

Global Water Distribution

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Water is most common and wide-spread constituent of the earth's natural environment and ecological systems. The total universal volume of water is ~1386 million cubic kilometers which is randomly distributed above, below and on the earth's surface (**Table 2**) (Gleick, 1993; Wikipedia Report: Water distribution on earth). The considerable volume of water on earth's surface exists in numerous renewable water resources that is oceans, seas, rivers, lakes, small ponds, glaciers, ice caps, groundwater streams, etc.

Globally, water distributed in all four prestigious components of environment, i.e., globally water distributed in hydrosphere, lithosphere, atmosphere and biosphere. Around 96.53% water on earth's surface present in oceans and only ~3.477% water present in continents and stored in numerous freshwater resources of the earth ecosystems. It is present in glaciers, ice-cap, groundwater, soil moisture, lakes, ponds, rivers, etc. (Jiménez Cisneros et al., 2014). Out of this water, ~50.04% water stored in the glaciers, ice-cap and permanent snow in the form of ice, ~48.89% water present in groundwater resources and remaining ~1.07% water present in lakes, ponds, and rivers. Hardly ~0.001% water present in atmosphere as clouds and water vapours and ~0.0001% water present in biosphere as biological fluid in the body of whole living beings, i.e., human body holds 60-78%, animal holds 50-95%, and plants and trees hold 50% water by body weight, and it is varied by species to species (Gleick, 1993; Wikipedia Report: Water distribution on earth).

Table 2: Worldwide estimation of complete global water distribution (Gleick, 1993; Wikipedia Report: Water distribution on earth).

Global Water Resources	Volume of Water (cubic km)	Total water (%)	Fresh water (%)
Oceans and Bays	1,338,000,000	96.53	--
Glaciers, Ice-cap and Permanent Snow	24,064,000	1.74	68.7
Groundwater	23,400,000	1.7	30.1
Soil Moisture	16,500	0.001	0.05
Ground Ice and Permafrost	300,000	0.022	0.86
Lakes and Ponds	176,400	0.013	0.26
Atmosphere (Clouds)	12,900	0.001	0.04
Swamp Water	11,470	0.0008	0.03
Rivers	2,120	0.0002	0.006
Biological Water	1,120	0.0001	0.003
Total	1,386,000,000	100	-

Generally, water is the most abundant constituent of earth and unevenly distributed throughout the world. Out of which, ~96.53% water, present in ocean and seas, is saline in nature and not safe for human drinking and any other purposes, therefore, the vast amount of water present on earth's surface is not useful for human beings. The only ~3.477% water of global water distribution is available as fresh water and safe for human drinking and for any other purposes. Out of which, ~68.70% freshwater present in glaciers, ice-caps and snow, ~30.1% freshwater present in groundwater resource, and remaining ~1.2% freshwater found in lakes, ponds, rivers and artificial man-made dams. Thus, only ~1.2% freshwater of global freshwater distributions is easily accessible for human beings that uses in thousands of activities such as drinking, domestic uses, irrigational and industrial uses, and many more (Mishra and Dubey, 2015; Wikipedia Report: Water distribution on earth).

The maximum groundwater is found upto the depth of 800 meter after the earth's ground surface (Freshwater Year, 2003; Margat and van der Gun, 2013). Therefore, it is economically as well as technologically feasible range, and accessible for human activities via well, tube-well and bore-well. Therefore, water is most wide-spread constituent of nature and exists in all four components of environment. It exists above, below and on the earth's surface in different physical states, i.e., liquid, solid (ice form) and gas (water vapour).

Major Resources of Freshwater on Earth's Surface

The nature's most significant resources of freshwater on the earth are considered into the three major classes such as atmospheric water, surface water and groundwater that are of potentially convenient for human beings. Freshwater is gradually distributed above, below and on the earth's surface. It is existing in various resources, i.e., river, lakes, ponds, man-made dams, groundwater reservoirs, glaciers, clouds, etc. It is useful for the human drinking, domestic, agriculture and industrial purposes, and most of the water from these resources are not easily accessible for human. The inadequate freshwater resources and rapidly increasing human population are the major difficulties for many countries of the world. Therefore, the desalinated sea water and recycled wastewater are another potential resource of potable water (Desalination for Safe Water Supply, WHO, 2007). Therefore, the water resources are potentially classified into three major categories such as atmospheric water (Clouds and Rainwater), groundwater and surface water, which is available above, below and on the earth's surface, respectively.

The major water resources are discussed below in detail:

Atmospheric Water Resources (Clouds, Water Vapours and Rainwater): Atmospheric water constitutes clouds, water vapours, rainwater, etc., are the extremely important and primary resources of freshwater. Water is permanent constituent of atmosphere and found in the range of 0.001% (Above polar region) to more than 5% (above the tropic region) of the earth. It exists in all three states such as gas (Water vapour and clouds), liquid (Droplets of rain) and solid (Snow) states.

The hydrological cycle permitting water vapours to condensed in the atmosphere and produce clouds. The clouds, condensed water, precipitated down on the earth's surface as rain and snow. The precipitated rainwater run-off over the earth's surface and stored in various reservoirs such as rivers, lakes, ponds, dams, etc. The snow stored in glaciers as permanent snow on the earth's surface. It is most natural freshwater of the earth's surface. Therefore, atmospheric water resources are accessible and useful freshwater resource for human beings.

A. Surface Water Resources: Surface water is next important freshwater resource that exists on the ground's surface and most of the surface water resources are easily accessible for human drinking and other uses. The surface water resources are the ponds, lakes, rivers, glaciers, permanent snow, seas, oceans, run-off rainwater, artificial reservoirs, etc. Generally, the water is found in two physical states on the earth's surface, i.e., liquid and solid (Ice).

Around 96.53% water of the global water distribution exist in the oceans and seas that is extremely saline and contaminated water in nature, i.e., the oceanic saline water is not fresh and not suitable for human drinking and other uses (Bhat, 2014; Barbara, 2005; Gleick, 1993 & 2011). Thus, the largest water resource of earth's surface is not useful for human beings. The only ~1.77% water of the global water distribution found on the earth's surface and stored in various resources such as rivers, lakes, artificial reservoirs, streams, ponds, ice-caps, glaciers, permanent snow, run-off rainwater, soil moisture, etc. It is fresh and fit for human drinking and other uses.

From these surface water resources, the glaciers, ice-caps and permanent snow is found in solid (ice) form and it is ~1.74% of the total global water distribution (**Table 2**). It constitutes freshwater but it is not easily accessible for human beings. The other surface water resources such as rivers, lakes, ponds, artificial reservoirs, streams, etc., are also contains freshwater and it is easily accessible for human beings. The run-off rainwater is also the freshwater resources that has run-off over the earth surface to the main receiving streams of the earth surface, but it is contaminated from human waste, industrial and agricultural waste, pathogenic microorganisms and turbidity. Thus, the contaminated run-off rainwater is not safest form of water and unsafe for human drinking. Therefore, a very small amount of surface water is fresh and pure in nature and easily accessible for human drinking and other domestic, industrial, and agricultural uses.

B. Groundwater Resources: Groundwater is third important freshwater resource that exists below the earth's surface, i.e., groundwater refers to any source of water that found under the soil layers and earth crust. It is ~1.70% of the total global water distribution (**Table 2**). It is one of the most essential sources of freshwater that is partially accessible for human beings. The maximum groundwater is found upto the depth of 800 meter from the earth surface (Freshwater Year, 2003; Margat and van der Gun, 2013). Therefore, the range of groundwater is technologically and economically feasible and accessible for human beings via well, tube-well, borewell, etc.

The groundwater is the natural water resources and it constitutes ~30.1% freshwater of total global freshwater distributions of the earth (**Table 2**). Therefore, the groundwater is fresh, clean and pure form of water that is safe for human drinking,

animal drinking, domestic uses, agricultural and industrial uses and other human activities. It is technically accessible through the open wells, bore-wells, shallow and deep springs, infiltration wells, thermal springs, etc.

The groundwater resources are most natural freshwater resources and charged by the natural surface water resources and by the run-off rainwater. The surface water and run-off rainwater absorbed by the soil and penetrates into the earth crust. It also enters into the ground through cervices, gravels and cracks in the rocks and through gravitational force, and permanently stored in the earth crust (**Fig. 5**).

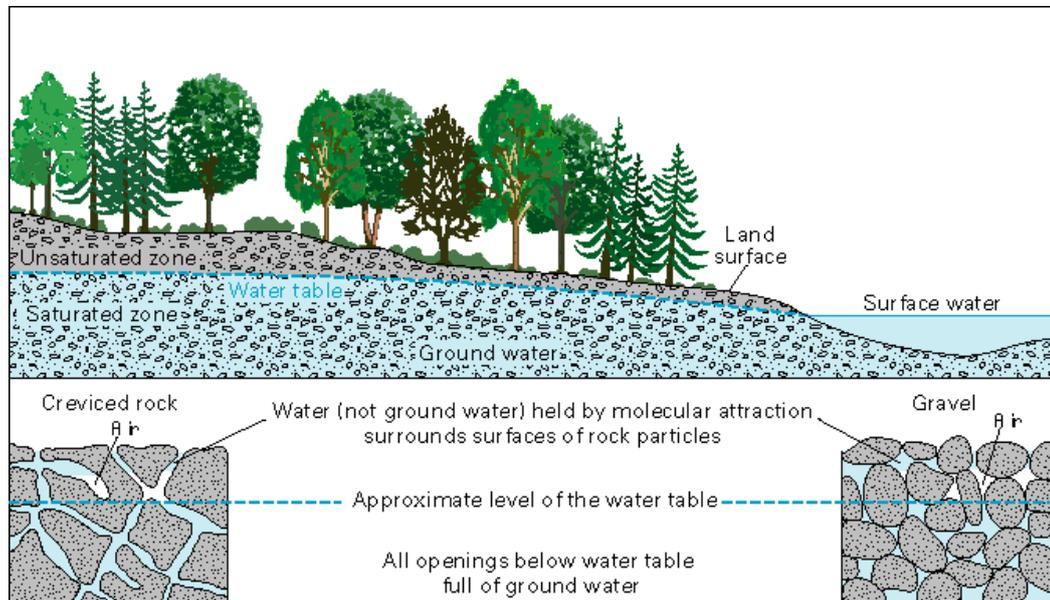


Figure 5: Graphical demonstration of groundwater that enters into the Earth's surface (How do hydrologists locate groundwater?).

The purity and composition of groundwater alters with depth from the earth ground surface. At lower depth from the ground surface, the groundwater found to have minor amount of minerals, i.e., it is fresh and purest form of groundwater that is safe for human drinking. The groundwater from the deeper wells has higher level of minerals and total dissolve solids (TDS) that is not fresh and not safe for human drinking and other uses. The level of contamination increases with increasing depth from ground surface. The quality of groundwater threatens near coastal region and the groundwater is not fresh and saline because it is highly contaminated by sea water. Thus, the groundwater near coastal region is not fresh and not suitable for human drinking and other uses.

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