MAIN PROBLEMS OF WATER RESOURCES: ISSUES RELATED TO WATER CONSUMPTION

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Abstract *This article explores the major problems facing global water resources, focusing particularly on issues related to water consumption and misuse. As the world's population approaches 8 billion, demand for freshwater is rapidly increasing while supply remains finite. The imbalance between availability and consumption has led to a crisis of water scarcity, quality degradation, and environmental deterioration. The study examines the scientific, economic, and social dimensions of water consumption, analyzing patterns across agriculture, industry, and domestic sectors. It highlights the consequences of overexploitation—such as groundwater depletion, river pollution, and ecosystem collapse—and discusses potential solutions including sustainable management, technological innovation, and policy reform. The paper concludes that addressing water problems requires a global shift in consumption behavior and a transition toward integrated water resource governance.*

Keywords: *water resources, water consumption, water scarcity, pollution, sustainability, agriculture, industrial use, water management, global environment.*

Introduction

Water is the essence of life and the cornerstone of sustainable development. Every human activity—from growing food to generating electricity-depends on water. Yet, despite its importance, the world is facing an unprecedented water crisis. Increasing demand, mismanagement, and pollution are rapidly transforming water from a renewable resource into a scarce commodity.

Globally, freshwater availability per capita has declined by more than 60% since 1960 (World Bank, 2023). Today, over 2 billion people lack access to safe drinking water, and more than 4 billion experience severe water scarcity at least one month per year (UN Water, 2023). The crisis is not caused by the absence of water itself Earth contains vast quantities but rather by unequal distribution, unsustainable consumption, and inadequate governance. Historically, civilizations have risen and fallen based on their ability to manage water. Ancient societies like Egypt, Mesopotamia, and the Indus Valley flourished around river systems, yet collapsed when those systems failed. In the modern era, technological progress has expanded access to water through dams, irrigation, and pipelines, but it has also accelerated depletion and pollution. Industrialization, population growth, and climate change now exert pressure on water resources at a scale never seen before. The global water footprint the total volume of freshwater used to produce goods and services has reached 9,087 billion cubic meters per year, or roughly 1,385 cubic meters per person annually (Hoekstra & Mekonnen, 2012; updated 2023 data). Agriculture accounts for around 70% of global withdrawals, industry for 22%, and households for 8%. But these averages hide regional inequalities: while North America and Europe consume the most water per capita, regions like Sub-Saharan Africa and Central Asia face severe shortages. This imbalance is more than a technical issue it is a moral and geopolitical challenge. Water scarcity threatens food production, energy security, and international stability. Groundwater overuse is leading to land subsidence, while pollution from industry and agriculture renders entire rivers undrinkable. In many developing nations, people spend hours each day collecting water instead of attending school or working.

The purpose of this article is to analyze the main problems of global water resources with a focus on issues related to consumption. The study aims to:

1. Examine the current state of global water resources and their distribution;
2. Identify the key problems caused by unsustainable water use;
3. Analyze water consumption patterns across major economic sectors;
4. Present scientific data on water scarcity and pollution;
5. Propose policy and technological measures for sustainable consumption.

Water is the foundation of civilization, yet its misuse endangers that very foundation. By understanding the underlying causes of the global water crisis, humanity can begin to design solutions that balance consumption with preservation. The following sections explore the main problems of water resources and the specific challenges associated with consumption, supported by empirical data and regional examples.

Main Problems of Water Resources

The challenges facing global water resources stem from both natural constraints and human-induced pressures. While the hydrological cycle theoretically renews water supplies, human activity has disrupted this balance, resulting in regional scarcity, pollution, and inequality. The main problems include water scarcity, pollution, inefficient consumption, and climate change impacts—all interconnected through unsustainable management.

1. Water scarcity and overexploitation

Water scarcity occurs when the demand for freshwater exceeds the available supply in a region. It is categorized into two types:

- Physical scarcity, when natural water availability is insufficient;
- Economic scarcity, when infrastructure or governance prevents access to existing resources.

According to the UNESCO World Water Development Report (2023), nearly 4 billion people—over half of the world's population—live under conditions of severe water stress at least one month per year. The situation is especially acute in North Africa, the Middle East, South Asia, and Central Asia.

The table below presents average renewable freshwater resources and per capita availability by region:

Region	Renewable Freshwater (km^3/year)	Population (million)	Per Capita (m^3/year)	Status
South America	12,000	440	27,000	Abundant
North America	6,000	590	10,000	Moderate abundance
Europe	3,500	750	4,600	Moderate
Africa	3,930	1,400	2,800	Scarce in many regions
Asia	14, 600	4,700	3,100	High stress zones
Oceania	2,300	44	52,000	Very abundant

World Average	43,000	7,900	5,443	-

Source: UNESCO (2023); FAO AQUASTAT (2023).

While global water appears sufficient, regional disparities make access unequal. For instance, South America contains almost 30% of the planet’s renewable freshwater, while North Africa and the Middle East share less than 1%. This inequality fuels political tension and resource conflicts.

Groundwater overexploitation further exacerbates scarcity. Aquifers, which supply nearly one-third of global freshwater, are being depleted faster than they can recharge. In India, China, and the United States—the world’s largest groundwater users overpumping has caused land subsidence and declining water tables by up to 1 meter per year in critical zones (World Bank, 2022).

2. Water pollution and quality degradation

Water pollution represents the second major global problem. It reduces the availability of safe water, destroys ecosystems, and imposes enormous health costs. According to UNEP (2023), over 80% of global wastewater is discharged into rivers, lakes, and oceans without adequate treatment.

The main sources of pollution include:

- Agricultural runoff (fertilizers, pesticides, animal waste);
- Industrial effluents (heavy metals, chemicals, microplastics);
- Urban wastewater (sewage, pharmaceuticals);
- Mining and energy extraction (acid drainage, oil spills).

These pollutants not only contaminate surface water but also seep into groundwater aquifers, making purification extremely costly.

Waterborne diseases are a direct consequence: cholera, dysentery, and diarrhea cause approximately 485,000 deaths annually, mostly in developing countries (WHO, 2023). Industrial contamination in regions such as the Ganges Basin (India), Citarum River (Indonesia), and Niger Delta (Nigeria) exemplifies how economic growth often outpaces environmental regulation.

3. Climate change and hydrological instability

Climate change intensifies all existing water problems. Rising global temperatures alter precipitation patterns, accelerate glacial melt, and increase evaporation rates. According to the IPCC Sixth Assessment Report (2023):

- The frequency of droughts has increased by 29% since 2000;

- Flood events have risen by 134%;
- Glacier mass has declined by nearly 30% since 1970.

These changes disrupt regional hydrological systems. For example:

- Sub-Saharan Africa faces prolonged droughts, threatening food production.
- South Asia experiences erratic monsoons, alternating between severe floods and dry spells.
- Central Asia is witnessing rapid glacial retreat in the Pamirs and Tien Shan, jeopardizing river flow sustainability.

Thus, the climate crisis is fundamentally a water crisis, where both scarcity and excess endanger human and ecological systems.

4. Unequal access and governance failures

The global water crisis is not merely a natural phenomenon—it is a governance failure. Inefficient allocation, corruption, lack of infrastructure, and poor transboundary cooperation all contribute to inequality.

- In low-income countries, 45% of water losses occur due to leakage and outdated infrastructure (OECD, 2022).
- Transboundary basins—such as the Nile, Tigris-Euphrates, and Amu Darya—cover nearly 60% of global freshwater flows, yet fewer than half are governed by international treaties (UNECE, 2021).
- Women and rural communities are disproportionately affected; in Sub-Saharan Africa, women spend over 200 million hours per day collecting water (UNDP, 2023).

Water inequity reinforces poverty, limits education, and perpetuates social disparities. Without integrated governance, technological solutions alone cannot solve the crisis.

5. Ecosystem degradation

Excessive consumption and pollution have degraded aquatic ecosystems worldwide. Wetlands—vital for biodiversity, flood control, and carbon storage—have declined by 35% since 1970 (Ramsar, 2023). Rivers no longer reach the sea in many regions due to damming and diversion, notably the Colorado River, Yellow River, and Amu Darya.

Such degradation diminishes the planet’s capacity to self-regulate. Reduced flows impair fisheries, destroy wildlife habitats, and increase vulnerability to floods and droughts. The health of aquatic ecosystems is thus a direct reflection of humanity’s relationship with water consumption.

Problems Associated with Water Consumption

Water consumption reflects the interaction between human activity and the environment. It determines not only the sustainability of economies but also the ecological health of the

planet. Unsustainable consumption patterns—driven by population growth, industrialization, and lifestyle changes—are among the primary causes of global water stress.

Water use can be divided into three main sectors: agriculture, industry, and domestic consumption. Each sector exhibits distinct patterns and challenges but shares one common characteristic—inefficiency.

1. Global structure of water consumption

According to FAO (2023) and World Bank (2023) data, global water withdrawals total approximately 4,000 km³ per year, distributed as follows:

Sector	Share of Total Withdrawals	Main Uses	Key Challenges
Agriculture	70%	Irrigation, livestock, aquaculture	Inefficiency, evaporation, salinization
Industry	22%	Cooling, manufacturing, mining, energy	Pollution, thermal discharge
Domestic (Municipal)	8%	Drinking, sanitation	Leakage, waste, unequal access

Source: FAO AQUASTAT (2023), World Bank (2023).

Although agriculture dominates global water consumption, industrial and domestic sectors are increasing rapidly due to urbanization and economic growth. The water-energy-food nexus—the interconnection among these sectors—makes consumption patterns particularly complex.

2. Agricultural water consumption

Agriculture is by far the largest consumer of freshwater, responsible for nearly 70% of all withdrawals and up to 90% in developing countries. The expansion of irrigation has boosted food production but also created unsustainable pressure on water resources.

Key problems include:

- Low irrigation efficiency: On average, only 56% of water used for irrigation actually reaches crops (FAO, 2023).
- Evaporation losses: In hot climates, up to 40% of irrigation water evaporates before reaching plants.

- Soil salinization: Over-irrigation without proper drainage leads to salt accumulation, reducing soil fertility.
- Groundwater depletion: Intensive irrigation in India, China, and the U.S. has lowered water tables by dozens of meters.

Modern irrigation methods such as drip and sprinkler systems, combined with remote sensing technologies, can improve efficiency by 30–50%. However, high costs and lack of infrastructure hinder their widespread adoption in developing countries. The agricultural water footprint extends beyond direct irrigation. It includes “virtual water”—the hidden water used to produce food, clothing, and other goods. For example:

- Producing 1 kg of beef requires around 15,000 liters of water.
- Producing 1 kg of rice uses about 2,500 liters.
- A cup of coffee consumes 140 liters from cultivation to processing.

Such figures illustrate how consumption choices in one country can impact water scarcity in another.

3. Industrial water consumption

Industry accounts for approximately 22% of global water withdrawals, but its share is far higher in developed economies—up to 50% in Europe and North America. Industrial water use is essential for:

- Cooling in power generation,
- Chemical and textile production,
- Mining and metallurgy,
- Electronics and semiconductors,
- Food and beverage processing.

However, industrial processes often return polluted or heated water to rivers, degrading ecosystems. For instance:

- The textile industry is responsible for about 20% of global freshwater pollution, mainly from dyeing and finishing.
- Thermal power plants discharge warm water that raises river temperatures, reducing oxygen levels and harming aquatic life.
- The mining sector contaminates groundwater with heavy metals such as arsenic and mercury.

In response, advanced economies are adopting closed-loop systems—technologies that recycle water within industrial cycles. Japan and Germany recycle up to 85–90% of their industrial water, while developing nations often recycle less than 10%. Industrial water consumption is also tightly connected to energy production. The International Energy Agency (2023)reports that water demand for energy will increase by 20% by 2030,

particularly for biofuel cultivation and power plant cooling. Without innovation, this growth will deepen competition between water and energy sectors.

4. Domestic and municipal consumption

Domestic water consumption covers drinking, cooking, cleaning, sanitation, and recreational uses. Although it represents only 8% of total withdrawals, its importance for human welfare and public health is critical.

Average household water use varies drastically across regions:

- North America: 350–400 liters per person per day;
- Europe: 150–200 liters;
- Asia: 80–150 liters;
- Africa: 20–60 liters.

The inequality is staggering an average U.S. citizen uses more water in one day than a person in Sub-Saharan Africa uses in a week. Urbanization worsens the challenge. By 2050, two-thirds of the global population will live in cities, increasing municipal water demand by 80% (UN Water, 2023). Yet leakage in aging urban systems results in up to 30–50% water loss before it even reaches consumers (OECD, 2022). In addition, household behavior—long showers, frequent laundry, excessive landscaping—significantly affects overall consumption. Educational campaigns and water pricing policies can reduce domestic use by up to 25% without sacrificing comfort (World Bank, 2023).

5. Virtual water and consumption globalization

The globalization of trade has created a phenomenon known as “virtual water trade”, meaning that countries import or export water implicitly through products. For example:

- The United States and Brazil are net exporters of virtual water through agricultural exports (soybeans, beef, maize).
- Countries like Japan, Egypt, and the Gulf states are net importers, relying on foreign water embedded in food and manufactured goods.

This interconnectedness means that water problems are no longer local—they are global. A drought in Argentina can affect coffee prices in Europe; excessive cotton irrigation in Central Asia contributed to the Aral Sea disaster. Therefore, sustainable water consumption must consider international supply chains and trade policies.

6. Socioeconomic and ethical dimensions

Beyond technical inefficiency, water consumption is deeply tied to social and ethical issues. Access to clean water remains highly unequal:

- Over 2 billion people still lack safely managed drinking water services (WHO/UNICEF, 2023).

- In many rural regions, women and children walk several kilometers daily to fetch water.
- Marginalized groups often pay 10–20 times more per liter of water from private vendors than urban residents connected to utilities.

Water scarcity also generates migration and conflict. The Middle East and North Africa, where per capita water availability has dropped below 500 m^3/year, are hotspots of hydropolitical tension. Competition over transboundary rivers the Nile, Jordan, and Tigris Euphrates illustrates how consumption at the national level can trigger regional disputes. Ethically, the debate continues: Is water a basic human right or an economic commodity? The answer determines how societies price, distribute, and protect it. Recognizing water as a human right implies universal access and sustainability over profit-driven allocation.

Conclusion

Water resources are the foundation of all biological and socio-economic systems. Yet, their degradation and overconsumption have brought humanity to a critical crossroads. The data presented in this study reveal that water problems are multidimensional—spanning environmental, economic, social, and political domains. The core issue is not the absolute lack of water, but rather how it is consumed, distributed, and valued.

Agriculture remains the main driver of water use, but inefficiencies in industry and households contribute significantly to waste. Climate change, pollution, and weak governance amplify these challenges, threatening both ecosystems and human welfare.

To address them, a global transformation in water ethics and management is needed—one that integrates technology, policy, and education. Every individual, company, and government shares responsibility for water stewardship.

The path forward lies in:

- Efficient consumption,
- Sustainable technologies,
- Cooperative governance,
- And a moral commitment to fairness.

Only by treating water not as an infinite resource but as a shared legacy can humanity ensure its availability for future generations. The sustainability of our civilization depends on how wisely we manage every drop.

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