Water scarcity

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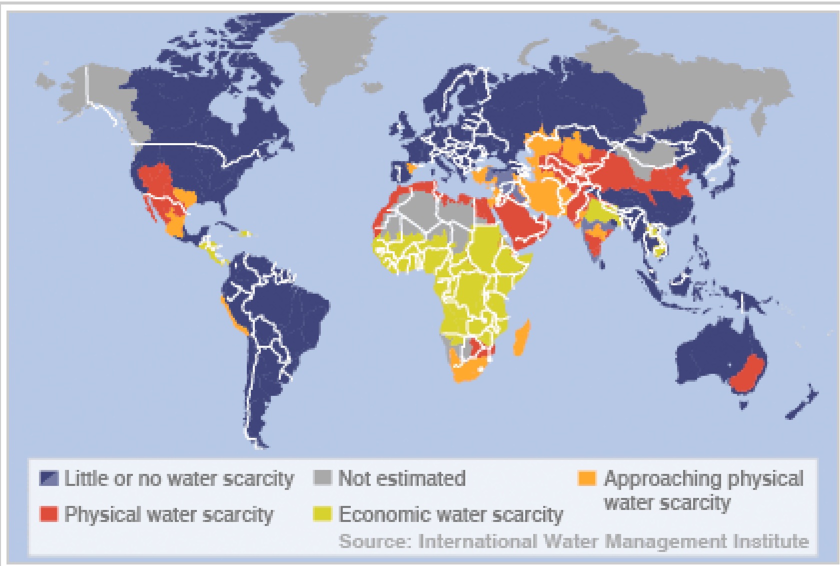
Water scarcity is the lack of sufficient available water resources to meet water needs within a region. It affects every continent and around 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water.[1]

In Meatu district, Simiyu Region, Tanzania (Africa), water most often comes from open holes dug in the sand of dry riverbeds, and it is invariably contaminated.

Water scarcity involves **water shortage**, **water stress** or deficits, and **water crisis**. The relatively new concept of *water stress* is difficulty in obtaining sources of fresh water for use during a period of time; it may result in further depletion and deterioration of available water resources.[2] *Water shortages* may be caused by climate change, such as altered weather-patterns (including droughts or floods), increased pollution, and increased human demand and overuse of water.[3] The term *water crisis* labels a situation where the available potable, unpolluted water within a region is less than that region's demand.[4] Two converging phenomena drive water scarcity: growing freshwater use and depletion of usable freshwater resources.[5]



Physical water scarcity and economic water scarcity by country. 2006

Water scarcity can result from two mechanisms:

- physical (absolute) water scarcity
- economic water scarcity

Physical water scarcity results from inadequate natural water resources to supply a region's demand, and economic water scarcity results from poor management of the sufficient available water resources. According to the United Nations Development Programme, the latter is found more often to be the cause of countries or regions experiencing water scarcity, as most countries or regions have enough water to meet household, industrial, agricultural, and environmental needs, but lack the means to provide it in an accessible manner.[6]

Many countries and governments aim to reduce water scarcity. The UN recognizes the importance of reducing the number of people without sustainable access to clean water and sanitation. The Millennium Development Goals within the United Nations Millennium Declaration aimed by 2015 to "halve the proportion of people who are unable to reach or to afford safe drinking water."[7]

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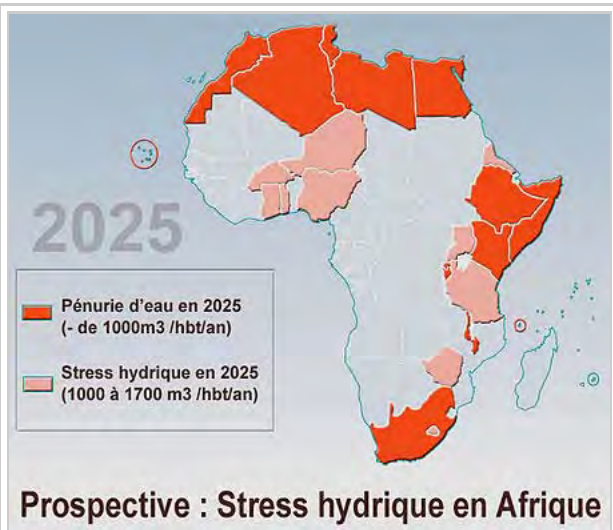
Water stress



GEO-2000 estimate for 2025, 25 African countries are expected to suffer from water shortage or water stress.[8]

The United Nations (UN) estimates that, of 1.4 billion cubic kilometers (1 quadrillion acre-feet) of water on Earth, just 200,000 cubic kilometers (162.1 billion acre-feet) represent fresh water available for human consumption.[9]

More than one in every six people in the world is water stressed, meaning that they do not have access to potable water.[6] Those that are water stressed make up 1.1 billion people in the world and are living in developing countries. According to the Falkenmark Water Stress Indicator,[10] a country or region is said to experience "water stress" when annual water supplies drop below 1,700 cubic metres per person per year. At levels between 1,700 and 1,000 cubic meters per person per year, periodic or limited water shortages can be expected. When a country is below 1,000 cubic meters per person per year, the country then faces water scarcity . In 2006, about 700 million people in 43 countries were living below the 1,700 cubic metres per person threshold.[6] Water stress is ever intensifying in regions such as China, India, and Sub-Saharan Africa, which contains the largest number of water stressed countries of any region with almost one fourth of the population living in a water stressed country.[6] The world's most water stressed region is the Middle East with averages of 1,200 cubic metres of water per person.[6] In China, more than 538 million people are living in a water-stressed region. Much of the water stressed population currently live in river basins where the usage of water resources greatly exceed the renewal of the water source.

Changes in climate

Another popular opinion is that the amount of available freshwater is decreasing because of climate change. Climate change has caused receding glaciers, reduced stream and river flow, and shrinking lakes and ponds. Many aquifers have been over-pumped and are not recharging quickly. Although the total fresh water supply is not used up, much has become polluted, salted, unsuitable or otherwise unavailable for drinking, industry and agriculture. To avoid a global water crisis, farmers will have to strive to increase productivity to meet growing demands for food, while industry and cities find ways to use water more efficiently.[11]

A New York Times article, "Southeast Drought Study Ties Water Shortage to Population, Not Global Warming", summarizes the findings of Columbia University researcher on the subject of the droughts in the American Southeast between 2005 and 2007. The findings published in the *Journal of Climate* say that the water shortages resulted from population size more than rainfall. Census figures show that Georgia’s population rose from 6.48 to 9.54 million between 1990 and 2007.[12] After studying data from weather instruments, computer models, and tree ring measurements, they found that the droughts were not unprecedented and result from normal climate patterns and random weather events. "Similar droughts unfolded over the last thousand years", the researchers wrote, "Regardless of climate change, they added, similar weather patterns can be expected regularly in the future, with similar results."[12] As the temperature increases, rainfall in the Southeast will increase but because of evaporation the area may get even drier. The researchers concluded with a statement saying that any rainfall comes from complicated internal processes in the atmosphere and are very hard to predict because of the large amount of variables.

Water crisis

When there is not enough potable water for a given population, the threat of a *water crisis* is realized.[4] The United Nations and other world organizations consider a variety of regions to have water crises of global concern.[13][14] Other organizations, such as the Food and Agriculture Organization, argue that there are no water crises in such places, but steps must still be taken to avoid one.[15]

Effects of water crisis

There are several principal manifestations of the water crisis.

- Inadequate access to safe drinking water for about 884 million people[16]
- Inadequate access to sanitation for 2.5 billion people,[17] which often leads to water pollution
- Groundwater overdrafting (excessive use) leading to diminished agricultural yields[18]
- Overuse and pollution of water resources harming biodiversity
- Regional conflicts over scarce water resources sometimes resulting in warfare.

Waterborne diseases caused by lack of sanitation and hygiene are one of the leading causes of death worldwide. For children under age five, waterborne diseases are a leading cause of death. According to the World Bank, 88 percent of all waterborne diseases are caused by unsafe drinking water, inadequate sanitation and poor hygiene.[19]

Water is the underlying tenuous balance of safe water supply, but controllable factors such as the management and distribution of the water supply itself contribute to further scarcity.

A 2006 United Nations report focuses on issues of governance as the core of the water crisis, saying "There is enough water for everyone" and "Water insufficiency is often due to mismanagement, corruption, lack of appropriate institutions, bureaucratic inertia and a shortage of investment in both human capacity and physical infrastructure".[20] Official data also shows a clear correlation between access to safe water and GDP per capita.[21]

It has also been claimed, primarily by economists, that the water situation has occurred because of a lack of property rights, government regulations and subsidies in the water sector, causing prices to be too low and consumption too high.[22][23][24]

Vegetation and wildlife are fundamentally dependent upon adequate freshwater resources. Marshes, bogs and riparian zones are more obviously dependent upon sustainable water supply, but forests and other upland ecosystems are equally at risk of significant productivity changes as water availability is diminished. In the case of wetlands, considerable area has been simply taken from wildlife use to feed and house the expanding human population. But other areas have suffered reduced productivity from gradual diminishing of freshwater inflow, as upstream sources are diverted for human use. In seven states of the U.S. over 80 percent of all historic wetlands were filled by the 1980s, when Congress acted to create a "no net loss" of wetlands.

In Europe extensive loss of wetlands has also occurred with resulting loss of biodiversity. For example, many bogs in Scotland have been developed or diminished through human population expansion. One example is the Portlethen Moss in Aberdeenshire.

On Madagascar's highland plateau, a massive transformation occurred that eliminated virtually all the heavily forested vegetation in the period 1970 to 2000. The slash and burn agriculture eliminated about ten percent of the total country's native biomass and converted it to a barren wasteland. These effects were from overpopulation and the necessity to feed poor indigenous peoples, but the adverse effects included widespread gully erosion that in turn produced heavily silted rivers that "run red" decades after the deforestation. This eliminated a large amount of usable fresh water and also destroyed much of the riverine ecosystems of several large west-flowing rivers. Several fish species have been driven to the edge of extinction and some, such as the disturbed Tokios coral reef formations in the Indian Ocean, are effectively lost. In October 2008, Peter Brabeck-Letmathe, chairman and former chief executive of Nestlé, warned that the production of biofuels will further deplete the world's water supply.

Deforestation of the Madagascar Highland Plateau has led to extensive siltation and unstable flows of western rivers.

Overview of regions suffering crisis impacts

There are many other countries of the world that are severely impacted with regard to human health and inadequate drinking water. The following is a partial list of some of the countries with significant populations (numerical population of affected population listed) whose only consumption is of contaminated water:[25]

- Sudan 12.3 million
- Venezuela 5.0 million
- Ethiopia 2.7 million
- Tunisia 2.1 million
- Cuba 1.3 million

Several world maps showing various aspects of the problem can be found in this graph (http://environment.newscientist.com/data/images/archive/2670/26700101.jpg) article.[26]

According to the California Department of Resources, if more supplies aren't found by 2020, the region will face a shortfall nearly as great as the amount consumed today. Los Angeles is a coastal desert able to support at most 1 million people on its own water; the Los Angeles basin now is the core of a megacity that spans 220 miles (350 km) from Santa Barbara to the Mexican border. The region's population is expected to reach 41 million by 2020, up from 28 million in 2009. The population of California continues to grow by more than two million a year and is expected to reach 75 million in 2030, up from 49 million in 2009. But water shortage is likely to surface well before then.[27]

Water deficits, which are already spurring heavy grain imports in numerous smaller countries, may soon do the same in larger countries, such as China and India.[28] The water tables are falling in scores of countries (including Northern China, the US, and India) due to widespread overpumping using powerful diesel and electric pumps. Other countries affected include Pakistan, Iran, and Mexico. This will eventually lead to water scarcity and cutbacks in grain harvest. Even with the overpumping of its aquifers, China is developing a grain deficit. When this happens, it will almost certainly drive grain prices upward. Most of the 3 billion people projected to be added worldwide by mid-century will be born in countries already experiencing water shortages. Unless population growth can be slowed quickly, it is feared that there may not be a practical non-violent or humane solution to the emerging world water shortage.[29][30]

After China and India, there is a second tier of smaller countries with large water deficits — Algeria, Egypt, Iran, Mexico, and Pakistan. Four of these already import a large share of their grain. But with a population expanding by 4 million a year, they will also likely soon turn to the world market for grain.[31]

According to a UN climate report, the Himalayan glaciers that are the sources of Asia's biggest rivers – Ganges, Indus, Brahmaputra, Yangtze, Mekong, Salween and Yellow – could disappear by 2035 as temperatures rise.[32] It was later revealed that the source used by the UN climate report actually stated 2350, not 2035.[33] Approximately 2.4 billion people live in the drainage basin of the Himalayan rivers.[34] India, China, Pakistan, Bangladesh, Nepal and Myanmar could experience floods followed by droughts in coming decades. In India alone, the Ganges provides water for drinking and farming for more than 500 million people.[35][36][37] The west coast of North America, which gets much of its water from glaciers in mountain ranges such as the Rocky Mountains and Sierra Nevada, also would be affected.[38][39]

By far the largest part of Australia is desert or semi-arid lands commonly known as the outback. In June 2008 it became known that an expert panel had warned of long term, possibly irreversible, severe ecological damage for the whole Murray-Darling basin if it does not receive sufficient water by October.[40] Water restrictions are currently in place in many regions and cities of Australia in response to chronic shortages resulting from drought. The Australian of the year 2007, environmentalist Tim Flannery, predicted that unless it made drastic changes, Perth in Western Australia could become the world’s first ghost metropolis, an abandoned city with no more water to sustain its population.[41] However, Western Australia's dams reached 50% capacity for the first time since 2000 as of September 2009.[42] As a result, heavy rains have brought forth positive results for the region.[42] Nonetheless, the following year, 2010, Perth suffered its second-driest winter on record[43] and the water corporation tightened water restrictions for spring.[44]

Physical and economic scarcity

Around one fifth of the world's population currently live in regions affected by Physical water scarcity, where there is inadequate water resources to meet a country's or regional demand, including the water needed to fulfill the demand of ecosystems to function effectively.[6] Arid regions frequently suffer from physical water scarcity. It also occurs where water seems abundant but where resources are over-committed, such as when there is over development of hydraulic infrastructure for irrigation. Symptoms of physical water scarcity include environmental degradation and declining groundwater as well as other forms of exploitation or overuse.[45]

Economic water scarcity is caused by a lack of investment in infrastructure or technology to draw water from rivers, aquifers or other water sources, or insufficient human capacity to satisfy the demand for water. One quarter of the world's population is affected by economic water scarcity. Economic water scarcity includes a lack of infrastructure, causing the people without reliable access to water to have to travel long distances to fetch water, that is often contaminated from rivers for domestic and agricultural uses. Large parts of Africa suffer from economic water scarcity; developing water infrastructure in those areas could therefore help to reduce poverty. Critical conditions often arise for economically poor and politically weak communities living in already dry environment. Consumption increases with GDP per capita in most developed countries the average amount is around 200–300 litres daily. In underdeveloped (e.g. African countries such as Mozambique, average daily water consumption per capita was below 10 L. This is against the backdrop of international organisations, which recommend a minimum of 20 L of water (not including the water needed for washing clothes), available at most 1 km from the household. Increased water consumption is correlated with increasing income, as measured by GDP per capita. In countries suffering from water shortages water is the subject of speculation.[46]

Human right to water

The United Nations Committee on Economic, Social and Cultural Rights established a foundation of five core attributes for water security. They declare that the human right to water entitles everyone to sufficient, safe, acceptable, physically accessible, and affordable water for personal and domestic use.[6]

Millennium Development Goals (MDG)

At the 2000 Millennium Summit, the United Nations addressed the effects of economic water scarcity by making increased access to safe drinking water an international development goal. During this time, they drafted the Millennium Development Goals and all 189 UN members agreed on eight goals. MDG 7 sets a target for reducing the proportion of the population without sustainable safe drinking water access by half by 2015. This would mean that more than 600 million people would gain access to a safe source of drinking water. In 2016, the Sustainable Development Goals replace the Millennium Development Goals.

Effects on environment


An abandoned ship in the former Aral Sea, near Aral, Kazakhstan.

Water scarcity has many negative impacts on the environment, including lakes, rivers, wetlands, and other fresh water resources. The resulting water overuse that is related to water scarcity, often located in areas of irrigation agriculture, harms the environment in several ways including increased salinity, nutrient pollution, and the loss of floodplains and wetlands.[6][47] Furthermore, water scarcity makes flow management in the rehabilitation of urban streams problematic.[48]

Through the last hundred years, more than half of the Earth's wetlands have been destroyed and have disappeared.[3] These wetlands are important not only because they are the habitats of numerous inhabitants such as mammals, birds, fish, amphibians, and invertebrates, but they support the growing of rice and other food crops as well as provide water filtration and protection from storms and flooding. Freshwater lakes such as the Aral Sea in central Asia have also suffered. Once the fourth largest freshwater lake, it has lost more than 58,000 square km of area and vastly increased in salt concentration over the span of three decades.[3]

Subsidence, or the gradual sinking of landforms, is another result of water scarcity. The U.S. Geological Survey estimates that subsidence has affected more than 17,000 square miles in 45 U.S. states, 80 percent of it due to groundwater usage. In some areas east of Houston, Texas the land has dropped by more than nine feet due to subsidence.[49] Brownwood, a subdivision near Baytown, Texas, was abandoned due to frequent flooding caused by subsidence and has since become part of the Baytown Nature Center.

Climate change

Aquifer drawdown or overdrafting and the pumping of fossil water increases the total amount of water within the hydrosphere subject to transpiration and evaporation processes, thereby causing accretion in water vapour and cloud cover, the primary absorbers of infrared radiation in the earth's atmosphere. Adding water to the system has a forcing effect on the whole earth system, an accurate estimate of which hydrogeological fact is yet to be quantified.

Depletion of freshwater resources

Apart from the conventional surface water sources of freshwater such as rivers and lakes, other resources of freshwater such as groundwater and glaciers have become more developed sources of freshwater, becoming the main source of clean water. Groundwater is water that has pooled below the surface of the Earth and can provide a usable quantity of water through springs or wells. These areas where groundwater is collected are also known as aquifers. Glaciers provide freshwater in the form meltwater, or freshwater melted from snow or ice, that supply streams or springs as temperatures rise. More and more of these sources are being drawn upon as conventional sources' usability decreases due to factors such as pollution or disappearance due to climate changes. The exponential growth rate of the human population is a main contributing factor in the increasing use of these types of water resources.[50]

Groundwater

Until recent history, groundwater was not a highly utilized resource. In the 1960s, more and more groundwater aquifers developed. Changes in knowledge, technology and funding have allowed for focused development into abstracting water from groundwater resources away from surface water resources. These changes allowed for progress in society such as the "agricultural groundwater revolution", expanding the irrigation sector allowing for increased food production and development in rural areas.[51] Groundwater supplies nearly half of all drinking water in the world.[52] The large volumes of water stored underground in most aquifers have a considerable buffer capacity allowing for water to be withdrawn during periods of drought or little rainfall.[50] This is crucial for people that live in regions that cannot depend on precipitation or surface water as a supply alone, instead providing reliable access to water all year round. As of 2010, the world's aggregated groundwater abstraction is estimated at approximately 1,000 km^3 per year, with 67% used for irrigation, 22% used for domestic purposes and 11% used for industrial purposes.[50] The top ten major consumers of abstracted water (India, China, United States of America, Pakistan, Iran, Bangladesh, Mexico, Saudi Arabia, Indonesia, and Italy) make up 72% of all abstracted water use worldwide.[50] Groundwater has become crucial for the livelihoods and food security of 1.2 to 1.5 billion rural households in the poorer regions of Africa and Asia.[53]

Although groundwater sources are quite prevalent, one major area of concern is the renewal rate or recharge rate of some groundwater sources. Abstracting from groundwater sources that are non-renewable could lead to exhaustion if not properly monitored and managed.[54] Another concern of increased groundwater usage is the diminished water quality of the source over time. Reduction of natural outflows, decreasing stored volumes, declining water levels and water degradation are commonly observed in groundwater systems.[50] Groundwater depletion may result in many negative effects such as increased cost of groundwater pumping, induced salinity and other water quality changes, land subsidence, degraded springs and reduced baseflows. Human pollution is also harmful to this important resource.

Glaciers

Glaciers are noted as a vital water source due to their contribution to stream flow. Rising global temperatures have noticeable effects on the rate at which glaciers melt, causing glaciers in general to shrink worldwide.[55] Although the meltwater from these glaciers are increasing the total water supply for the present, the disappearance of glaciers in the long term will diminish available water resources. Increased meltwater due to rising global temperatures can also have negative effects such as flooding of lakes and dams and catastrophic results.[56]

Measurement

Hydrologists today typically assess water scarcity by looking at the population-water equation. This is done by comparing the amount of total available water resources per year to the population of a country or region. A popular approach to measuring water scarcity has been to rank countries according to the amount of annual water resources available per person. For example, according to the Falkenmark Water Stress Indicator,[10] a country or region is said to experience "water stress" when annual water supplies drop below 1,700 cubic metres per person per year. At levels between 1,700 and 1,000 cubic metres per person per year, periodic or limited water shortages can be expected. When water supplies drop below 1,000 cubic metres per person per year, the country faces "water scarcity".[57] The United Nations' FAO states that by 2025, 1.9 billion people will live in countries or regions with absolute water scarcity, and two-thirds of the world population could be under stress conditions.[58] The World Bank adds that climate change could profoundly alter future patterns of both water availability and use,thereby increasing levels of water stress and insecurity, both at the global scale and in sectors that depend on water.[59]

Other ways of measuring water scarcity include examining the physical existence of water in nature, comparing nations with lower or higher volumes of water available for use. This method often fails to capture the accessibility of the water resource to the population that may need it. Others have related water availability to population.

In 2012 in Sindh, Pakistan a shortage of clean water led people to queue to collect it where available

Another measurement, calculated as part of a wider assessment of water management in 2007,[60] aimed to relate water availability to how the resource was actually used. It therefore divided water scarcity into 'physical' and 'economic'. Physical water scarcity is where there is not enough water to meet all demands, including that needed for ecosystems to function effectively. Arid regions frequently suffer from physical water scarcity. It also occurs where water seems abundant but where resources are over-committed, such as when there is overdevelopment of hydraulic infrastructure for irrigation. Symptoms of physical water scarcity include environmental degradation and declining groundwater. Water stress harms living things because every organism needs water to live.

Renewable freshwater resources

Renewable freshwater supply is a metric often used in conjunction when evaluating water scarcity. This metric is informative because it can describe the total available water resource each country contains. By knowing the total available water source, an idea can be gained about whether a country is prone to experiencing physical water scarcity. This metric has its faults in that it is an average; precipitation delivers water unevenly across the planet each year and annual renewable water resources vary from year to year. This metric also does not describe the accessibility of water to individuals, households, industries, or the government. Lastly, as this metric is a description of a whole country, it does not accurately portray whether a country is experiencing water scarcity. Canada and Brazil both have very high levels of available water supply, but still experience various water related problems.[50]

It can be observed that tropical countries in Asia and Africa have low availability of freshwater resources.

The following table displays the average annual renewable freshwater supply by country including both surface-water and groundwater supplies.[61] This table represents data from the UN FAO AQUASTAT, much of which are produced by modeling or estimation as opposed to actual measurements.

Total renewable freshwater supply by country[61]

Rank	Country	Annual renewable water resources (km^3/year)	Region	Year of estimate
1	Kuwait	0.02	Asia	2008
2	St. Kitts and Nevis	0.02	North and Central America	2000
3	Maldives	0.03	Asia	1999
4	Malta	0.07	Europe	2005
5	Antigua and Barbuda	0.1	North and Central America	2000
6	Qatar	0.1	Asia	2008
7	Barbados	0.1	North and Central America	2003
8	Bahrain	0.1	Asia	2008
9	United Arab Emirates	0.2	Asia	2008
10	Cape Verde	0.3	Africa	2005
11	Djibouti	0.3	Africa	2005
12	Cyprus	0.3	Europe	2007
13	Libya	0.6	Africa	2005
14	Singapore	0.6	Asia	1975
15	Jordan	0.9	Asia	2008
16	Comoros	1.2	Africa	2005
17	Oman	1.4	Asia	2008
18	Luxembourg	1.6	Europe	2007
19	Israel	1.8	Asia	2008
20	Yemen	2.1	Asia	2008
21	Saudi Arabia	2.4	Asia	2008
22	Mauritius	2.8	Africa	2005
23	Burundi	3.6	Africa	1987
24	Trinidad and Tobago	3.8	North and Central America	2000
25	Swaziland	4.5	Africa	1987
26	Lebanon	4.5	Asia	2008

Rank	Country	Annual renewable water resources (km^3/year)	Region	Year of estimate
27	Tunisia	4.6	Africa	2005
28	Reunion	5.0	Africa	1988
29	Lesotho	5.2	Africa	1987
30	Eritrea	6.3	Africa	2001
31	Macedonia	6.4	Europe	2001
32	Armenia	7.8	Former Soviet Union	2008
33	Gambia	8.0	Africa	2005
34	Brunei	8.5	Asia	1999
35	Jamaica	9.4	North and Central America	2000
36	Rwanda	9.5	Africa	2005
37	Mauritania	11.4	Africa	2005
38	Algeria	11.6	Africa	2005
39	Moldova	11.7	Former Soviet Union	1997
40	Estonia	12.3	Europe	2007
41	Estonia	12.8	Former Soviet Union	1997
42	Haiti	14.0	North and Central America	2000
43	Somalia	14.2	Africa	2005
44	Botswana	14.7	Africa	2001
45	Togo	14.7	Africa	2001
46	Czech Republic	16.0	Europe	2007
47	Denmark	16.3	Europe	2007
48	Syria	16.8	Asia	2008
49	Malawi	17.3	Africa	2001
50	Burkina Faso	17.5	Africa	2001
51	Namibia	17.7	Africa	2005
52	Belize	18.6	North and Central America	2000

Rank	Country	Annual renewable water resources (km^3/year)	Region	Year of estimate
53	Zimbabwe	20.0	Africa	1987
54	Belgium	20.0	Europe	2007
55	Dominican Republic	21.0	North and Central America	2000
56	Lithuania	24.5	Former Soviet Union	2007
57	El Salvador	25.2	North and Central America	2001
58	Romania	25.7	Europe	2007
59	Benin	25.8	Africa	2001
60	Equatorial Guinea	26	Africa	2001
61	Fiji	28.6	Oceania	1987
62	Morocco	29.0	Africa	2005
63	Kenya	30.7	Africa	2005
64	Guinea-Bissau	31.0	Africa	2005
65	Slovenia	32.1	Europe	2007
66	Niger	33.7	Africa	2005
67	Azerbaijan	34.7	Former Soviet Union	2008
68	Mongolia	34.8	Asia	1999
69	Bosnia and Herzegovina	37.5	Europe	2003
70	Cuba	38.1	North and Central America	2000
71	Senegal	39.4	Africa	1987
72	Albania	41.7	Europe	2001
73	Chad	43.0	Africa	1987
74	Solomon Islands	44.7	Oceania	1987
75	Kyrgyzstan	46.5	Former Soviet Union	1997
76	Ireland	46.8	Europe	2003
77	South Africa	50.0	Africa	2005
78	Sri Lanka	50.0	Asia	1999

Rank	Country	Annual renewable water resources (km^3/year)	Region	Year of estimate
79	Slovakia	50.1	Europe	2007
80	Ghana	53.2	Africa	2001
81	Switzerland	53.5	Europe	2007
82	Belarus	58.0	Former Soviet Union	1997
83	Egypt	58.3	Africa	2005
84	Turkmenistan	60.9	Former Soviet Union	1997
85	Poland	63.1	Europe	2007
86	Georgia	63.3	Former Soviet Union	2008
87	Sudan	64.5	Africa	2005
88	Afghanistan	65.0	Asia	1997
89	Uganda	66.0	Africa	2005
90	Taiwan	67.0	Asia	2000
91	Korea Rep	69.7	Asia	1999
92	Greece	72.0	Europe	2007
93	Uzbekistan	72.2	Former Soviet Union	2003
94	Portugal	73.6	Europe	2007
95	Iraq	75.6	Asia	2008
96	Korea DPR	77.1	Asia	1999
97	Côte d'Ivoire	81	Africa	2001
98	Austria	84.0	Europe	2007
99	Netherlands	89.7	Europe	2007
100	Tanzania	91	Africa	2001
101	Bhutan	95.0	Asia	1987
102	Honduras	95.9	North and Central America	2000
103	Tajikistan	99.7	Former Soviet Union	1997
104	Mali	100.0	Africa	2005

Rank	Country	Annual renewable water resources (km^3/year)	Region	Year of estimate
105	Zambia	105.2	Africa	2001
106	Croatia	105.5	Europe	1998
107	Bulgaria	107.2	Europe	2010
108	Kazakhstan	109.6	Former Soviet Union	1997
109	Ethiopia	110.0	Africa	1987
110	Finland	110.0	Europe	2007
111	Spain	111.1	Europe	2007
112	Guatemala	111.3	North and Central America	2000
113	Costa Rica	112.4	North and Central America	2000
114	Hungary	116.4	Europe	2007
115	Suriname	122.0	South America	2003
116	Iran	137.5	Asia	2008
117	Uruguay	139.0	South America	2000
118	Ukraine	139.5	Former Soviet Union	1997
119	Central African Republic	144.4	Africa	2005
120	Panama	148.0	North and Central America	2000
121	Sierra Leone	160.0	Africa	1987
122	Gabon	164.0	Africa	1987
123	Iceland	170.0	Europe	2007
124	Italy	175.0	Europe	2007
125	United Kingdom	175.3	Europe	2007
126	Sweden	183.4	Europe	2007
127	Angola	184.0	Africa	1987
128	France	186.3	Europe	2007
129	Germany	188.0	Europe	2007
130	Nicaragua	196.7	North and Central America	2000

Rank	Country	Annual renewable water resources (km^3/year)	Region	Year of estimate
131	Serbia-Montenegro*	208.5	Europe	2003
132	Nepal	210.2	Asia	1999
133	Turkey	213.6	Asia	2008
134	Mozambique	217.1	Africa	2005
135	Guinea	226.0	Africa	1987
136	Liberia	232.0	Africa	1987
137	Pakistan	233.8	Asia	2003
138	Guyana	241.0	South America	2000
139	Cameroon	285.5	Africa	2003
140	Nigeria	286.2	Africa	2005
141	Laos	333.6	Asia	2003
142	Paraguay	336.0	South America	2000
143	Australia	336.1	Oceania	2005
144	Madagascar	337.0	Africa	2005
145	Latvia	337.3	Former Soviet Union	2007
146	Norway	389.4	Europe	2007
147	New Zealand	397.0	Oceania	1995
148	Thailand	409.9	Asia	1999
149	Japan	430.0	Asia	1999
150	Ecuador	432.0	South America	2000
151	Mexico	457.2	North and Central America	2000
152	Cambodia	476.1	Asia	1999
153	Philippines	479.0	Asia	1999
154	Malaysia	580.0	Asia	1999
155	Bolivia	622.5	South America	2000
156	Papua New Guinea	801.0	Oceania	1987
157	Argentina	814.0	South America	2000
158	Congo	832.0	Africa	1987
159	Vietnam	891.2	Asia	1999

Rank	Country	Annual renewable water resources (km^3/year)	Region	Year of estimate
160	Chile	922.0	South America	2000
161	Myanmar	1045.6	Asia	1999
162	Bangladesh	1210.6	Asia	1999
163	Venezuela	1233.2	South America	2000
164	Congo, Democratic Republic (formerly Zaire)	1283	Africa	2001
165	India	1907.8	Asia	1999
166	Peru	1913.0	South America	2000
167	Colombia	2132.0	South America	2000
168	China	2738.8	Asia	2008
169	Indonesia	2838.0	Asia	1999
170	United States of America	3069.0	North and Central America	1985
171	Canada	3300.0	North and Central America	1985
172	Russia	4498.0	Former Soviet Union	1997
173	Brazil	8233.0	South America	2000

Outlook

Wind and solar power such as this installation in a village in northwest Madagascar can make a difference in safe water supply.

Construction of wastewater treatment plants and reduction of groundwater overdrafting appear to be obvious solutions to the worldwide problem; however, a deeper look reveals more fundamental issues in play. Wastewater treatment is highly capital intensive, restricting access to this technology in some regions; furthermore the rapid increase in population of many countries makes this a race that is difficult to win. As if those factors are not daunting enough, one must consider the enormous costs and skill sets involved to maintain wastewater treatment plants even if they are successfully developed.

Reducing groundwater overdrafting is usually politically unpopular, and can have major economic impacts on farmers. Moreover, this strategy necessarily reduces crop output, something the world can ill-afford given the current population.

At more realistic levels, developing countries can strive to achieve primary wastewater treatment or secure septic systems, and carefully analyse wastewater outfall design to minimise impacts to drinking water and to ecosystems. Developed countries can not only share technology better, including cost-effective wastewater and water treatment systems but also in hydrological transport modeling. At the individual level, people in developed countries can look inward and reduce overconsumption, which further strains worldwide water consumption. Both developed and developing countries can increase protection of ecosystems, especially wetlands and riparian zones. These measures will not only conserve biota, but also render more effective the natural water cycle flushing and transport that make water systems more healthy for humans.

A range of local, low-tech solutions are being pursued by a number of companies. These efforts center around the use of solar power to distill water at temperatures slightly beneath that at which water boils. By developing the capability to purify any available water source, local business models could be built around the new technologies, accelerating their uptake. For example, bedouins from the town of Dahab in Egypt have installed AquaDania's WaterStillar, which uses a solar thermal collector measuring two square metres to distill from 40 to 60 litres per day from any local water source. This is five times more efficient than conventional stills and eliminates the need for polluting plastic PET bottles or transportation of water supply.[62]

Global experiences in managing water crisis

It is alleged that the likelihood of conflict rises if the rate of change within the basin exceeds the capacity of institution to absorb that change.[38] Although water crisis is closely related to regional tensions, history showed that acute conflicts over water are far less than the record of cooperation.

The key lies in strong institutions and cooperation. The Indus River Commission and the Indus Water Treaty survived two wars between India and Pakistan despite their hostility, proving to be a successful mechanism in resolving conflicts by providing a framework for consultation inspection and exchange of data. The Mekong Committee has also functioned since 1957 and survived the Vietnam War. In contrast, regional instability results when there is an absence of institutions to co-operate in regional collaboration, like Egypt's plan for a high dam on the Nile. However, there is currently no global institution in place for the management and management of trans-boundary water sources, and international co-operation has happened through ad hoc collaborations between agencies, like the Mekong Committee which was formed due to an alliance between UNICEF and the US Bureau of Reclamation. Formation of strong international institutions seems to be a way forward – they fuel early intervention and management, preventing the costly dispute resolution process.

One common feature of almost all resolved disputes is that the negotiations had a “need-based” instead of a “right–based” paradigm. Irrigable lands, population, technicalities of projects define "needs". The success of a need-based paradigm is reflected in the only water agreement ever negotiated in the Jordan River Basin, which focuses in needs not on rights of riparians. In the Indian subcontinent, irrigation requirements of Bangladesh determine water allocations of The Ganges River. A need based, regional approach focuses on satisfying individuals with their need of water, ensuring that minimum quantitative needs are being met. It removes the conflict that arises when countries view the treaty from a national interest point of view, move away from the zero-sum approach to a positive sum, integrative approach that equitably allocated the water and its benefits.

The Blue Peace framework developed by Strategic Foresight Group in partnership with the Governments of Switzerland and Sweden offers a unique policy structure which promotes sustainable management of water resources combined with cooperation for peace. By making the most of shared water resources through cooperation rather than mere allocation between countries, the chances for peace can be increased.[63] The Blue Peace approach has proven to be effective in cases like the Middle East (http://www.strategicforesight.com/publication_pdf/40595Blue%20Peace_Middle%20East.pdf) [64] and the

Nile basin (http://www.strategicforesight.com/publication_pdf/84153Blue%20Peace%20for%20the%20Nile.pdf).[65]

See also

- California Water Wars
- Chinese water crisis
- Consumptive water use
- Deficit irrigation
- List of water supply and sanitation by country
- Peak water
- Water resource policy
- Water conflict
- Water footprint
- Water security
- Water contamination
- Water resources
- Water scarcity in Africa
- Water in Africa
- Water crisis in the Democratic Republic of the Congo

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Further reading

- An International Food Policy Research Institute book (http://www.springer.com/environment/global+change+-+climate+change/book/978-3-642-04614-8) about the intersection of water policy, globalization and food security: Ringler, C., Biswas, A., and Cline, S., eds. 2010. Global Change: Impacts on Water and Food Security. Heidelberg: Springer.
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External links

- "Beyond scarcity: Power, poverty and the global water crisis". United Nations Development Programme

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- The World Bank's work and publications on water resources (http://water.worldbank.org/water/)
- BBC News World Water Crisis Maps (http://news.bbc.co.uk/hi/english/static/in_depth/world/2000/world_water_crisis/default.stm)
- Water Crisis Information Guide – From Middletown Thrall Library. Subjects include: Drinking Water, Government Information, International Challenges and Efforts, Global Water Issues, Oceanography, Sea Levels, Desalination, Water Scarcity, Pollution and Contaminants, Conservation and Recycling, News and Special Reports, and library catalog subject headings for further research. (http://www.thrall.org/special/water.html)

Wikibooks has a book on the topic of: ***Drinking water***

Categories: Water scarcity | Environmental economics | Human activities with impact on the environment | Environmental issues with water | Futurology | Global natural environment | Water supply | Water treatment