

HYDROLOGIC CYCLE AND WATER USAGE

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Contents

1. Stocks of water on the Earth
2. Hydrologic cycle
3. Water balance and usage
4. Preservation and effective use of water resources

Glossary

Bibliography

Biographical Sketches

Summary

The stocks of water and the hydrologic cycle on the Earth are quantitatively described and the present statuses of water balances and usage in Japan and the USA are compared. The necessity and usefulness of wastewater reuse for saving the limited water resources in the world is also discussed.

1. Stocks of water on the Earth

Water is the origin of life. If there were not water on the Earth, no living things would have come into existence. The life of a living organism is maintained by water contained within its body. Water accounts for about 70% of the body-weight of adult humans, and as much as 80% of that of new-born babies. Generally, the body of a fish is about 75% water; jellyfish, however, contain as much as 96% water. An adult human needs to drink about two liters of water every day. In addition to sustaining the life of every cell, water is also used for many other purposes, such as temperature control, transportation, dissolving materials, washing, maintaining the functions of natural ecosystems, etc. Water is clearly one of the essential resources for human activities.

Water present everywhere on the Earth. It exists in the seas, lakes, ponds, rivers, and under the ground. It also exists in glaciers and mountains as ice and/or permanent snow. Water is also contained in living things, plants, soils and the atmosphere. The water located in lakes, ponds, and rivers is called surface water and that located under the ground is called groundwater or subsurface water. Fresh surface water and groundwater are major water resources for human activities. The stocks and location of water on the Earth are shown in Table 1.

Location	Amount (10 ³ km ³)	Percentage*
Oceans	1,357,000	96.26
Subsurface	25,700	1.82
Rivers	1.4	0.00099
Freshwater lakes	91	0.0065
Saline lakes	85	0.0060
Glaciers (ice and permanent snow)	26,410	1.87
Soil	80	0.0056
Atmosphere	13	0.00092
Living biomass	1.2	0.000085
Total	1,409,607	

*The approximate values (the sum of the data does not equal to 100%)

Table 1. Stocks of water on the Earth
Data from Naganuma, 1978 and Masters, 1997

The water in the seas is estimated to be $1\,357\,000 \times 10^3 \text{ km}^3$. This is based on the total area of the World Ocean being about $361 \times 10^6 \text{ km}^2$, and the mean depth about 3800 m. More than 96% of the world's water is located in the seas. The amount of groundwater is about $25\,700 \times 10^3 \text{ km}^3$, which accounts for about 1.82% of the total stock of water in the world, and half the total fresh water. The water in fresh lakes, ponds and rivers is $92 \times 10^3 \text{ km}^3$, which is only 0.007% of total water and 0.18% of fresh water. The amount of water in the forms of ice and permanent snow is about $26\,410 \times 10^3 \text{ km}^3$, which is nearly equal to the amount of groundwater.

The total area of glaciers and ice sheets in the world is about $16 \times 10^6 \text{ km}^2$ (about 10% of the land area), and 90% of that is located in Antarctica. The amount of water in soils is about $80 \times 10^3 \text{ km}^3$, which is similar to the volume stored in fresh lakes. The water contained in the atmosphere is only $13 \times 10^3 \text{ km}^3$, or 0.0009% of total water. In addition to water vapor, it includes various natural phenomena such as clouds, rain and snow.

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Biographical Sketches

Koichi Fujie is a professor in the Department of Ecological Engineering at Toyohashi University of Technology, Japan. He completed his PhD in environmental chemistry and engineering at Tokyo Institute of Technology; his PhD thesis was entitled “Oxygen transfer and power economy characteristics of biological wastewater treatments”. Professor Fujie’s research and teaching interests are focused on the sustainability of human society supported by industrial activities. He stresses that minimization of resource and energy consumption, with their environment loading, are essential for sustainability. His major research fields are water and wastewater treatment, development of material recycling technology, bioremediation and design of sound material cycle networks.

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