Water Solutions that Help Protect Ecosystems

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OVERVIEW: The 21st century has been called the "water century" because of problems such as water pollution and water shortages in various parts of the world. By supplying a variety of products associated with the protection of water resources, Hitachi has been playing a part in helping solve these problems. In addition to the supply of products and systems, Hitachi is promoting its intelligent water system concept which aims to optimize the water cycle across cities or entire catchments, undertaking actions targeted at coordinating the operation of water treatment with information and control systems. New initiatives by Hitachi based on this concept and aimed at ecosystem protection include protection of endangered species by providing water supplies in desert regions and protection of marine ecosystems by treating ship ballast water or removing red tide algae.

INTRODUCTION

WITH two-thirds of its surface covered by ocean, the Earth has been called a water planet, yet fresh water accounts for less than 3% of the global total. Of this, the proportion of fresh water in directly accessible locations such as rivers, lakes, and aquifers is smaller still.

While fresh water is essential to terrestrial ecosystems as well as human activity, it is unevenly distributed across the world's limited land areas and in many places access to safe water is difficult (see Fig. 1). According to the World Health Organization (WHO), growing demand, increasing pollution, and other water issues are manifesting themselves as a result of factors such as the increasing populations in developing and emerging economies and the relentless progress of economic activity. As a consequence, it has been reported that 1.1 billion people around the world do not have access to safe drinking water and 2.6 billion do not have basic sanitation infrastructure such as sewage systems. The United Nation's MDGs (Millennium Development Goals) have set a target of cutting these numbers in half by 2015.

In Japan, meanwhile, with most of the country being well endowed with water resources and a high proportion of the population served by water

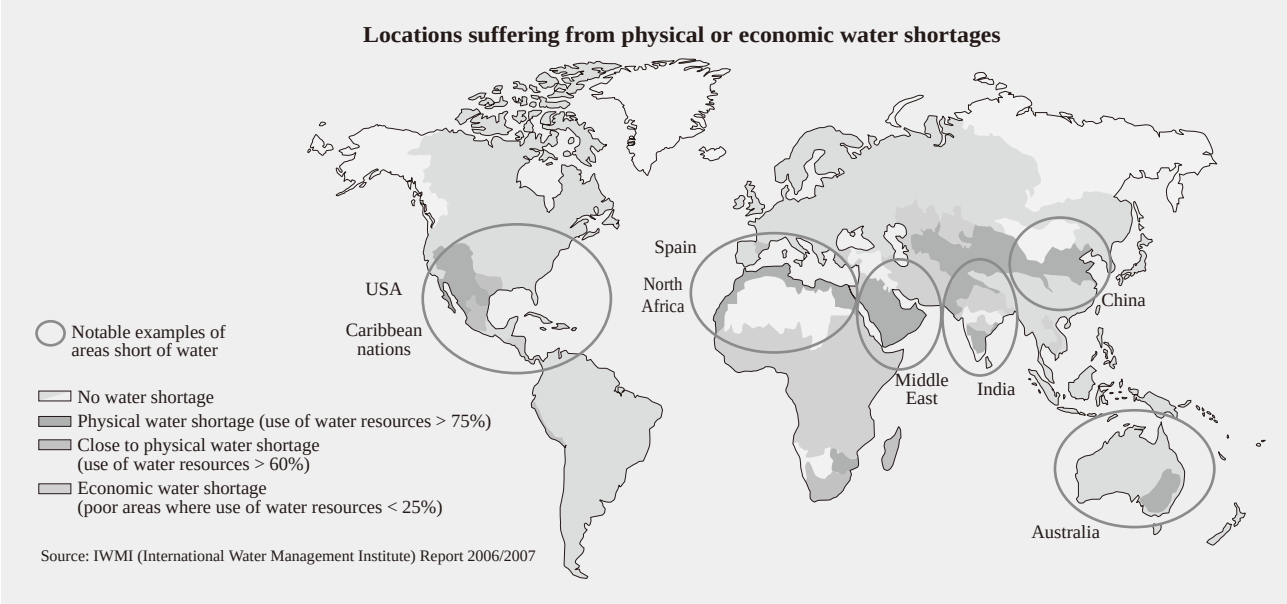

Fig. 1—State of Global Water Resources.
Most areas suffering from physical or economic water shortages are in the lower latitudes.

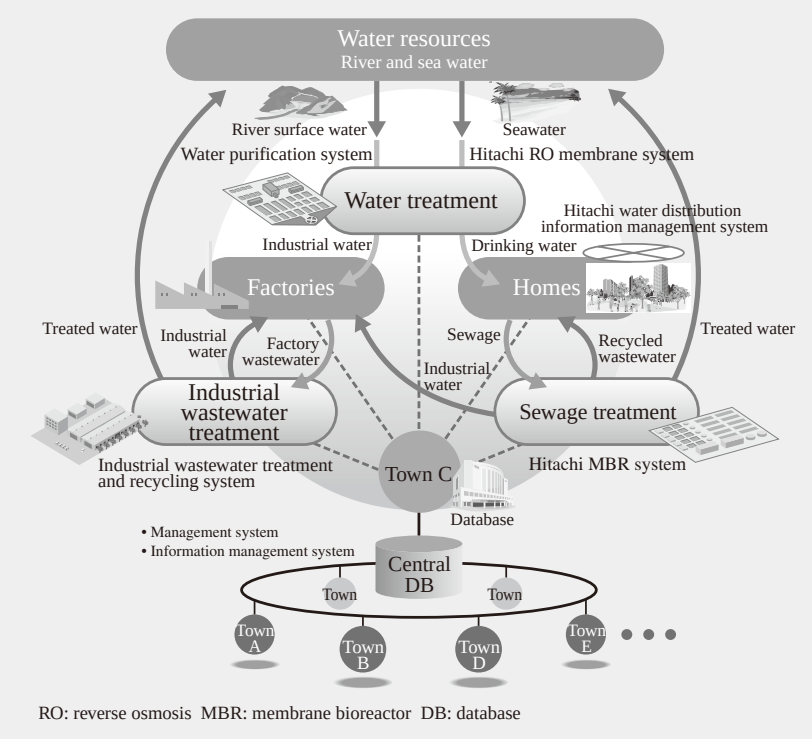

Fig. 2—Intelligent Water System Concept. The concept aims to achieve overall optimization of water resources for a city by integrating excellent water treatment systems with advanced information management systems.

supply and sewage infrastructure, daily life normally offers few opportunities to appreciate how precious water really is. However, when the Great East Japan Earthquake in March 2011 damaged much of the water supply and sewage infrastructure, it made people aware once more of the importance of water. It is also possible to look at things in terms of "virtual water" whereby the high proportion of Japan's food that is imported means it is indirectly importing the water used in the production of grain and livestock. The essential role of water in supporting life is as important in Japan as it is in other countries.

The 21st century has been called the "water century" during which problems associated with water will come to the fore. It is recognized that the need to secure water resources and ensure their efficient exploitation, appropriate treatment, and reuse is growing globally and it is desirable that people set out to solve these challenges in a way that takes account of ecosystems and other aspects of the environments in which water is found.

This article describes Hitachi water solutions that help protect the ecosystem.

CONTRIBUTION TO WATER SAFETY AND SOCIETY

Hitachi has been supplying products and other technologies relating to water resources for close to a century.

Specifically, the water-related systems supplied by Hitachi in Japan total more than 500 water supply systems, more than 2,800 sewage systems, and more than 200 industrial water systems including facilities supplied to the electricity, steel, and automotive industries. Hitachi also has experience in fields like hydrosphere purification.

Water supply and sewage systems are part of the basic infrastructure that supports our way of life. To contribute to their safety and security, the requirement is not only to supply advanced products but also subsequently to maintain their initial levels of performance and functionality over the long term so that they can remain capable of continuous operation. To achieve this, Hitachi in its role as manufacturer has an ongoing involvement in the inspection, repair, and other maintenance of these products.

For example, facilities supplied by Hitachi suffered significant damage in the Great East Japan Earthquake referred to earlier and the subsequent tsunami. In response, Hitachi worked together with the operators of these water supply and sewage systems in the immediate aftermath of the disaster to get them up and running again. As a result, more than 60% of the damaged facilities were back in operation within a month. For the remaining facilities, Hitachi has been doing its utmost to survey their status and investigate remediation measures.

FUTURE DIRECTION FOR WATER RESOURCES

In recent years, Japan has achieved a high level of adoption of water supply, sewage, and other water infrastructure and is now in an era of "ongoing management" in which safety and security are maintained through the appropriate management of existing facilities. In emerging economies, meanwhile, the trend toward constructing advanced environmental cities, which include water infrastructure, is accelerating in various parts of the world.

In response to these new circumstances, Hitachi in addition to supplying its excellent products also recognizes the importance of creating an intelligent environment for water systems by integrating these individual products to achieve overall optimization. Hitachi has gone on to consolidate this approach to optimizing the water cycle across cities or entire catchments in the form of its proposed intelligent water system concept (see Fig. 2).

For example, water treatment systems supplied by Hitachi to support water resources include seawater desalination systems using RO (reverse osmosis) membranes, industrial wastewater treatment and recycling systems, and MBR (membrane bioreactor) systems for sewage treatment. However, providing a high-quality sewage treatment system on its own is not enough to optimize the water cycle across cities, catchments, or other environments. Instead it is necessary to manage the entire water cycle in ways such as keeping water resource use to a minimum and treating sewage effectively so that the water can be reused.

Hitachi's approach is to work toward the overall optimization of the water cycle through the sophisticated and integrated management of water treatment systems using information and control systems in the belief that this will lead to the protection of water resources and ecosystems. In addition to supplying water treatment and information and control systems, Hitachi seeks to operate a global water resource business that is comprehensive in scope, extending from planning through to construction, maintenance, and commercial operation. One example of this is its investment in Malé Water & Sewerage Company Pvt. Ltd. in the Maldives.

EXAMPLE WATER TREATMENT SYSTEMS DESIGNED FOR ECOSYSTEM PROTECTION

Hitachi is proceeding with a number of practical initiatives based on an intelligent approach to protecting water in the environment through the overall optimization of the water cycle.

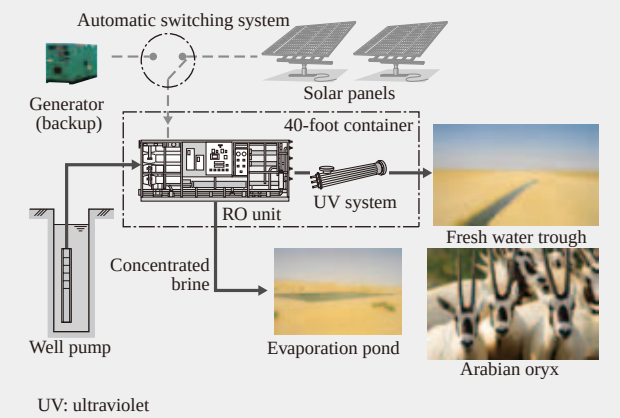

Fig. 3—Flow Chart of Solar RO System.
Salt-contaminated groundwater is pumped up and then desalinated in the RO units to produce fresh water. Photovoltaic generation provides the operating power.

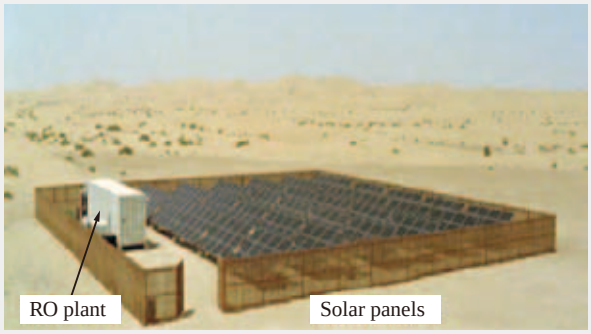

Fig. 4—Example Solar RO System Site.
The 35-kW standalone photovoltaic generation system powers an RO unit which can produce 4 m^3/h of fresh water.

The following sections introduce some recent case studies of water treatment systems and businesses that deal with ecosystem protection and other aspects of water in the environment.

Use of Water Treatment to Protect Endangered Species

The Arabian oryx is a member of the bovid family with long horns. Despite being admired in the Arab world for its beauty which is extolled in works of art and literature, its low remaining population has seen it designated as an endangered species. As well as diminishing the biodiversity of the Arabian peninsula, its extinction in the wild would constitute the loss of a cultural treasure. To prevent this, the government of the United Arab Emirates (UAE) is taking steps to protect the Arabian oryx through a project which uses water treatment systems powered by energy from the sun. The project is a prominent example of what the UAE is doing to protect the ecosystem and Hitachi is also contributing.

Use of renewable energy for water treatment

Demand for safe drinking water in the UAE is forecast to grow rapidly. Sea water desalination plants are an important technology for this nation poor in fresh water resources, but because they consume large amounts of energy, use of solar or other forms of renewable energy has become essential amid concerns about depletion of natural resources.

The Environment Agency—Abu Dhabi (EAD) has set out its future plans and associated strategies for the environment which make particular note of protection of the Arabian oryx. In a pioneering project which forms part of this strategy, the EAD has constructed 30 combined desalination systems and solar power plants, the latter comprised of photovoltaic panels. Hitachi Plant Technologies, Ltd. won a contract to construct 15 of these units. The units are installed in comparatively remote locations in the central, eastern, and western regions of the Rub'al Khali Desert. They use RO membranes to desalinate groundwater with a high salt concentration in remote desert locations to provide the water resources required to sustain biodiversity.

Obtaining groundwater and construction of desalination systems

The source of water for this project is groundwater drawn from wells which has a salt concentration of up to 35,000 ppm. An RO membrane is used to desalinate the water and the units include an evaporation pond with a design that considers the rate of evaporation and surface area to prevent the highly salty wastewater from contaminating the environment. To prevent the water from becoming stagnant, troughs have been constructed for recirculating the fresh water produced by the units.

Because each of the units operates on its own in a remote location, no central power supply is available. For this reason, the units include a photovoltaic power system to provide an ideal solution that supplies the power required to operate the units with minimal burden on the environment (see Fig. 3 and Fig. 4).

Use of Water Treatment to Protect Marine Ecosystems

Hitachi's ballast water purification system

Hitachi's ballast water purification system complies with the rules stipulated for ballast water management (International Convention for the Control and Management of Ships' Ballast Water and Sediments) with the aim of preventing harm to the environment, property, and resources caused by the transport of harmful aquatic organisms and pathogens in ships' ballast water and sediments. This system works by adding magnetic powder and coagulant to the water being treated (sea water, brackish water, or fresh water) causing any plankton, microorganisms, sand, or similar material it contains to clump together with the magnetic powder in small clusters of about 1 mm (called "flocs"). A magnet and filter can then be used to separate out these flocs efficiently so that the treated water satisfies the standard for ballast water discharge. A feature of this environmentally sustainable system is that it does not use any disinfectants and it is designed to avoid harm to living things, the environment, and the ship itself. As the only such system in the world to not be based on sterilization, it was granted the first type approval by the Japanese government in March 2010. Subsequently, in December 2010, the first commercial system unit (with a capacity of 800 m^3/h) was installed in the Sunny Joy, an LPG (liquefied petroleum gas) carrier with a tank capacity of 78,000 m^3 owned by Yuyo Steamship Co., Ltd. (see Fig. 5). Hitachi is now marketing the system as a technology able to help protect the marine environment and biodiversity.

Fig. 5—Sunny Joy LPG Carrier Fitted with Hitachi's Ballast Water Purification System and Owned by Yuyo Steamship Co., Ltd.
An LPG (liquefied petroleum gas) carrier with a capacity of 78,500 m^3, the Sunny Joy mainly operates on the sea lanes linking the Middle East and Asia.

Red tide removal system

By taking advantage of the features of magnetic separation with its ability to treat water at high speed, the scope of application of the ballast water treatment technology is being expanded to the separation of oil and water from oil-associated water. This section describes a system supplied to remove red tide plankton.

The ill effects of red tide algal blooms have been reported along the coast of Oman and the gulf coast

Fig. 6—Red Tide Removal System Installed in the Gulf Coast of the Arabian Peninsula.
The plant has a capacity of 400 m³/h and is installed in four 20-foot containers for ease of transport.

of the Arabian Peninsula in the Middle East. Red tides can have a severe impact on aquaculture and seawater desalination plants, including the shutting down of a seawater desalination plant in the UAE for about a month during 2010(1). Although the use of algaecides(2) has been proposed as a countermeasure for this problem, there are concerns about their impact on the environment. Instead, the EAD has installed a ballast water treatment system as a demonstration to investigate its potential as a way of removing red tide algae without placing a large burden on the environment. Because they wished to test it at a number of different locations, the system was containerized.

The system has capacity of 400 m³/h and was installed at locations in the gulf coast of the Arabian Peninsula that are prone to outbreaks of red tide. Fig. 6 shows a photograph of the system after installation. To track the varying depth of the red tide, the water collection unit is able to move between depths of 1 m to 7 m. Based on the results of the demonstrations, the EAD intends to move the system to a new site in the summer of 2011 and continue collecting data.

For the future, Hitachi intends to establish techniques for reusing the magnetic powder as well as reducing other operating costs and, based on the data collected from the trial, will market the system for applications such as pre-processing at seawater desalination plants.

CONCLUSIONS

This article has described Hitachi water solutions that help protect the ecosystem.

Water is an important resource essential to all sorts of life forms, not just humans. Hitachi intends to continue contributing to the protection of water resources as well as ecosystems by the overall optimization of the water cycle through new initiatives such as intelligent water system and by supplying a range of specific products.

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