Kumamoto, Japan

Using natural systems for groundwater conservation: mineral water from the tap

In cooperation with neighboring municipalities, Kumamoto City has maintained groundwater recharge levels and protected watershed forests. By protecting the natural systems and conserving Kumamoto's high-quality groundwater, the city can provide its citizens with high quality "mineral water from the tap". Over 472 hectares of farmland which are flooded in selected months and watershed protection of about 550 hectares contribute to this success.

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Abstract

Kumamoto City presents a good example for protecting and making effective use of the existing natural environment to provide quality public services. The city is endowed with high-quality groundwater. Among Japanese cities with a population of 700,000 or more, Kumamoto is the only city where almost all of its water supply is from groundwater - rare even worldwide. Kumamoto City adopted the "Declaration of the Groundwater Preservation City" in 1976, and has since made a continuous effort to conserve groundwater. It has also pro-actively worked with neighboring municipalities to conserve water.

Population / Land area
~ 730,000 (2010) / 390 km^2

Municipal budget
Approx. 253 billion Yen (2010)
(US$ 3 billion)

Kumamoto joined ICLEI in April 1995

Importance of water conservation in urban growth

The city does not have an alternative source for groundwater, and may face a crisis when the groundwater dries up or is polluted. Kumamoto used to be called the 'City of Forest', but with rapid urbanization since the early 1970s the amount of groundwater that percolates has decreased while water use has increased. The decline in groundwater recharge levels from paddy fields, which is due to the practice of converting paddy fields to dry fields, has accelerated the fall in groundwater levels. One third of Kumamoto region's annual groundwater recharge of about 640 million m^3 comes from the recharge of paddy fields. With declining rice consumption and low prices less land is used for rice production, with a substantial decrease in the recharge from these fields. The use of paddy fields for rice production has dropped to about 50 percent of the areas that used to be paddy fields. It has also become imperative to take countermeasures against groundwater pollution caused by excessive nitrogen from fertilizers and livestock waste.

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Case Study

City context

Kumamoto City is located in the southwest of the Kyushu Island. The city has a gentle terrain stretching out below the Mount Aso in the east and to the Ariake Sea in the west. Kumamoto city has the third largest population in Kyushu, next to Fukuoka and Kitakyushu.

Photo: Kumamoto City

Water-saving month parade.

The groundwater system, an integration of natural endowment and human effort, has contributed to the development of the climate and culture of Kumamoto. The Kumamoto Region with 11 municipalities including Kumamoto City is located between the western foot of the Aso Caldera Rim and the Ariake Sea.

The Mount Aso erupted four times over the period 270,000 to 90,000 years b.c. Pyroclastic flows from these eruptions deposited and accumulated into a layer. Rain can easily percolate through this layer and flow on the underlying bedrock, an impermeable stratum, at a relatively fast rate. It takes five to 20 years, on average, for groundwater to discharge in this region, which is relatively fast in comparison to other places.

About 400 years ago, Kiyomasa Kato, the first lord of Higo Kumamoto Province, carried out a large-scale paddy field development in the middle basin of the Shirakawa River to make groundwater more abundantly available. Due to the soil, where water can easily percolate through, paddy fields in this region have a recharge rate five to ten times greater than that of other regions, and are therefore called “strainer paddy fields”. Water percolates through these paddy fields and flows out in the city center. Tap water in Kumamoto City comes from groundwater, which is chlorinated only at a minimum level without further purification. As a result citizens can drink “mineral water from the tap”.

Groundwater conservation through extensive cooperation

Kumamoto City has carried out various initiatives to conserve its groundwater, including the adoption of the Declaration of the Groundwater Preservation City in 1976, and the installation of groundwater observation wells in 1986. As part of these efforts, the city has conducted research on groundwater flows.

The research has revealed that the groundwater recharge depends on the farmland and forests in the upper and middle basins of the Shirakawa River and the Midorikawa River, which run through the towns of Ozu, Kikuyo and Mifune, municipalities located in the east of Kumamoto City.

As a result, the city needs to cooperate with neighboring municipalities in order to conserve groundwater. The city formulated an agreement to maintain and increase the groundwater recharge through cross-municipal cooperation. Major cooperative initiatives started in 2004. It included a project to flood converted paddy fields in the mid-basin of the Shirakawa River and to maintain the watershed protection forests in the upper basin.

Project to flood converted paddy fields. In order to maintain the recharge from paddy fields Kumomoto city started a flooding project through the cooperation with the Council for Sustainable Water Use in Agriculture, which consists of Kumamoto City, Ozu and Kikuyo towns, four local land improvement districts, JA (Japan Agricultural Cooperatives) Kikuchi and JA Kumamoto City East Branch, in 2004. The project provides subsidies to encourage farmers to flood their converted paddy fields with water from the Shirakawa River everyday for one to three months between May and October. Farmers may flood their fields after harvesting and before planting and growing crops.

The amount of subsidies depends on the length of flooding. The flooding is effective not only to recharge groundwater levels, but also to limit negative effects of weeds, insects, diseases, and continuous cropping. Moreover, flooding helps to reduce the use of agricultural chemicals, prevents groundwater pollution and reduces financial costs.

Flooding period	Subsidy per 0.1 hectare
1 month	11,000 Yen (~ US$ 131)
2 months	16,500 Yen (~ US$ 196)
3 months	22,000 Yen (~ US$ 261)

Converted paddy fields

To ease the fall of rice prices, caused by the decline in rice consumption and surplus of rice, the government of Japan has limited areas and amounts of rice production. Farmers are forced to produce crops other than rice in their paddy fields. These fields are known as “converted paddy fields.” Converted paddy fields are not flooded when they are used for cultivation of crops other than rice, and therefore do not contribute to groundwater recharge.

Land improvement districts ("Midori Nets")

A Midori Net is a local organization that carries out land improvement projects, such as the development of channels and farmlands to maintain the infrastructure for agricultural production. It mainly consists of local farmers and other parties related to agriculture.

Establishing a brand for agricultural products. Rice production requires a particularly long period of flooding of four to five months. In this area, the production of one kilogram of rice results in a groundwater recharge of about 20 to 30 m^3. As such it is important to encourage that rice production is continued and the local farm management stabilized. Rice and vegetables produced in this area have subsequently been marketed under special brand name 'Gift of Water'.

Maintaining and protecting watershed forests. Important watershed forests, which are vital to Kumamoto City, are located in the upper basins of the Shirakawa River and the Midorikawa River outside the city. Like rice fields, the maintenance of watershed forests requires cooperation among neighboring municipalities. Having seen the serious damage caused by the flood of the Shirakawa River in 1953, municipalities in the upper basin and those in the lower basin recognize that maintaining forests is crucial for disaster and flood prevention, and pro-actively work together towards mutual benefit. In the past, the major tree species planted were conifers for the forest industry. Since 2004, however, increased planting of broad-leaved trees has taken place, in order to improve recharge capacity of the forests. At the same time the forest industry is declining. From the perspective of biodiversity, the increase of broad-leaved forests is expected to provide more habitats for a wider variety of species.

Photo: ICLEI Japan

Flooding of a converted paddy field. A sign is placed in every field showing the period of flooding.

Photo: ICLEI Japan

This free flowing well, as one of the city's water sources, discharges 14,000 cm^3 of groundwater at 18 degrees Centigrade everyday of the year.

Conserving water quality. For Kumamoto City, where all of its water supply is from groundwater, the rise of nitrate-nitrogen concentration in groundwater in recent years is a pressing issue. The city developed the Second Plan for the Reduction of Nitrate-Nitrogen Loads in Kumamoto Region in March 2010, and has cooperated with farmers, the agriculture industry, and academics to promote various measures related to livestock waste and fertilizer application.

Raising awareness of citizens. Groundwater conservation cannot be achieved only by increasing recharge capacity. Kumamoto City is raising awareness among its citizens to reduce the use of water in the city. With corporate efforts, the water extraction limit imposed on major extractors, and the decline of agriculture, the overall water extraction has steadily decreased since the 1980s year by year. However, due to lifestyle changes, the use of groundwater in everyday life is on the rise. Kumamoto City has carried out various initiatives to emphasize the importance for saving water. At the beginning of the fiscal 2008, the city designated three months from July to September as the 'Water Saving Months', disclosing the amount of daily water use per person and promoting the use of water-saving devices.

Results and impacts of the project

Flooding of converted paddy fields. Since 2004 converted paddy fields are flooded regularly. In the fiscal year 2008, altogether 432 farmers flooded 472 hectares of converted paddy fields every month. When combined with 74 hectares that are flooded by three business entities every month, groundwater recharge totaled 16,370,000 m^3.

'Gift of Water' brand. The 'Gift of Water' brand for agricultural products produced in the mid-basin of the Shirakawa River are consumed at university and corporate cafeterias. These agricultural products from the Kumamoto Region not only contribute to groundwater recharge, but also support ecological agriculture that uses a small amount of agricultural chemicals. It reduces food mileage, contributes to the local economy and lowers environmental impact. The brand marketing helps to communicate that people can protect local water and agriculture.

Protection of watershed forests. Kumamoto City has maintained watershed protection forests of about 550 hectares. With the agreements with the neighboring municipalities on forest maintenance in 2004, the city has planted broad-leaved trees for the maintenance and protection of watershed forests of about 100 hectares by 2008. The entire effort, afforestation, growth, maintenance, and cutting, is being conducted on the premise that the earnings from the forests would be divided at a certain ratio (e.g. 30 percent to the government and 70 percent to the municipality; 40 percent for the public sector and 60 percent for the private sector).

Reduction in water consumption. The amount of water used per citizen has steadily decreased, which contributes to maintaining natural systems and supports their healthy functioning. The water-saving movement provides a chance for citizens, who used to take high-quality groundwater for granted, to become more aware of the importance and value of groundwater.

Lessons learned

Extensive cooperation is indispensable for the preservation of ecological systems. To tackle issues that cannot be solved within one administrative district or one municipality alone, cooperation with concerned adjacent municipalities is indispensable. Groundwater recharge in paddy fields and forests in neighboring municipalities is crucial for groundwater conservation. The maintenance of such fields and forests requires efforts and understanding by the related municipalities and the city as a consumer of water. Opportunities for the city include subsidies and purchases of agricultural land and products from the preservation areas.

Comprehensive perspectives are required. Until very recently, Kumamoto City has focused on the maintenance of the quantity of groundwater. In terms of quality, it has prevented contamination by volatile organic compounds (for example tetrachloroethylene and benzene) with early detection and early countermeasures before any serious damage is caused. Currently, the city is facing an issue of groundwater pollution caused by excessive nitrogen from fertilizers and livestock waste. Because of the widespread sources of the pollution, this issue cannot be solved only with efforts by the city. Cross-municipal cooperation is needed more than ever. Some wells can no longer be used for extraction because the nitrogen concentration of the water is too high. The city has developed a long-term plan to implement measures, such as appropriate treatment and use of livestock waste and development of treatment facilities.

Drawing upon citizen participation. Citizens can and do participate in planting, thinning, and weeding activities. Tree-planting ceremonies provide good opportunities for children to learn about the importance of water conservation.

Replication

Advances in science and engineering have made it possible to purify water by using sophisticated technology, albeit with considerable cost and energy. Protection and appropriate maintenance of the existing natural systems will lead to the provision of public services without additional future cost, but needs to build upon proper research and understanding of natural systems.

According to an estimate, dam construction and waterworks (excluding maintenance) for 100,000 tons of river water per day would cost nearly 65 billion yen (approx. US$ 7.7 billion). If Kumamoto City would have extracted water from rivers running through the city, it would need to spend a considerable amount more to remove sulfur from the Mount Aso. The city is taking advantage of the groundwater recharge system to obtain quality groundwater.

Kumamoto City has made an enormous effort to supply drinking water almost 100 percent from groundwater. Other municipalities may learn from the city's approach in providing public services by taking advantage of and protecting local natural systems.

Budget and finances

The 2010 budget of Kumamoto City allocated about 270 million Yen (approx. US$ 3.2 million) overall to the protection of the water environment, which includes about 54 million Yen (approx. US$ 0.64 million) for the flooding project in the mid-basin of the Shirakawa River and about 82 million Yen (approx. US$ 0.97 million) for the maintenance of watershed protection forests. Meanwhile, some local companies have provided funding for the project to flood converted paddy fields.

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Local Action for Biodiversity

The Local Action for Biodiversity (LAB) program is a global urban biodiversity program coordinated by ICLEI - Local Governments for Sustainability´s Global Biodiversity Centre, in partnership with the International Union for Conservation of Nature (IUCN). The LAB Pioneer program began in 2006 with a selected group of local and regional authorities from around the world, representing over 54 million citizens. The program provides an accessible and enabling platform for committed, leading local governments from around the world. This is achieved by profiling and promoting the importance of urban biodiversity and the role of local governments in its management, as well as by sharing the experiences, successes and challenges of urban biodiversity management in the participating cities and local authorities.
ICLEI provides guidance in assessment, planning and implementation; strategic networking opportunities; profiling opportunities for the participating local authorities at global and regional events; and creates a platform for local authorities to contribute to global advocacy on biodiversity issues.
www.iclei.org/biodiversity

Sources

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KUMAMOTO WATER LIFE

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