

## No.12 Water Circulations - 1

Annual precipitation on lands is 970 mm on average. So if we assume that the precipitation on both ocean and land is 970 mm on average for each, annual precipitation on the whole earth will be about  $430,000 \text{ km}^3$ . This water forms a huge circulation system among the atmosphere, lands, (underground,) and the ocean, changing into vapor, fresh water, seawater, and ice.

Of them, water from the rainfall that land organisms use is 30% of the total, which is  $130,000 \text{ km}^3$ . There exist, of course, differences depending on areas, such as deserts where there is no rain and tropical forests where it often rains heavily. However, this amount,  $130,000 \text{ km}^3$ , is considered the total annual amount of fresh water that maintains the ecosystem in the whole land including metropolitan areas (i.e., Tokyo) and tropical forests (i.e., Amazon) (This amount excludes the amount of snowfalls).

Simply saying, the water circulates as follows; vapors evaporated from the surface of the earth with the solar energy, mostly from the ocean, become clouds; clouds become rain or snow, which falls on surface of the earth; and this rain, or snow, goes back to the ocean through rivers. There are three processes in this circulation system.

The first process is that water is used by all organisms such as plants on the surface of the grounds.

The second process is the evaporation from the surface of the water (there is 1 % of vapor in the air).

The third is that the water penetrates underground and flows into groundwater layers. In some groundwater layers, the current velocity is relatively fast and water is supplied in a few years cycle. And in other groundwater layers called "fossil aquifers," the water is supplied through thousands of years, similar to the fossil fuels. Icebergs and glaciers in the North and South Poles are considered to be variations of the fossil aquifer. Aquifers are formed through thousands of year, or millions of year circulation systems. Although huge amount of water is stored in these aquifers, it flows quite slowly, thus circulates spending a long time.

Therefore, if we use water more than the amount of water that needs to be supplied to fossil aquifers, it is obvious that the global water circulation will become

corrupt and not be sustainable.

Current water demand in the world is about 5,000 km<sup>3</sup> (5 trillions tons), which is about 4% of above-mentioned total precipitation on the surface of lands.

Apart from the issue whether this 4% of total precipitation is much enough or not, there are dangerous signs when fresh water is supplied in agricultural areas, including soils, in recent years.

The first sign is the phenomenon that major rivers in the world run dry before they flow into the ocean. For example, in the United States, Colorado River hardly flows into the Gulf of California. In the case of China, the Yellow River was dried up for 133 days in 1996 and for 226 days in 1997 (the year of drought) before it flew into the ocean. This phenomenon is rapidly increasing in recent years.

The second sign is a drop of the groundwater level. The groundwater level is dropping in the worldly important grain-producing regions, such as Texas in the United States, Punjab in India, and Heibei in China. If this continues, the seawater penetrates in the seaside areas and is blended with the fresh water. Therefore, people in those areas cannot use the groundwater as the fresh water.

There is 97 % of not-frozen fresh water in the underground aquifers, from which drinking water is provided to one-third of global population (The Earth Data Book, 2001).

The third is the pollution of groundwater. The water stays in rivers for 16 days on average, whereas it stays underground for 1,400 years. Large quantities of synthetic chemical substances and heavy metal are released, gradually penetrate in the groundwater, and are stored up in the underground aquifers.

The fourth is the decrease of glaciers in the North and the South Poles, which is due to the global warming. Some river flows from glaciers. So the decrease of glaciers signifies the decrease of resources of freshwater. Similar to fossil aquifers, there will be less water than the amount of water that needs to be supplied to rivers.

The signs described above shows that we are withdrawing the "principal of a fixed account" of water resources, or, a source of our lives.

If we keep using the water in the same manners, fresh water resources will be dried up in 10 - 20 years. This will directly strike the food production and put 1.3 billions people into starvation, who currently live with less than 2 dollars everyday.

Average precipitation in Japan is about 1,700 mm per year, which is twice as that of the world average. There is plentiful water so Japan has been called “the country of beautiful scenery” since the ancient time.

However, Japan relies 80 % of foods on other countries and imports foods from them the most of the world. Importing foods is equal to importing “water.” Therefore, we need to be aware of the fact that the satiation of our country deprives water resources of other countries.

#### Statistical Information

Water Balance in Japan (The National Land Agency, *Water Resources in Japan*, 2000)

- Average precipitation: 650 billions tons/ year
- Average amount of evaporation: 230 billions tons (35 %)/ year
- Average amount of water use by human: 80.2 billions tons (12 %)/year (Details are; agricultural use; 59.0, living use; 16.4, and industrial use; 13.8)

Of the rest 338.8 billions tons (57 %), most flows into the ocean through rivers while a part remains as groundwater.

“Water possesses strong abilities of dissolving, transporting and classifying various substances. It circulates dramatically but smoothly, leaving from and going back to the ocean while changing into vapor, fluid water, and ice” (Yasushi Kitano, *The Science of Water* (new edition), 1995).

“We have underestimated the nature as follows; water is so extensive and clear that nothing can change its color; rivers are so huge and affluent with water that no human activities can change its quality; and trees and natural forests are affluent that they will never extinct but regenerate” (Address by Victoria Chilabo, the Minister of Natural Resources and Tourism in Zimbabwe, in the Environmental and Developmental Committee in 1986, Saburo Ooki).

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