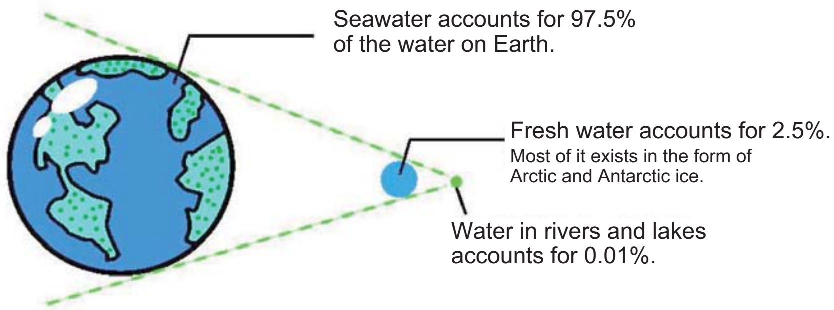
Building an Ultra Water Saving Society

Launched in 2007, the Water Security Council of Japan, or Team Water Japan, has been discussing a new water system for a global population of 10 billion. The Building Research Institute has taken on important related work including the development of an ultra water saving sanitary system.

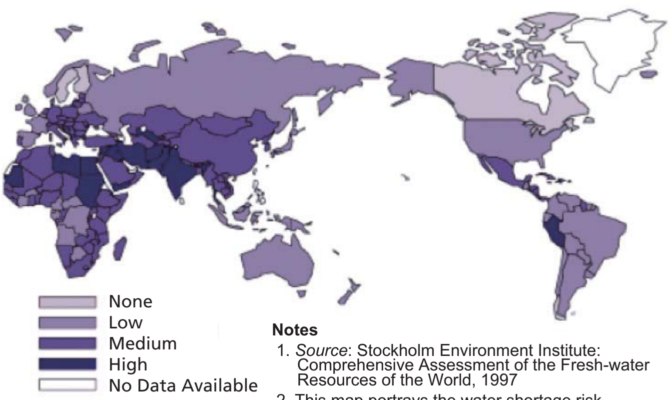
Fig. 1: Water Resources on the Earth



Only 0.01% of the water on the entire planet is available for our domestic use.

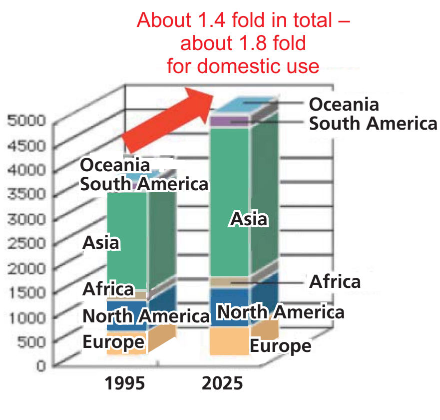
Fig. 2: Risk of Water Resources Shortage

Water Shortage Risk Levels



Notes
1. *Source*: Stockholm Environment Institute: Comprehensive Assessment of the Fresh-water Resources of the World, 1997
2. This map portrays the water shortage risk level of each country estimated from the current water consumption in comparison with water resources available, water supply reliability and compound indicators based on relations with state revenues.

Future Outlook of Worldwide Water Demand



Source: Ministry of Land, Infrastructure, Transport and Tourism: *Water Resources in Japan* (2009)

Many countries will face water shortage as a result of rapid population growth and social development that will lead to an increase in use of safe drinking water and of toilets.

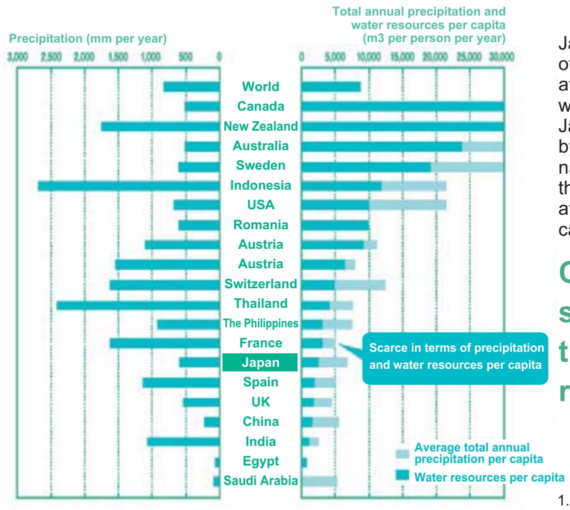
Fresh water accounts for merely 2.5% of the water on Earth. The proportion of usable water in rivers and lakes is as small as 0.01% (**Figure 1**).

At present, safe drinking water is not always available to 16% of people in developing countries, or to 13% of the worldwide population. Forty-seven percent of those living in developing countries or 38% of people around the world lack reliable access to toilets and other sanitary facilities. The contamination of water sources with human waste exacerbates the shortage of drinking water (**Figure 2**).

In urban districts of developing countries, demographic growth and concentration are intensifying. In these areas, it is a top priority issue to secure drinking water, to save water by controlling water demand, and to achieve sanitation by means of wastewater treatment to prevent the pollution of drinking water sources and infectious diseases.

However, it is becoming difficult to maintain the sanitary level and to preserve drinking water in a way that keeps pace with popu-

Fig. 3: Water Resources in the World and in Japan



Japan is located at the east end of Monsoon Asia, one of the rainiest regions in the world. The country's average annual precipitation is about double the worldwide average of the continental area. However, Japan's total annual precipitation per capita, calculated by multiplying the average annual precipitation by the national land area and dividing the resulting value by the total population, is around one third the global average. The internal renewable water resources per capita are less than half the world average.

China and the rest of Asia face serious water shortage. In Japan, the precipitation and the water resources per capita are limited.

1. ***Source***: Created on the basis of Ministry of Land, Infrastructure, Transport and Tourism: *Water Resources in Japan* (2009)

Notes:

1. ***Source***: Created by the Water Resources Department of the Ministry of Land, Infrastructure, Transport and Tourism on the basis of the AQUASTAT from the Food and Agriculture Organization (FAO).
2. ***Source***: Statistics Bureau of the Ministry of Internal Affairs and Communications: *Population Census* (2005) for Japan's population and Water Resources Department of the Ministry of Land, Infrastructure, Transport and Tourism for the averages of the precipitation and the water resources in 1975-200523/

Japan's average annual precipitation: About double the world average
Japan's water resources per capita: Less than half the world average

lation growth and concentration using the traditional approaches of different countries.

The modern water supply and sewerage system was established as a system for developed countries in the nineteenth century in which the global population was still less than one billion. It is premised on massive consumption of water and energy.

Given the limited capacity of water resources, this makes it very challenging to respond to worldwide population growth and to the modernization of developing countries.

The global population has been climbing rapidly since the advent of the modern age. It reached nearly 6.9 billion in 2010, according to the 2010 edition of the State of World Population report from the United Nations Population Fund.

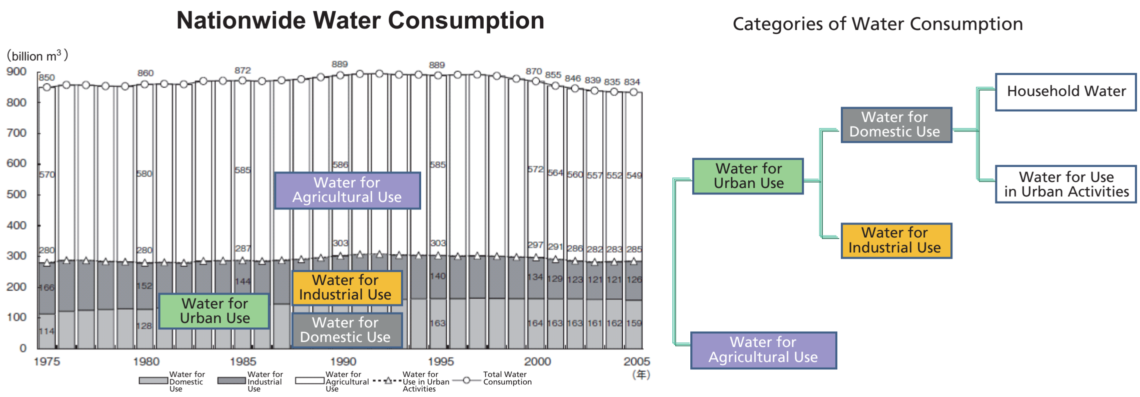
All environmental issues derive from population issues and problems with water resources are no exceptions. Needless to say, population control is ultimately essential. In recent years, the population increase has been slowing after a number of measures were adopted.

Even so, many researchers forecast that the worldwide population will reach around 10 billion at the end of the twenty-first century. It is essential to take this scale of population into consideration when studying water-related systems.

Japan has an average yearly precipitation of 1,700 millimeters. That is about double the worldwide average. However, the precipitation per capita is just about one-third the global average level. The precipitation range is wide, both seasonally and regionally. Especially in the populous Kanto region, the amount of water available is about a quarter of the nationwide average (**Figure 3**).

In 2005, water consumption for agricultural use in Japan amounted to 54.9 billion m^3, for industrial use 12.6 billion m^3, and for domestic use 15.9 billion m^3 (**Figure 4**).

Fig. 4: Breakdown of Water Consumption in Japan



Source: Created on the basis of Ministry of Land, Infrastructure, Transport and Tourism: *Water Resources in Japan* (2009)

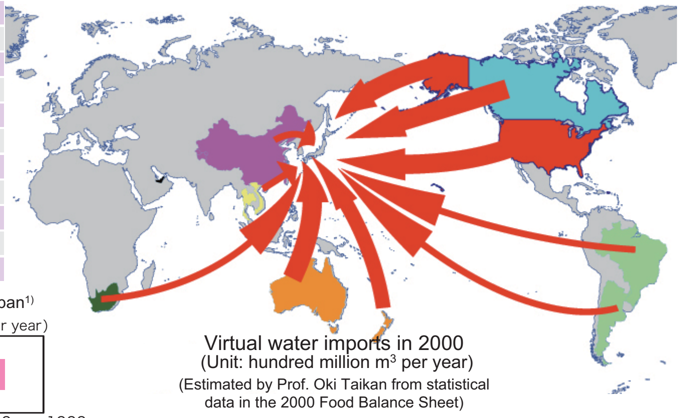
Domestic use of water is responsible for about 20% of the total water consumption. It accounts for nearly 60% of the total consumption of utility water for urban use.

Fig. 5: Japan as Global Water Consumer

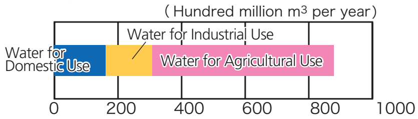
Import Origins of Virtual Water Consumed in Japan

(billion m^3)

USA	38.9
Australia & New Zealand	8.9
Canada	4.9
Brazil & Argentina	2.5
China	2.2
Denmark	1.4
Thailand & Vietnam	1.3
UAE	0.3
South Africa	0.3
Others	3.3
Total	64.0



Reference: Water Consumption in Japan[1)]



Source for 1): Ministry of Land, Infrastructure, Transport and Tourism: *Water Resources in Japan* (2009)

Japan imports as much as 64 billion m^3 of virtual water in a year. This quantity surpasses the quantity of water consumed for agricultural use in the country. (Japan's food self-sufficiency is about 40%.)

In Japan, agriculture is responsible for a very large percentage of water consumption, yet the country's food self-sufficiency is as low as about 40%. Imports of agricultural and livestock products effectively means that Japan consumes the water required to produce these products. This concept of water is called virtual water.*1 As a food importer, Japan consumes a huge amount of virtual water by importing food.

At the moment, Japan imports as much as 64 billion m^3 of virtual water per year, which surpasses the annual water consumption of 54.9 billion m^3 for domestic agricultural use (**Figure 5**).

Improving Japan's food self-sufficiency would require extra water resources, but efforts to cut industrial water consumption are nearing their limit.

On the other hand, domestic water consumption accounts for about 20% of total water consumption in Japan, and urban water consumption for around 60% of total utility water consumption. They suggest that there is sufficient room for reducing this consumption. To prepare for water shortages caused by abnormal climate conditions and for the suspension of water supply after a disaster, it will be vital to reduce this water consumption.

Because of climate change, circumstances surrounding water resources are increasingly uncertain. To effectively utilize water sources and build a social foundation that is resistant to various issues arising from the water resources, it is necessary to work strategically to secure water sources and to make effective use of water.

In Japan as well, these issues attracted public attention as a matter of water security and became increasingly recognized as pressing problems. In 2007, the Water Security Council of Japan (WSCJ), also known as Team Water Japan for Global Water Security, was established.

Constructing a Water System for 10 Billion People

A study of a water system designed for the world population of 10 billion has only just begun. Many different investigations are underway in separate related domains. They range from research to improve existing water supply and sewerage technologies to eco-sanitation technologies such as compost toilets.

Initiatives for ultra and hyper water saving in buildings have been sporadically implemented in areas facing difficulty in water supply and for economic reasons. They are helpful to construction of a water system that can serve 10 billion people in many different respects, including minimization of the water supply and sewerage infrastructure, advanced and recycling treatment of wastewater taking advantage of the effect of the reduction of the wastewater volume, and prevention of environmental contamination with sewage water by means of separated treatment.

The ultra water saving technology in buildings is consequently drawing attention as one of the fundamental technologies of a water system for 10 billion people.

Ultra water saving and its benefits

(i) Ultra water saving for reducing water consumption

Domestic water consumption constitutes about 60% of water consumption for urban use. Nearly 80% of it is household water and the remaining 20% is for use in urban activities.

Household water consumption could be lowered to around 50% of the current level by intensively using water saving technologies.

The water consumption of the sewage water treatment line may be cut by 95% or more. In addition to mere water saving, the option of full recycling and reuse on site is becoming viable in economic terms.

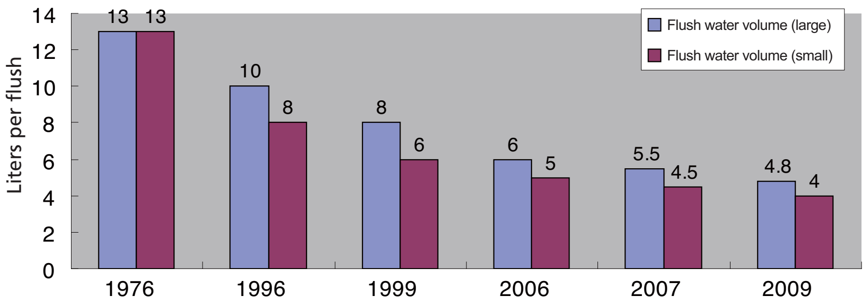
(ii) Ultra water saving for reducing the burden on the existing water supply and sewerage infrastructure

Water saving in buildings is expected to reduce the burden on the existing water supply and sewerage infrastructure as well as long-time social costs for operation and maintenance.

(iii) Ultra water saving for easing the burden for infrastructure construction

The economic burden for the con-

Fig. 6: Trend in Flush Water Volume for Toilet Bowls



struction of new infrastructure can be minimized by planning a minimized water supply and sewerage infrastructure premised on buildings that incorporate water saving technologies.

(iv) Ultra water saving for reducing the impact that pollutes the water environment

It is possible to attenuate the environmental impact by introducing advanced treatment with sewerage, septic tanks and suchlike, and to treat nutrient salts by capitalizing on the surplus capacity of the existing treatment facilities generated from the water saving.

The water saving will also dramatically boost the applicability of recycling treatment technology, which hitherto has not been economically viable. It also enables a separated treatment technology involving individual treatment of the sewage water.

Given these social circumstances, the Water Security Council of Japan (WSCJ), or Team Water Japan, launched in 2007, has been discussing a new water system for a global population of 10 billion. At the Water Week Commemorative Symposium organized by the Ministry of Land, Infrastructure, Transport and Tourism in July 2010, it proposed the construction of a water saving society.

On the basis of that suggestion, the Takumizu Team, represented by Sankai Toshihiro of the Building Research Institute, was registered with the WSCJ in February 2011 as a new action team aiming at building a water saving society. It recently commenced its activity.

Technological Development Relating to Ultra Water Saving in Buildings by the Building Research Institute

The Building Research Institute has been studying the construction of a water saving society in collaboration with the industrial, governmental and academic sectors through its activities in Team Water Japan and in the Water Week Commemorative Symposium.

With respect to water saving, considerable progress was made in technical development by technological development efforts in the private sector. For further stepping up the water saving, it is indispensable to overcome technological issues involved in water saving, ultra water saving and hyper water saving.

Take the western-style toilet bowl for example. The latest model produces a significant water saving effect as it consumes less than half the amount of water consumed by the 1976 model in a single flush (**Figure 6**).

However, with this water saving toilet bowl, the wastewater drainpipe could be blocked. That prevents it from being used in any non-residential applications. The wastewater piping for non-residential applications is more complicated and longer than that for residential use. Paper consumption is relatively larger in non-residential applications.

Moreover, even if it is confined to residential use, it has a drawback in waste conveyance performance through the wastewater piping. It is difficult to reduce water consumption beyond about five liters per flush. Toilet bowls for aircraft, trains and suchlike with a flush water volume of several hundred milliliters or less per flush have already found practical use. They used a special technology that averts the problem on waste conveyance in the wastewater drainpipe.

To improve water savings in residential and other buildings, it is essential to eliminate the bottleneck of waste conveyance through wastewater piping, while still meeting the legal requirements on sanitary performance in buildings. Studying not just the toilet bowl but the entire system, including wastewater piping, is indispensable. The application of technologies used on aircraft and trains to buildings must also be studied.

The Building Research Institute has developed a system with a hyper water saving toilet bowl consuming 600 milliliters or less of water per flush. It is designed to address the problem with existing individual septic tank. **Figures 7 and 8** illustrate an example of its achievements.

On the basis of the research findings, the Building Research Institute will be continuing its research and development activities to resolve technical issues on the system of ultra water saving sanitary equipment in buildings.

The purpose of these activities is to help use water resources effectively and to reduce the impact on the environment by clearing the technical hurdles associated with a system of ultra water saving sanitary equipment in a building. This is a first step towards creating a society that conserves water, in anticipation of a world population of 10 billion.

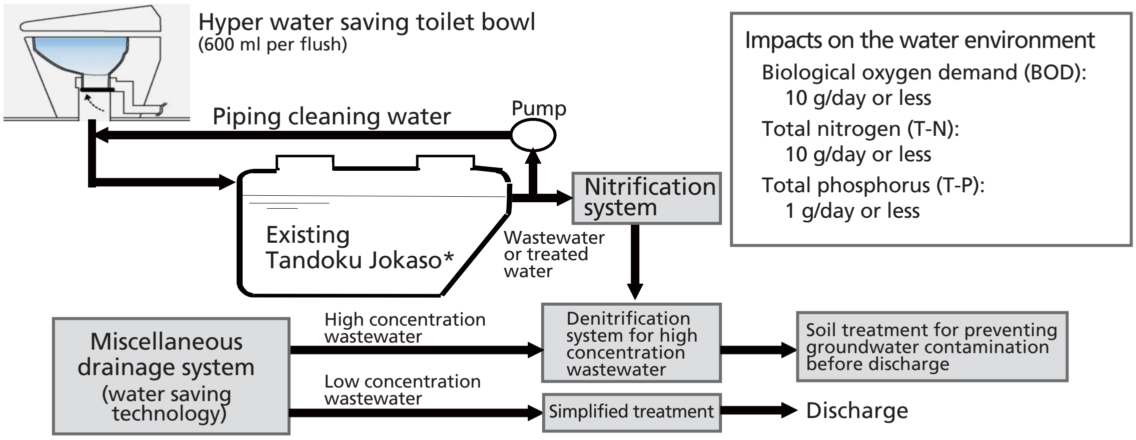
The focus of the study is a system of hyper water saving sanitary equipment, comprising:

(i) Apparatuses and devices with low water consumption, such as an ultra water saving toilet bowl with a flush water volume of around five liters, a hyper water saving toilet bowl with a flush water volume of about 600 milliliters, and water circulating bathtubs and dishwashers that achieve huge water consumption cuts;

(ii) Water supply and wastewater equipment compatible with ultra and hyper water saving devices; and

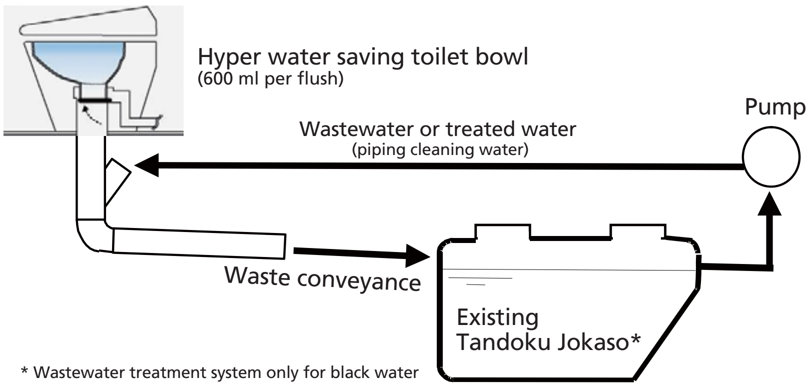
(iii) On-site wastewater treatment

Fig. 7: Water Saving Wastewater Treatment System for Household Use Compatible with Existing Tandoku Jokaso*



* Wastewater treatment system only for black water

Fig. 8: Wastewater Pipe Cleaning System Ensuring Waste Conveyance



* Wastewater treatment system only for black water

equipment with ultra and hyper water saving performance.

With regard to onsite wastewater treatment equipment with ultra and hyper water saving performance, consideration will be given to separate human waste treatment facilities in regions served by sewerage systems and to wastewater treatment facilities designed for developing countries.

Technologies for planning, designing and evaluating the system of hyper water saving sanitary equipment and those for assessing the basic technologies that constitute the system will be established.

It is said that the twenty-first century is an era of water. Preservation and effective use of water resources are an issue of international significance.

The world is facing a universal challenge of surpassing the modern water supply and sewerage system that was created in the United Kingdom in the nineteenth century and that now stands as a de facto standard in today's society.

It would be difficult for the traditional modern system of water supply and sewerage to support a global population of 10 billion. With respect to flush toilets, however, research is underway on the issues of:

(i) Toilet systems free from water consumption, such as the dry toilet or the composting toilet;

(ii) Toilet systems with hyper water saving toilet bowls for minimizing water consumption; and

(iii) Toilet systems with fully cyclic use of water.

The Building Research Institute is striving to create an ultra water saving sanitary system that corresponds to the systems mentioned in (ii) and (iii) above. It comprises technology for ultra-low water consumption throughout the building, including toilets, and technologies for the reuse and full recycling of water and for separated wastewater treatment that can be introduced as a result of the ultra-low water consumption. Based on a simple and plain concept of ultra water saving, a feature of this system is that it can be effectively used to upgrade modern water supply and sewerage systems and build distributed on-site treatment systems.

Civilized society is vulnerable to damage caused in the event of disaster. Should the electric power or water supply and sewerage system fail, it is difficult even to maintain a living environment with a minimal level of sanitation.

In any event like this, assistance to victims and the burden on infrastructure may be eased considerably if the sanitary living environment needs less water. Water saving and ultra water saving will work very effectively in the case of providing toilets and other sanitary facilities with a function that maintains minimum functionality even in a disaster.

It is believed that the question of securing the ability to respond to damage from disasters and other events should also be scrutinized at the time of studying water saving and ultra water saving measures in buildings.

Notes: 1. Virtual water. Virtual water refers to the volume of water required for the agriculture and livestock that is regarded as being traded at the time of importing and exporting agricultural and livestock products.