

Global Water Resources

Highlights from assessment activities over the past two decades, which are used to establish present and future water trends, reveal that:

1. Freshwater resources are unevenly distributed, with much of the water located far from human populations. Many of the world's largest river basins run through thinly populated regions. There are an estimated 263 major international river basins in the world, covering ~231 059 898 km² or 45.3% of the Earth's land surface area (excluding Antarctica).
2. Groundwater represents about 90% of the world's readily available freshwater resources, and some 1.5 billion people depend upon groundwater for their drinking water.
3. Agricultural water use accounts for about 75% of total global consumption, mainly through crop irrigation, while industrial use accounts for about 20%, and the remaining 5% is used for domestic purposes.
4. It is estimated that two out of every three people will live in water-stressed areas by the year 2025. In Africa alone, it is estimated that 25 countries will be experiencing water stress (below 1,700 m³ per capita per year) by 2025. Today, 450 million people in 29 countries suffer from water shortages.
5. Clean water supplies and sanitation remain major problems in many parts of the world, with 20% of the global population lacking access to safe drinking water. Water-borne diseases from faecal pollution of surface waters continue to be a major cause of illness in developing countries. Polluted water is estimated to affect the health of 1.2 billion people, and contributes to the death of 15 million children annually.

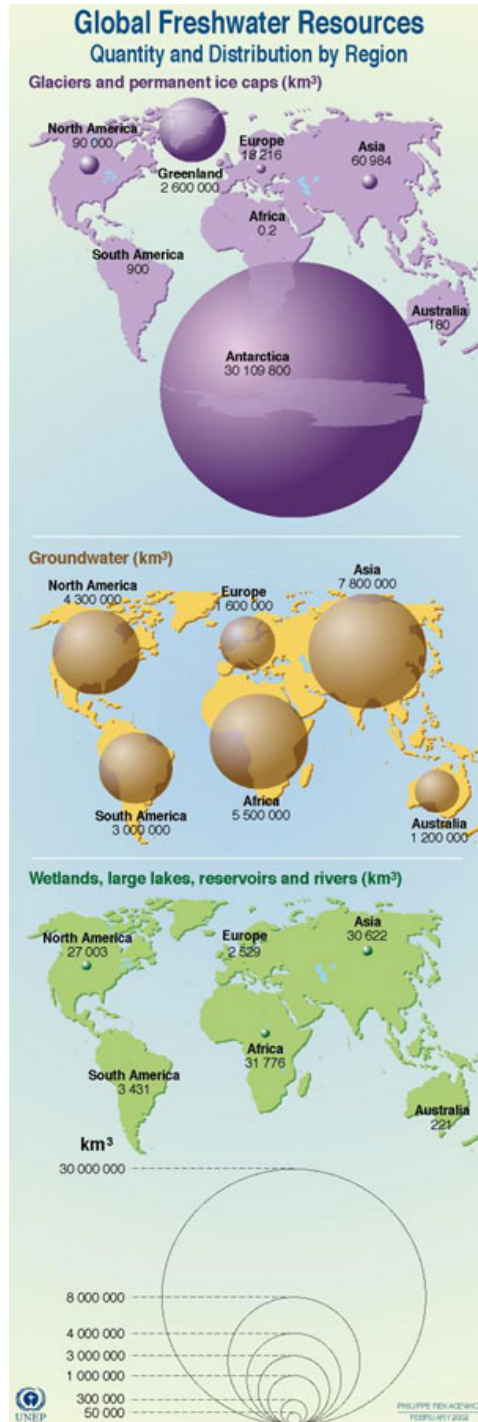
A wide variety of human activities also affects the coastal and marine environment. Population pressures, increasing demands for space and resources, and poor economic performances can all undermine the sustainable use of our oceans and coastal areas. Serious problems affecting the quality and use of these ecosystems include:

1. Alteration and destruction of habitats and ecosystems. Estimates show that almost 50% of the world's coasts are threatened by development-related activities.
2. Severe eutrophication has been discovered in several enclosed or semi-enclosed seas. It is estimated that about 80% of marine pollution originates from land-based sources and activities.
3. In marine fisheries, most areas are producing significantly lower yields than in the past. Substantial increases are never again likely to be recorded for global fish catches. In contrast, inland and marine aquaculture production is increasing and now contributes 30% of the total global fish yield.
4. Impacts of climate change may include a significant rise in the level of the world's oceans. This will cause some low-lying coastal areas to become completely submerged, and increase human vulnerability in other areas. Because they are highly dependent upon marine resources, small island developing states (SIDS) are especially vulnerable, due to both the effects of sea level rise and to changes in marine ecosystems.

UNEP is involved in promoting Integrated Coastal Management (ICM) through a broad variety of initiatives, as a way of resolving current and future problems at a

local/ecosystem-based level. Through its different assessment activities, UNEP focuses on highlighting key areas to promote policy recommendations.

Global Freshwater Resources



Note: Estimates refer to standing volumes of freshwater.
Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999; World Meteorological Organisation (WMO); International Council of Scientific Unions (ICSU); World Glacier Monitoring Service (WGMS); United States Geological Survey (USGS).

Glaciers and icecaps cover about 10% of the world's landmass. These are concentrated in Greenland and Antarctica and contain ~70% of the world's freshwater. Unfortunately, most of these resources are located far from human habitation and are not readily accessible for human use.

According to the United States Geological Survey (USGS), 96% of the world's frozen freshwater is at the South and North poles, with the remaining 4% spread over 550 000 km² of glaciers and mountainous icecaps measuring about 180 000 km³ (UNEP, 1992; Untersteiner, 1975; WGMS, 1998, 2002).

Groundwater is by far the most abundant and readily available source of freshwater, followed by lakes, reservoirs, rivers and wetlands:

- Groundwater represents over 90% of the world's readily available freshwater resource (Boswinkel, 2000). About 1.5 billion people depend upon groundwater for their drinking water supply (WRI, UNEP, UNDP, World Bank, 1998).
- The amount of groundwater withdrawn annually is roughly estimated at ~600-700 km³, representing about 20% of global water withdrawals (WMO, 1997).
- A comprehensive picture of the quantity of groundwater withdrawn and consumed annually around the world does not exist.

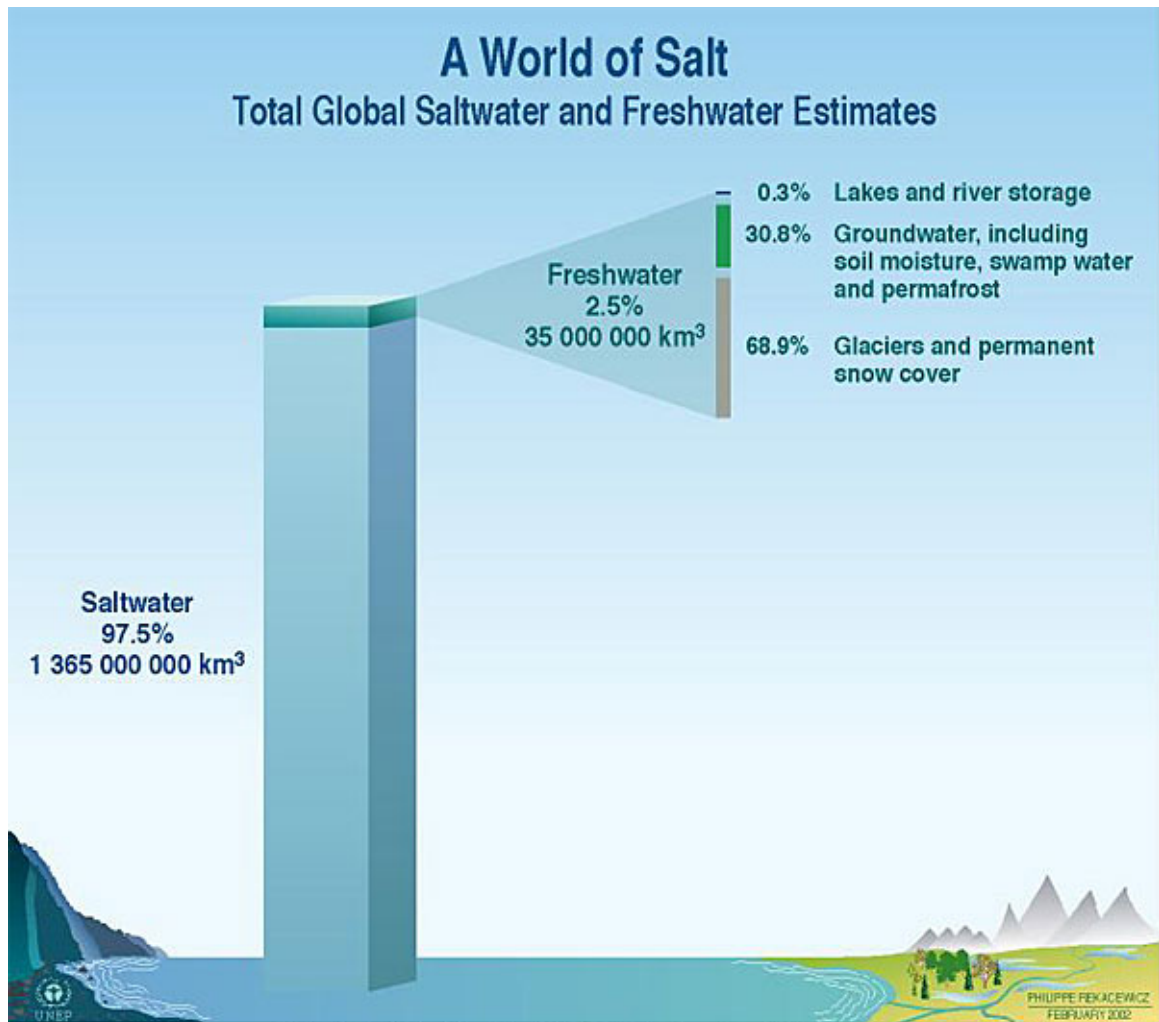
Most **freshwater lakes** are located at high altitudes, with nearly 50% of the world's lakes in Canada alone. Many lakes, especially those in arid regions, become salty through evaporation, which concentrates the inflowing salts.

Reservoirs are artificial lakes, produced by constructing physical barriers across flowing rivers, which allow the water to pool and be used for various purposes. The volume of water stored in reservoirs worldwide is estimated at 4 286 km³ (Groombridge and Jenkins, 1998)

Wetlands include swamps, bogs, marshes, mires, lagoons and floodplains. The 10 largest wetlands in the world by area are: West Siberian Lowlands (780 000-1 000 000 km²), Amazon River (800 000 km²), Hudson Bay Lowlands (200 000-320 000 km²), Pantanal (140 000-200 000 km²), Upper Nile River (50 000-90 000 km²), Chari-Logone River (90 000 km²), Hudson Bay Lowlands in the South Pacific (69 000 km²), Congo River (40 000-80 000 km²), Upper Mackenzie River (60 000 km²), and North America prairie potholes (40 000 km²) (Pidwiny, 1999).

The total global area of wetlands is estimated at ~2 900 000 km² (Groombridge and Jenkins, 1998). Most wetlands range in depth from 0-2 metres. Estimating the average depth of permanent wetlands at about one metre, the global volume of wetlands could range between 2 300 km³ and 2 900 km³.

The Caspian Sea, the Dead Sea, and the Great Salt Lake are among the world's major salt lakes.



Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999.

Estimates of global water resources based on several different calculation methods have produced varied estimates. Shiklomanov in Gleick (1993) estimated that:

- The total volume of water on Earth is ~1.4 billion km³.
- Some 8 million km³ or 30.8% is stored underground in the form of groundwater (shallow and deep groundwater basins up to 2 000 metres, soil moisture, swamp water and permafrost). This constitutes about 97% of all the freshwater that is potentially available for human use.

- The volume of freshwater resources is ~35 million km³, or about 2.5% of the total volume.
- Of these freshwater resources, ~24 million km³ or 68.9% is in the form of ice and permanent snow cover in mountainous regions, the Antarctic and Arctic regions.
- Freshwater lakes and rivers contain an estimated 105 000 km³ or ~0.3% of the world's freshwater.
- The total usable freshwater supply for ecosystems and humans is ~200 000 km³ of water, which is < 1% of all freshwater resources, and only 0.01% of all the water on Earth (Gleick, 1993; Shiklomanov, 1999).

Resources

The total volume of water on Earth is about 1 400 million km³ of which only 2.5 per cent, or about 35 million km³, is freshwater (see table below). Most freshwater occurs in the form of permanent ice or snow, locked up in Antarctica and Greenland, or in deep groundwater aquifers. The principal sources of water for human use are lakes, rivers, soil moisture and relatively shallow groundwater basins. The usable portion of these sources is only about 200 000 km³ of water — less than 1 per cent of all freshwater and only 0.01 per cent of all water on Earth. Much of this available water is located far from human populations, further complicating issues of water use.

The replenishment of freshwater depends on evaporation from the surface of the oceans. About 505 000 km³, or a layer 1.4 metres thick, evaporates from the oceans annually. Another 72 000 km³ evaporates from the land. About 80 per cent of all precipitation, or about 458 000 km³/year, falls on the oceans and the remaining 119 000 km³/year on land. The difference between precipitation on land surfaces and evaporation from those surfaces (119 000 km³ minus 72 000 km³ annually) is run-off and groundwater recharge — approximately 47 000 km³ annually (Gleick 1993). The figure opposite shows one estimate of the average annual water balance of major continental areas, including precipitation, evaporation and run-off. More than one-half of all run-off occurs in Asia and South America, and a large fraction occurs in a single river, the Amazon, which carries more than 6 000 km³ of water a year (Shiklomanov 1999).

Major stocks of water

	<i>volume (1 000 km³)</i>	<i>% of total water</i>	<i>% of total freshwater</i>
Salt water			
Oceans	1 338 000	96.54	
Saline/brackish groundwater	12 870	0.93	
Salt water lakes	85	0.006	
Inland waters			
Glaciers, permanent snow cover	24 064	1.74	68.7
Fresh groundwater	10 530	0.76	30.06
Ground ice, permafrost	300	0.022	0.86
Freshwater lakes	91	0.007	0.26
Soil moisture	16.5	0.001	0.05
Atmospheric water vapour	12.9	0.001	0.04
Marshes, wetlands*	11.5	0.001	0.03
Rivers	2.12	0.0002	0.006
Incorporated in biota*	1.12	0.0001	0.003
Total water	1 386 000	100	
Total freshwater	35 029		100

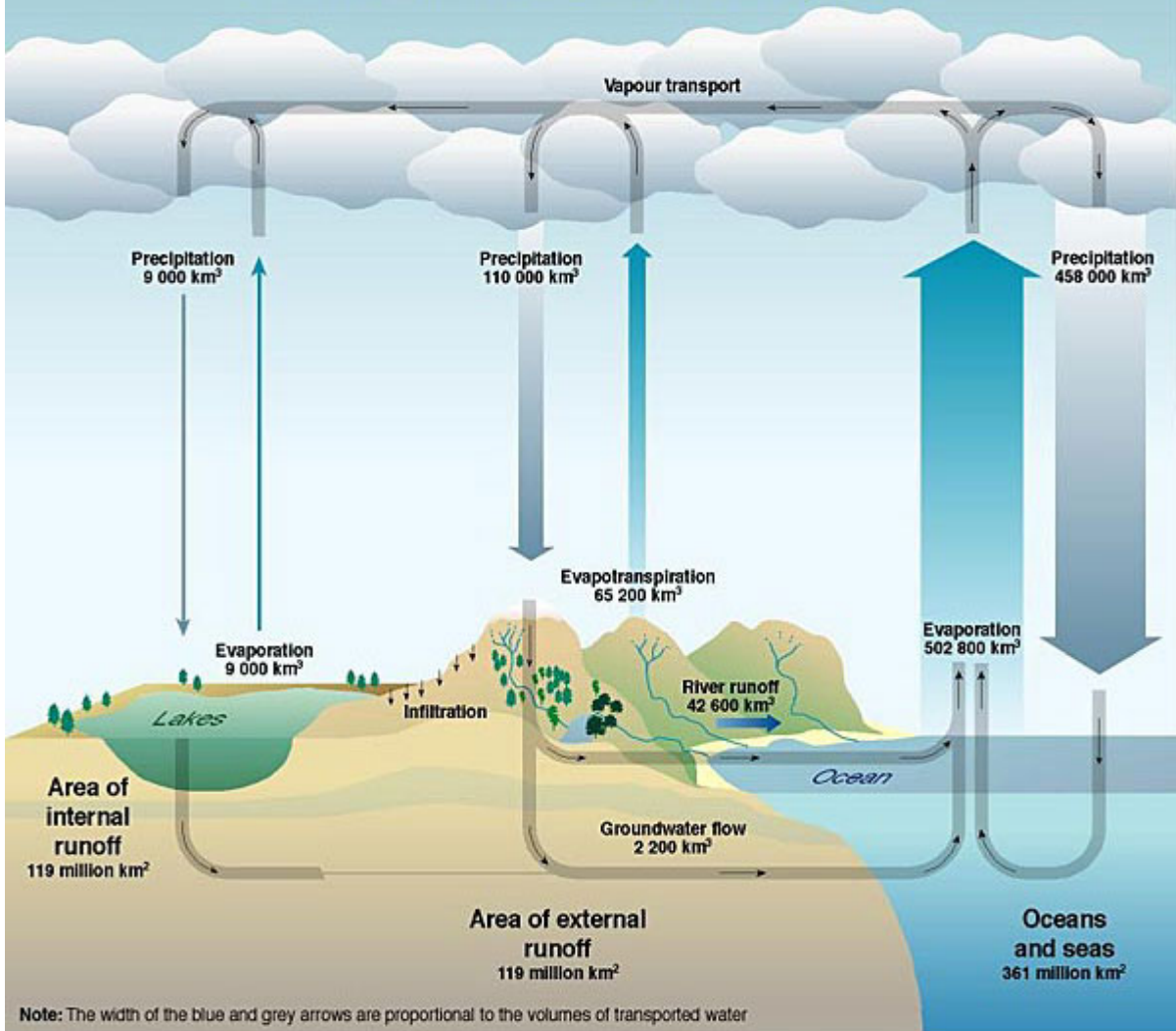
Source: Shiklomanov 1993

Notes: totals may not add exactly due to rounding

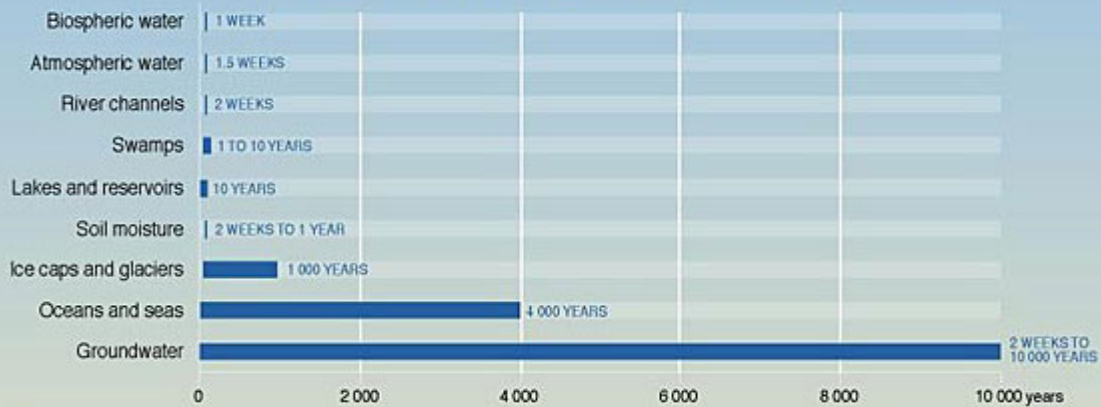
* Marshes, wetlands and water incorporated in biota are often mixed salt and freshwater

The World's Water Cycle

Global Precipitation, Evaporation, Evapotranspiration and Runoff



Estimated Residence Times of the World's Water Resources



PHILIPPE REKAWCZ
AVELINE

Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999; Max Planck, Institute for Meteorology, Hamburg, 1994; Freeze, Allen, John, Cherry, *Groundwater*, Prentice-Hall: Engle wood Cliffs NJ, 1979.

Water is transported in different forms within the **hydrological cycle** or 'water cycle'. Shiklomanov in Gleick (1993) estimates that each year about 502 800 km³ of water evaporates over the oceans and seas, 90% of which (458 000 km³) returns directly to the oceans through precipitation, while the remainder (44 800 km³) falls over land.

With evapo-transpiration totalling about 74 200 km³, the total volume in the terrestrial hydrological cycle is about 119 000 km³. About 35% of this, or 44 800 km³, is returned to the oceans as run-off from rivers, groundwater and glaciers. A considerable portion of river flow and groundwater percolation never reaches the ocean, having evaporated in internal runoff areas or inland basins lacking an outlet to the ocean. However, some groundwater that bypasses the river systems reaches the oceans. Annually the hydrological cycle circulates nearly 577 000 km³ of water (Gleick, 1993).

Adapted from: UNEP (2002). *Vital Water Graphics: An Overview of the State of the World's Fresh and Marine Waters*. <http://www.unep.org/vitalwater> [Accessed 11 August 2006]