filled in the 1930s.[9] In Central Asia, the Aral Sea (actually an immense lake) shrunk by more than 60 percent between 1973 and 2000 as rivers that supplied the lake were diverted for **irrigation**.[10]

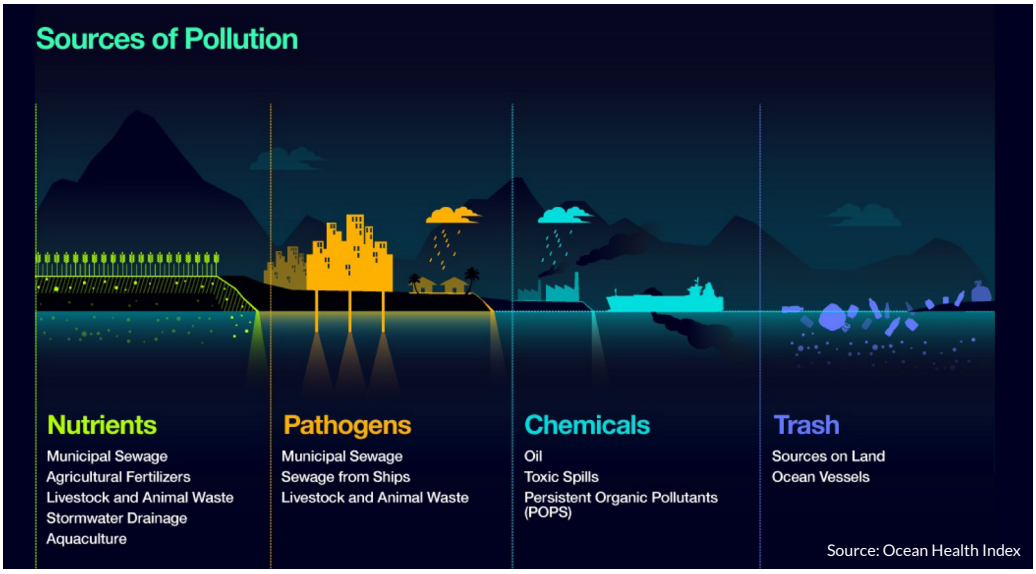
Aside from irrigation, water is used for manufacturing and food processing. **Hydroelectric** power plants use water to generate electricity. Nuclear power plants and other industries use water for cooling purposes. Water is used countless times each day by individuals for bathing, drinking, washing clothes and dishes, and flushing toilets. People in the U.S. withdraw about 322 billion gallons of water each day (both freshwater and salt water) for residential, industrial, and agricultural purposes.[11] Although per capita water use has decreased with improved

technology and water conservation in recent years, Americans still use more water, both in total and in per capita terms, than any other industrialized country in the world. An average resident of France, for example, uses about one-third the water of a typical resident of the U.S.[12]

Water supply is also being impacted by global climate change. In many regions of the globe, including the American West, the climate is becoming hotter and drier, leading to decreased rain and snow, with resulting drought. Western states have been in the midst of a drought for much of the 21st century, with climate change affecting the length and severity of dry conditions. From South Africa to Brazil to North Korea, extreme drought has been affecting agriculture, the economy, and households as water shortages become a fact of life.

## Muddying the waters

Pollution further compounds water shortages. Various human activities and water uses have degraded the nature and quality of the world's water supply. Polluted and poisoned by sewage, agricultural runoff and industrial wastes, water flows back into our streams, rivers, lakes, and oceans. Globally, 80 percent of wastewater flows untreated into rivers, lakes, and highly productive coastal zones.[13] Frequently these wastes pollute waters used for drinking and irrigation. As urbanization in **developing countries** increases, more people may be exposed to unsafe drinking water.




There are three main areas of water pollution: ocean pollution, groundwater contamination, and surface water contamination. Comprising 71 percent of the Earth's surface, the oceans receive most of the world's wastes. In recent years, unmanaged urban growth, coastal construction, intensive agriculture, offshore oil drilling, mineral extraction, deforestation, boating, overfishing, and acid rain have increasingly fouled the seas around us. The industrialized countries of the world now put more tons of trash into the ocean each year than they take out in tons of fish.

Another source of ocean pollution is spilled oil. Great attention was brought to this phenomenon in 2010 when the Deepwater Horizon, a British Petroleum rig, exploded in the Gulf of Mexico, releasing 4.9 million barrels of oil until the spill was capped three months later. The spill, considered to be the worst environmental disaster in U.S. history, caused extensive damage to marine and wildlife habitats, as well as to the commercial fishing and tourism industry along the Gulf Coast.

# A deadly drink

Groundwater and surface water contamination is also a grave concern throughout the world. In developing countries, **water-borne biological hazards** (bacteria, viruses, parasites, etc.) are responsible for high infant mortality rates. Parasites, resulting from water pollution or poor sanitation practices, are found in surface waters of many semi-arid countries. Microbiological agents and parasites can be contracted from swimming in polluted waters or from eating contaminated shellfish. Globally, diarrheal diseases caused by unsafe water, poor sanitation, and hygiene claim over 800,000 lives each year.[14] Millions more suffer from intestinal worms, **schistosomiasis**, and **trachoma**.

A woman draws water from a well in Rajasthan, India.

While water-borne germs are found mostly in less developed countries, developed nations suffer chemical pollution, which has emerged as a serious threat to all countries that have introduced industrialization and chemically-supported agriculture. Some organic impurities occur naturally, but inorganic contaminants of drinking water are usually the result of various industrial compounds discharged from manufacturing plants, small trade sources, and households. Underground toxic storage tanks, pesticides, toxic waste dumps, and septic tanks all pose serious threats to groundwater quality. For example, a single gallon of used motor oil that comes into contact with a source of **fresh water** can render 1 million gallons of that fresh water undrinkable.

As of 2016, more than 80 percent of the water in underground wells on the heavily-populated North China Plain were deemed unfit for drinking or bathing because of contamination from industry and farming. Ammonia, nitrites and nitrates are the major pollutants, with heavy metals and toxic organic compounds found in some areas.[15]

For the most part, drinking water in the U.S. is clean and safe to drink, thanks to the **Clean Water Act**, enacted in 1972. The Clean Water Act set water quality standards and limited contaminated discharges into U.S. waters. The Act is continuously being updated and is enforced by the U.S. Environmental Protection Agency. One threat to America's drinking water is crumbling infrastructure, as water pipes age and degrade. A high-profile water catastrophe hit Flint, Michigan in 2014-2015 when lead from aging pipes leached into the water supplied by the Flint River, exposing thousands of people to lead contamination and health risks. A landmark infrastructure law enacted in 2021 includes $15 billion to replace lead pipes across the U.S. This is especially urgent in historically underserved communities like Flint. Studies have shown that populations of color and low-income populations are more likely to live with aging and inadequate water infrastructure, largely because of residential segregation in the United States.[16]

Left to right: a lead pipe, a corroded steel pipe, and a lead pipe treated with anti-corrosion material.

Water pollution can also prove deadly to all sorts of marine life. When human wastes and pesticide and herbicide runoff wash into surface water sources or oceans, they alter the nutrient and chemical composition of the water, often making it more suitable for various kinds of algae. The algae blocks light and uses oxygen needed by fish and other aquatic species to survive. This process, called **eutrophication**, is hazardous to aquatic life. Freshwater holds over 10 percent of life on the planet and 35 percent of vertebrates. Between 1970 and 2016, populations of freshwater species declined by 84 percent.[17]

## Staying above water

From 2000 to 2020, 2 billion more people gained access to safely-managed drinking water (from 3.8 to 5.8 billion). That still leaves about 2 billion people (1 in 4 people) lacking this vital service. Strides have been made in expanding access to safely managed sanitation services (toilets and latrines) as well. Even so, nearly half the world population still live without these improvements, with a half billion people still practicing open defecation.[18]

Goal 6 of the **United Nations Sustainable Development Goals (SDGs)** is to "Ensure availability and sustainable management of water and sanitation for all" by 2030. The World Health Organization (WHO) estimates the price tag of this goal at $26 billion annually.[19] Yet the investment bears dividends. For every $1 invested in water and sanitation improvements, over $4 is returned in increased productivity, primarily based on improved health and more time to work.[20] Today, over two-thirds of people in sub-Saharan African countries have to leave their homes to collect water for cooking, drinking and bathing, often walking long distances with heavy buckets. Most of this backbreaking work falls to women and children. Reaching a target to provide clean water to all the world's people would also need to include ready accessibility.[21]

Combatting water scarcity will prove to be more challenging. The most obvious step is to improve the efficiency with which water is used and to recycle used water. Currently, less than 20 percent of used water worldwide is collected or treated.[22] Using water conserving appliances such as low-flow toilets and showerheads can reduce the amount of water used in households. More efficient means of irrigating crops can reduce water use in agriculture.

Some arid regions have been looking to desalination to alleviate water scarcity. **Desalination** is a process of removing salt from both seawater and subterranean "brackish" waters to make it drinkable. Twice as expensive as treating rainwater or waste water, desalination also has environmental drawbacks including energy use and salt disposal. Often the salty brine is injected back into the ground, increasing the **salinity** of soil or rivers downstream.[23]

Water is essential for economic and social development, public health and agriculture, and there is no substitute. To meet the future needs of the world's people will require a combination of water conservation, pollution treatment and new technologies. It may also require the global community to rethink our diets, enforce environmental protections, and stabilize population size to be able to sustainably manage this finite resource.

---

[1] World Health Organization. (2019, June 14). *Drinking-water*. [Fact sheet]. Retrieved from https://www.who.int/en/news-room/fact-sheets/detail/drinking-water

[2] United Nations. (2021, March 21). *The United Nations World Water Development Report 2021: Valuing Water*. Paris: UNESCO. Retrieved from https://www.unwater.org/publications/un-world-water-development-report-2021/

[3] UN-Water. (2021, July). *Summary Progress Update 2021: SDG 6 – water and sanitation for all*. Geneva, Switzerland.

[4,12] Food and Agriculture Organization of the United Nations. (n.d.). AQUASTAT – FAO's Global Information System on Water and Agriculture. [Data set]. Retrieved December 10, 2021 from https://www.fao.org/aquastat/en/

[5] WWAP (United Nations World Water Assessment Programme). (2015, March 20). *The United Nations World Water Development Report 2015: Water for a Sustainable World*. Paris: UNESCO. Retrieved from http://www.unesco.org/new/en/loginarea/natural-sciences/environment/water/wwap/wwdr/2015-water-for-a-sustainable-world/

[6] Oskin, B. (2018, October 17). Aquifers: Underground Stores of Freshwater. *LiveScience*. Retrieved from https://www.livescience.com/39625-aquifers.html

[7] Frankel, T.C. (2015, June 16). New NASA data show how the world is running out of water. *The Washington Post*. Retrieved from https://www.washingtonpost.com/news/wonk/wp/2015/06/16/new-nasa-studies-show-how-the-world-is-running-out-of-water/

[8] McGuire, V.L. (2017). Water-level and recoverable water in storage changes, High Plains aquifer, predevelopment to 2015 and 2013–15: U.S. Geological Survey Scientific Investigations Report 2017–5040, 14 p., https://doi.org/10.3133/sir20175040; Frankel, J. (2018, May 17). Crisis on the High Plains: The Loss of America's Largest Aquifer – the Ogallala. *University of Denver Water Law Review*. Retrieved from http://duwaterlawreview.com/crisis-on-the-high-plains-the-loss-of-americas-largest-aquifer-the-ogallala/

[9] Fountain, H. (2016, May 27). The Winter Was Wet, but California Could Get Thirsty Again. *The New York Times*. Retrieved from https://www.nytimes.com/2016/05/28/science/california-water-drought-el-nino.html

[10] NASA. (2001, May 5). *The Shrinking Aral Sea*. The Earth Observatory. Retrieved June 2, 2016 from https://earthobservatory.nasa.gov/images/1396/the-shrinking-aral-sea

[11] Maupin, M.A. (2018). Summary of estimated water use in the United States in 2015: U.S. Geological Survey Fact Sheet 2018-3035, 2 p., https://doi.org/10.3133/fs20183035

[13] WWAP (United Nations World Water Assessment Programme). (2017, March 22). *The United Nations World Water Development Report 2017: Wastewater, The Untapped Resource*. Paris: UNESCO. Retrieved from http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/2017-wastewater-the-untapped-resource/

[14] World Health Organization. (2019). *Water, sanitation, hygiene and health: a primer for health professionals*. Geneva: World Health Organization. Retrieved from https://apps.who.int/iris/handle/10665/330100

[15] Xia, C. (2016, April 11). 80% underground water undrinkable in China. *China.org.cn*. Retrieved from http://www.china.org.cn/environment/2016-04/11/content_38218704.htm

[16] Fedinick, K.P., Taylor, S., & Roberts, M. (2019, September). *Watered Down Justice*. Natural Resources Defense Council, Coming Clean and Environmental Justice Health Alliance. [Report]. Retrieved from https://www.nrdc.org/sites/default/files/watered-down-justice-report.pdf

[17] WWF. (2020). *Living Planet Report 2020: Bending the curve of biodiversity loss*. Almond, R.E.A., Grooten M. and Petersen, T. (Eds). Gland, Switzerland: WWF. Retrieved from https://www.icriforum.org/living-planet-report-2020-bending-the-curve-of-biodiversity-loss/

[18] United Nations Department of Economic and Social Affairs. (2021). *The Sustainable Development Goals Report 2021*. Retrieved from https://unstats.un.org/sdgs/report/2021/

[19] UN-Water. (2015, July 15). Means of Implementation: A focus on Sustainable Development Goals 6 and 17. Retrieved from https://www.unwater.org/publications/means-implementation-focus-sustainable-development-goals-6-17/

[20] United Nations. (2014, November 19). Every dollar invested in water, sanitation brings four-fold return in costs – UN. *UN News*. Retrieved from https://news.un.org/en/story/2014/11/484032-every-dollar-invested-water-sanitation-brings-four-fold-return-costs-un

[21] Graham, J.P., Hirai, M., & Kim, S. (2016). An analysis of water collection labor among women and children in 24 sub-Saharan African countries. *PLOS ONE* 11(6), doi:10.1371/journal.pone.0155981.

[22] Corcoran, E., Nellemann, C., Baker, E., Bos, R., Osborn, D. & Savelli, H. (2010). *Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment.* United Nations Environment Programme, UN-HABITAT, GRID-Arendal. Retrieved from https://wedocs.unep.org/handle/20.500.11822/9156

[23] Johnston, C. (2015, May 27). Desalination: the quest to quench the world's thirst for water. *The Guardian*. Retrieved from https://www.theguardian.com/technology/2015/may/27/desalination-quest-quench-worlds-thirst-water