

Water as the New Gold
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Global renewable water resources per capita vary significantly by country, largely driven by population size and annual rainfall variability, with an average of roughly 24,776 cubic meters per person yearly, notes [ChartsBin.com](https://www.chartsbin.com). Nations with large populations or arid climates often have the lowest per capita water, while countries like Canada, Iceland, and Russia are among the highest due to immense freshwater assets and smaller populations.

This paper will focus on the effect of the failure of nations to capture and recycle rainwater and gray water and how this affects not only their economic growth but results in oceanic pollution and failure to combat climate change. We will review international strategies and emerging technologies that could anticipate and cope with the growing water shortages that are causing reliance now on imported bottle water.

Keywords; Water Resources, Oceanic Pollution, Climate Change, recycling wastewater. Circular Economies.

1.0 Is Water as a resource in scarce supply worldwide? ¹

Even in countries with adequate water resources, water scarcity is not uncommon. Although this may be due to a number of factors — collapsed infrastructure and distribution systems, contamination, conflict, or poor management of water resources — it is clear that climate change, as well as human factors, are increasingly denying children their right to safe water and sanitation.

Water scarcity limits access to safe water for drinking and for practising basic hygiene at home, in schools and in health-care facilities. When water is scarce, sewage systems can fail and the threat of contracting diseases like cholera surges. Scarce water also becomes more expensive.

Water scarcity takes a greater toll on women and children because they are often the ones responsible for collecting it. When water is further away, it requires more time to collect, which often means less time at school. Particularly for girls, a shortage of water in schools impacts student enrolment, attendance and performance. Carrying water long distances is also an enormous physical burden and can expose children to safety risks and exploitation.

Key facts

- **Four billion people — almost two thirds of the world's population — experience severe water scarcity for at least one month each year.**

¹ Our Oceans Incorporated is an Australian registered charity that can accept and grant tax deductibility – see www.ouroceans.org.au

- **Over two billion people live in countries where water supply is inadequate.**
- **Half of the world's population could be living in areas facing water scarcity by as early as 2025.**
- **Some 700 million people could be displaced by intense water scarcity by 2030.**
- **By 2040, roughly 1 in 4 children worldwide will be living in areas of extremely high water stress.**

As the factors driving water scarcity are complex and vary widely across countries and regions, UNICEF works at multiple levels to introduce context-specific technologies that increase access to safe water and address the impacts of water scarcity. UNICEF focusses on:

- **Identifying new water resources:** We assess the availability of water resources using various technologies, including remote sensing and geophysical surveys and field investigations.
 - **Improving the efficiency of water resources:** We rehabilitate urban water distribution networks and treatment systems to reduce water leakage and contamination, promoting wastewater reuse for agriculture to protect groundwater.
 - **Planning for urban scarcity:** We plan for future water needs by identifying available resources to reduce the risk of cities running out of water.
 - **Expanding technologies to ensure climate resilience:** We support and develop climate-resilient water sources, including the use of deeper groundwater reserves through solar-powered water networks. We also advance water storage through small-scale retention structures, managed aquifer recharge (where water is pumped into underground reserves to improve its quality), and rainwater harvesting.
 - **Changing behaviours:** We work with schools and communities to promote an understanding of the value of water and the importance of its protection, including by supporting environmental clubs in schools.
 - **Planning national water needs:** We work with key stakeholders at national and sub-national levels to understand the water requirements for domestic use and for health and sanitation, and advocate to ensure that this is reflected in national planning considerations. However there are other direct methods to cope with water scarcity.
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2.0 Other direct methods to cope with water scarcity

As climate change accelerates, water scarcity is becoming a defining global crisis. Water-scarce nations are investing heavily in technology to turn seawaters into life-saving drinking water, with desalination and advanced purification becoming as vital to survival as oil is to energy.

Methods Used Worldwide to Produce Drinkable Water in 2026 include-

- **Advanced Reverse Osmosis (RO):** The dominant technology, widely used in arid regions like Qatar, Israel, and Australia. New plants use advanced membranes, high-pressure pumps (up to 60 bar), and post-treatment mineralization to turn seawater into potable water, sometimes producing over 600 million liters daily.
- **Solar-Powered Atmospheric Water Harvesting:** A "breakthrough"

technology, using advanced materials and hydrogels that absorb moisture from the air at night and release it using sunlight during the day. These can produce up to 1,000 liters per day, making them ideal for arid, off-grid regions.

- **Membrane Distillation & Solar Thermal Desalination:** These systems use concentrated solar energy to boil seawater, which then vaporizes and condenses into clean water. They are designed to operate without grid power, using multi-effect distillation to maximize efficiency.
- **Wave-Powered Desalination:** Startups like Oneka use ocean wave energy to power desalination "Iceberg" units, removing salt from seawater without using electricity, capable of providing drinking water for thousands of people.
- **Nanofiltration and Advanced Membranes:** Nanotechnology-based materials, including graphene-based membranes, are being used to enhance selectivity. They allow water to pass more easily while removing molecular-level pollutants, including heavy metals, microplastics, and microorganisms.
- **Deep-Sea Pressure Filtration:** Innovative, silent machines are operating 2,000 feet beneath the ocean surface, leveraging natural deep-sea pressure to force water through filters, avoiding the high energy costs and brine pollution of land-based plants.
- **Water Reuse and Advanced Oxidation Processes (AOP):** Wastewater treatment plants are evolving into "resource recovery" centers, using ozone, hydrogen peroxide, and UV light to convert wastewater into high-quality, potable water, closing the water loop in urban environments. ([Hella Water: Premier Chinese Water Treatment Solutions](#))

Top 2026 Water Treatment Trends

- **AI and Internet of Things (IoT):** Real-time AI monitoring and smart sensors are replacing manual testing, enabling proactive maintenance and AI-driven quality control to optimize water quality 24/7.
- **Modular/Decentralized Water Systems:** Prefabricated, mobile water treatment plants (like containerized units) allow for rapid, decentralized deployment to remote areas or communities facing emergency water shortages.
- **Bioremediation:** Using bio-based methods and engineered microorganisms to remove contaminants, offering a greener, lower-energy alternative for industrial wastewater treatment

3.0 Using water resources that already exist from rainwater and wastewater treatment

One smart solution is to start collecting the water that lands on your roof. So how many countries do this now? ²

There are 195 countries in the world as of 2026, comprising 193 member states of the United Nations and two non-member observer states.

While there is no single, universally agreed-upon number of countries that *exclusively* focus on rainwater harvesting, dozens of countries have active, large-scale rainwater harvesting (RWH) programs. These are driven by national policy, drought management, and rural water supply needs.

Key Countries and Regions Concentrating on Rainwater Harvesting

- China: A global leader in RWH, using it extensively in rural and northern regions.
- India: Implements extensive rooftop harvesting and traditional, community-based RWH, particularly in drought-prone states.
- Brazil: Famously deployed the "1 Million Cisterns" program to provide water to its semi-arid northeast region.
- Australia: Implements national and state-level incentives (rebates) for residential and commercial rainwater tanks.
- Germany: Known as a European leader, utilizing smart urban RWH and encouraging it through strict building policies.
- Thailand & Cambodia: Widely implement rooftop RWH to combat rural droughts.
- New Zealand: Uses rainwater extensively for residential drinking water in many areas.
- African Region: Many countries like Ethiopia, Senegal, and Tanzania engage in RWH, often supported by global partnerships (UNEP) to enhance climate resilience.

Factors Driving Concentration

- Water Scarcity/Stress: Over 20 countries, particularly in North Africa, West Asia, and South Asia, face high water stress, prompting serious efforts in RWH, water reuse, and desalination.
- Adaptation Planning: Around 70 countries have developed National Adaptation Plans (NAPs), which frequently include rainwater harvesting as a strategy to combat climate change.

The Global Rain Water Harvesting Collective specifically partners with government bodies in countries like Ethiopia, India, Nepal, and Senegal to promote RWH as a global movement.

3.1 Wastewater Management leaders and largest plants³

There are five key Global & Industrial Leaders -

- Xylem Inc.: A leader in automation and smart sensors for predictive maintenance and high-flow industrial wastewater streams.
- Veolia: A global leader specializing in municipal and industrial wastewater management.
- SWA Water Australia: Known for providing turnkey engineering solutions and high-grade CPI oil separators for industrial applications.

- REMONDIS: Provides sustainable water management and specializes in phosphorus recovery from sewage sludge.
- DuPont: A major provider of membrane filtration and advanced chemical treatments.

Apart from these there are specialized Treatment & Regional Leaders -

- True Water Australia: A premier provider of specialized commercial and residential sewage treatment systems, delivering over 2,000 turnkey projects.
- CleanaWater: Experts in industrial water management systems, offering spill control and treatment solutions.
- BioCycle: Focuses on environmentally responsible Aerated Wastewater Treatment Systems (AWTS) for treating and recycling water.
- BIOSeptic: Specializes in domestic and commercial wastewater systems, including septic and aerated systems.

3.2 Key Technologies and Trends

The industry is driven by advancements in membrane filtration, biological treatment innovations, and smart water management platforms that enhance efficiency and safety. Companies are focusing on sustainability, aiming for the treatment and recycling of water for non-potable uses.

It is interesting to consider the top five countries connecting their population to wastewater treatment - since 2014, Chile Share of Population Connected to a Wastewater Treatment Plant rose 1point per year. In 2019, the country was number 1 comparing other countries in Share of Population Connected to a Wastewater Treatment Plant at 104.91 Percent. Netherlands, Luxembourg and Germany respectively ranked number 2, 3 and 4 in this ranking. Costa Rica witnessed the best average annual growth at +28.1points per year, while Canada recorded the worst performance at -0.1points per year. Chile also had the lowest share of population not connected to sewerage - in 2017, the country was number 30 comparing other countries in Share of Population Not Connected to Public Sewerage or Independent Wastewater Treatment with 0.03 Percent. Costa Rica lead the ranking with 75.41 Percent in 2019, a growth of 0.3points compared to 2018. Ireland, Slovakia and Slovenia respectively ranked number 2, 3 and 4 in this ranking. Israel witnessed the best average annual growth at +52.1points per year, while Austria was the worst growing country at -58.8points per year.

3.3 The USA has the largest wastewater treatment plant in the world

The Metropolitan Water Reclamation District's wastewater treatment plant in near Stickney, Ill. has many names, both formal and informal.

The formal name is the Stickney Water Reclamation Plant. Gizmodo Magazine has a more appropriate name for the 413-acre facility: "The Crappiest Place On Earth."

But is it best known as the world's largest wastewater treatment plant, serving over 2.4 million people in Chicago and 46 suburban communities.

"What wastewater is essentially is any of the water that you use in your home, industry or wherever that goes down the drain, and we essentially treat it here," said Adam Gronksi, plant manager. "We treat it to a standard where basically it's good and safe for the fish and the aquatic species of the waterway that we discharge to."

The massive facility has been the world's largest wastewater facility since it opened in 1930, cleaning an average of 700 million gallons of water per day. In months like January and February, however, when melted snow and rain can add to the wastewater component, or in other rainy months during the summer, the facility can treat up to 1.44 billion gallons per day.

Nearly 100 years after its inception, the Stickney plant remains the world's largest for treating wastewater, according to the U.S. Water Alliance. But it now has rivals; in North America, treatment facilities in Boston, Detroit and Montreal all have the ability to treat over 1 billion gallons.

And globally, the Bahr El-Baqar wastewater treatment plant in northwest Egypt, which opened in 2021, is expected to surpass the Stickney plant. The Guinness Book of World Records already lists it as the world's largest wastewater treatment plant.

But for now, there is nothing like Stickney, especially in terms of efficiency in dealing with wastewater.

"It keeps our cities and towns in our region livable because this is a point source where lots of flow is coming in, lots of flow going out," Cummings said. "It's all done in one small step, highly efficient."

The entire wastewater treatment process at the Stickney WRP takes approximately 12 hours, a remarkable feat considering the transformation it achieves.

But the Stickney plant goes beyond simply cleaning wastewater. It also recovers valuable resources from the wastewater process.

Most notably, the organic solids removed during treatment are transformed into biosolids, a nutrient-rich soil amendment used for landscaping and agriculture. Phosphorus is also extracted from the wastewater and converted into a slow-release fertilizer, "Crystal Green," reducing reliance on mined phosphorus.

"This technology is not new; it's been going on for a long time," Cummings said. "It's a tried and true method of treatment."

4.0 Conclusion⁴

So given the scarcity of water resources worldwide why have so few of the most arid countries not adopted rainwater harvesting and wastewater management.

The failure of countries to adopt comprehensive wastewater management is a multifaceted issue, driven primarily by financial constraints, inadequate infrastructure, weak regulatory enforcement, and a lack of technical expertise. While high-income nations treat over 90% of their wastewater, low-income countries manage only a small fraction (roughly 5.8%), leading to severe environmental and health risks.

The main factors preventing the adoption of wastewater management are:

1. Financial and Economic Constraints

- High Capital Costs: Building wastewater treatment plants (WWTPs), sewer networks, and pumping stations requires significant upfront investment, which is often unfeasible for developing countries.
 - Operating and Maintenance Fees: Even if infrastructure is built, many municipalities cannot afford the high, continuous costs of energy, chemical usage, and skilled labor needed to operate treatment plants.
 - Low Cost Recovery: Many cities operate at a loss because wastewater collection fees are too low or non-existent, making the systems economically unsustainable.
2. Infrastructure and Technical Gaps
- Aging Infrastructure: In many places, existing sewer systems are old, leaking, or breaking down, allowing untreated raw sewage to leach into the environment.
 - Urban Growth Outpacing Infrastructure: Rapid urbanization and population density in cities of the global south often outpace the expansion of sanitation infrastructure.
 - Lack of Skilled Personnel: There is a shortage of qualified personnel to design, operate, and maintain complex treatment systems, leading to system failures.
3. Institutional and Regulatory Failures
- Weak Enforcement of Regulations: Even when regulations exist, they are often not enforced. There are frequently no penalties for non-compliance or illegal discharge of raw wastewater into water bodies.
 - Fragmented Responsibilities: Water management is often handled by multiple, overlapping ministries or agencies, leading to fragmented responsibilities, poor coordination, and a lack of clear ownership.
 - Lack of Priority and Political Will: Wastewater management is often a low priority for local and national governments, who may prioritize other infrastructure projects.
4. Societal and Public Awareness Barriers
- Lack of Public Awareness: There is often limited awareness among citizens, farmers, and even government officials regarding the potential health impacts of using raw wastewater for irrigation.
 - The "Yuck" Factor: Public distrust of recycled wastewater, combined with a lack of transparency regarding the quality of treated water, causes resistance to water reuse initiatives.
5. Environmental and Geographic Factors
- Climate Change and Disasters: Increased flooding and rainfall can inundate sanitation systems, while extreme drought can render sewer systems inoperable.
 - Land Scarcity: In densely populated urban areas, it can be difficult to find the necessary land to construct treatment facilities.
6. Mismanagement and Data Gaps
- Unclear Information: Households may wrongly report having a functioning septic tank when, in reality, they have a non-standard "leach-pit" that does not treat wastewater.
 - Lack of Data: Many low-income countries lack data on wastewater treatment, which hampers the development of effective, evidence-based policies.

These factors create a cycle where untreated wastewater continues to contaminate water sources, causing disease and environmental damage, particularly in high-density informal settlements and rural areas.

Unfortunately recent world events have distracted funding bodies that could help from this vital issue focussing attention on energy over water resources, but by the end of this decade the world may refocus.

¹ Statistics on the scarcity of water resources can be derived from various sources, including government reports, international organizations, and academic studies. Here are some key sources of statistics on water scarcity:

UNESCO

<https://www.unesco.org › reports › wwdr › en>

World Bank Water Data

<https://wbwaterdata.org>

UNICEF

<https://www.unicef.org › wash › water-scarcity>

² Sourced from Woldometer, Cleanawater UNEP - UN Environment Programme

³ biocyclevic.com.au

⁴ Sources from ScienceDirect.com and The University of Sydney