Master's Program in Environmental Sciences
Doctoral Program in Sustainable Environmental Studies
University of Tsukuba, Japan

# Completion Report of Domestic Internship in Japan

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# Contents

# Chapter 1 Report of Nagasaki

## 1.1 Regional visit to Nagasaki

The domestic internship participants from the University of Tsukuba visited some historical places related to the atomic bombing in Nagasaki, such as: the Nagasaki Atomic Bomb Museum, Memorial plaque for the ruined wall section of Urakami Cathedral, the Fountain of Peace, the Nagasaki Memorial Peace Park and the Peace statue. After, the historical journey of the participants continued to other places, which were: the old church of Oura Church (the biggest and oldest church in Japan) and the Glover Garden. Visiting both places showed the participants part of Japan's efforts in modernization and internalization.

### 1.1.1 Overview of the Nagasaki Atomic Bomb

An atomic bomb called 'fat-man" was dropped on Nagasaki by an American B-29 bomber, at 11:02 a.m. on August 9, 1945. It was dropped three days after the dropping of an atomic bomb on Hiroshima. The primary target was originally Ogura, but the upper air was cloudy due to previous bombing so the bomb was dropped on Nagasaki instead. This was because, according to orders, the bombardier had to drop it using his own eyesight. The atomic bomb had two main characteristics: The first one was its strong explosive power, which was much greater any other bomb, and the second one was, the radiation which came out such as neutrons and gamma rays. For the people who lived there, these characteristics had both short and long-term effects. The casualties were as follows (1)**:**

1) The number of dead: 73,884
2) The number of wounded: 74,909
3) The number of the sufferers: 120,820

Actually, there were even more sufferers as the number did not include future generations. People who were born to radiation suffers had a higher risk than others to contract an autoimmune disorder. From this tragedy and the hope never to experience such an error again, the Nagasaki Atomic Bomb Museum was built.

### 1.1.2 The Nagasaki Atomic Bomb Museum

Anyone who has visited the Nagasaki Atomic Bomb Museum might have feeling of

Note:

1.The Nagasaki Atomic Bomb Museum (upper left)
2.Nagasaki-type atomic bomb (Fatman) (upper right)
3.Damages caused by the blast (lower left)
4.Damages caused by the flash of heat (lower right)

Fig. 1.1 The Nagasaki Atomic Bomb Museum

sorrow for this tragic day in history which is reflected by the many artifacts that show the damages caused by the atomic bomb.

The Nagasaki Atomic Bomb Museum was opened in April 1996 as a part of the 50$^{th}$ anniversary projects of the Nagasaki atomic bombing (Fig. 1.1). This museum replaced the Nagasaki International Culture Hall, where a number of artifacts related to the atomic bombing were exhibited. In addition to these artifacts, the museum exhibits a number of photographs that depict the devastation caused by the atomic bomb and show the lead-up to this tragic day, and the history of the development of nuclear arms and our subsequent desire for peace (2).

The museum shows that the most of Nagasaki was destroyed, and a tremendous number of lives were lost. People who narrowly escaped immediate death suffered physical and psychological damage afterwards. Even now, many atomic bomb survivors are still suffering. The atomic bomb injuries and damages were divided into three groups according to the various forms of energy (3), as follows:

1) Atomic bomb burns:

After the bombing of Nagasaki, large areas of fire with an approximately 200 m diameter were spread over 4 km from the hypocenter. The ground temperature reached up to 6, 000 degree Celsius. Large number of population working outside was mainly affected by the burning of exposed parts of body. Almost 80, 000 people died. The total number of completely burned people was 11, 574.

2) Atomic bomb wounds:

The strong power of bomb explosion was calculated to be equal to 21, 000 tons of TNT. Victims were mainly affected by the direct explosive power and indirectly by the collapsing of their houses and from debris flow. Approximately, 18, 409 houses were damaged completely and 6, 835 houses were partially damaged.

3) Atomic bomb radiation injuries:

The chronic and long term effects of Nagasaki bombing were due to the spread of radiation from the atomic bomb. The explosion of the atomic bomb released radiation, mostly gamma and neutrons rays. A radiation dose more than LD50 (lethal dose) severely damaged the life of people near the one kilometer of the hypocenter. The effect of radiation is long term. It also damaged others types of living things due to the fallout of radiation left in atmosphere (environment). The persons who were not near the hypocenter did not die or become wounded, but after a period of time, symptoms of general fatigue, diarrhea, fever, leucopenia and appetite loss, resulted in many deaths.

### 1.1.3 Hypocenter of the atomic bomb explosion

We visited the point believed to be the hypocenter of the atomic bomb explosion. On the plaque written at that point (the monument in the figure marks the hypocenter) states that, on August 9, 1945, 11.02 a.m., an atomic bomb exploded 500 m and about one-third of Nagasaki City was destroyed, 150, 000 people killed or injured, and it was said

Fig. 1.2 Hypocenter of the atomic bomb explosion

at the time that this area would be devoid of vegetation for 75 years (Fig. 1.2). Now, the hypocenter remains as an international peace park and a symbol of the aspirations of the world for harmony (4).

### 1.1.4 Memorial plaque for the ruined wall section of Urakami Cathedral

During our visit, only the broken church wall of the Urakami Cathedral remained to be seen. It was located on a small hill about 500 m northeast of the atomic bomb hypocenter.

Construction of the church was started in 1895 and was completed in 1914 through donations and voluntary labor service by the Catholic believers. The explosion of the atomic bomb at 11.02 a.m., 9 August 1945 destroyed Urakami Cathedral which was the grandest church in East Asia at that time. Nagasaki City installed this plaque as a prayer for the repose of the souls of the atomic bomb victims and to ensure that this tragedy is never repeated.

We also visited the Nagasaki Memorial Peace Park. Thousands of colorful paper cranes were scattered around the Peace Park. These folded paper cranes are offered as prayers for eternal peace in the world. Other memorials found in this park included the Children's Peace monument, the Peace Bell, the Fountain of Peace, and the Peace Statue (Fig. 1.3).

The Peace of Statue  The Fountain of Peace

Fig. 1.3 Nagasaki Memorial Peace Park

The World Peace Symbol Zone was established to make a strong appeal to the world for the eventual realization of everlasting peace for all mankind under the pledge "Peace from Nagasaki" and to make Nagasaki a sacred place for world peace by displaying peace monuments donated from all over the world, such as:

- The Statue of a Maiden (the People's Republic of China)
- The Monument of People's Friendship (the Former German Democratic Republic)
- The Joy of Life (Former Czechoslovakia)
- The Statue of Peace (Former U.S.S.R)
- 'A Call' (Former Bulgaria)
- 'Dedicated to Peace' (Santos, Brazil)
- 'Earth Constellation' (St. Paul, Minnesota, U.S.A)
- The Monument to Peace (Porto, Portugal)

- The Hymn to Life (Pistoia, Italy)

The Peace Statue, a prayer for everlasting world peace and a symbol of the supreme hope of human beings, was unveiled in 1955 for the 10th anniversary of the atomic bombing. Its construction took five years and was made possible by donations from people in Japan and across the world. The statue is highly symbolic. The right hand points skyward to warn of the threat of nuclear bombs while the left hand stretches out horizontally to symbolize world peace and its lightly closed eyes represent a prayer for the repose of the souls of all atomic bomb victims. The statue is 9.7 m high and sits on a base 3.9 m in height. The sculptor was Seibo Kitamura, a renowned artist from Nagasaki Prefecture (4).

The Fountain of Peace was built in August 1969 for the victims who lost their lives in 1945 atomic bomb. The monument, which sprays water in the shape of a dove's wings, was made by Nagasaki City and the National Council for World Peace & the Abolition of Nuclear Weapons with donations from all over Japan.

### 1.1.5 The Oura Church

'The Church of the 26 Japanese Martyrs', or its more common name, the Catholic Oura Church, was built by a Frenchman in 1863, after the end of isolation (Fig. 1.4). This church was the oldest remaining Christian building in Japan. The Church was designated as a national treasure. It was constructed in the Edo period. At the time, there was an order called Kinkyo-rei (Edicts banning Christianity).


Fig. 1.4 The Oura Church

In the history, 26 martyrs were executed at the hill called hill of Nishizaka. At the end of the isolation, a change of regime had occurred and, the Kinkyo-re was finished. Thus in 1865, this church was built and dedicated to the martyrs. The church was directed to be built on the hill of Nishizaka. The reasons for the executions at the place were related to Dejima, Nagasaki. Dejima was the only place where a missionary could live, so it is thought that the execution was meant as a stern warning to the people of Nagasaki.

This church is also famous for other events such as the finding of crypto-Christians. In Uragami, there had been some crypto-Christian for over 250 years. After the church was built, the people believed the church was a Catholic church, and they told the priest of their beliefs. This was surprising, because Japan had carried out the Kinkyo-rei for a long time. Moreover, under a ban, the people had kept their Christian beliefs for over 250 years (5).

### 1.1.6 Glover Garden

In the afternoon, we visited the former Glover House in Minami-Yamatemachi, Nagasaki-city. This house is the oldest western-style wooden building remaining in Japan and was built on the hill of Minami-Yamate in 1863.

Thomas Blake Glover (1838-1911), who was born in Scotland, came to Nagasaki in 1859 at the age of 21 when the ports of Japan were opened. After the Meiji Restoration, Glover was a business leader and made great contributions towards the introduction of modern technologies to Japan. Through shipbuilding, coal mining, and the tea trade, Glover contributed greatly to the modernization of Japan. He is known as the father of Japanese beer, and the Kirin Beer logo shares Glover’s famous moustache (6).

## 1.2 The Isahaya Land Reclamation Project

The Isahaya Land Reclamation Project was one of the the main destinations in Nagasaki, in order to learn about one of the most controversial policies of the Japanese government, concerning biodiversity and known as the “Guillotine of Isahaya Bay”. The participants there obtained some important data, facts, and other information on this project.

### 1.2.1 The lecture of Isahaya Land Reclamation Project

We visited to the welfare office of Nagasaki city. Mr. Ryoji Tokitsu, who is a member of Ariake Kai Gyomin Shimin Network (Fishermen’s Network for the Sea of Ariake) gave us a general introduction about the Isahaya Land Reclamation Project (Fig. 1.5).

Fig. 1.5 The lecture about Isahaya Land Reclamation Project

The Isahaya Bay Reclamation has a long history which was began about 600 years ago. Today's plan of the large-scale and compound reclamation was started by "the Nagasaki Large Reclamation Plan" in 1952. The project being done at present was named after "the Isahaya Bay Disaster Prevention Total Reclamation Project" planned in 1983 (7). The national Isahaya Bay reclamation work is based on the “national Isahaya Bay reclamation work plan” announced in 1985. After some delays, on April 14, 1997, the water gate of the embankment was closed (8).

The main purposes of the Isahaya Land reclamation Project were: 1) to control the flooding of the coastal town of Isahaya and 2) develop agricultural land, by closing the tidal flats and shallows of Isahaya Bay by building a 7 km sea dike across the bay. The “new” developed area was divided into agricultural land and a reservoir which stores the water from the river for irrigation and fresh water supply for the city. The land is prepared for agriculture with a high productivity by developing large-scale flat farmland which has the regulating reservoir and water supply.

A critical need to build some form of flood control in the area was seen in the flood of 1957, which brought about great damage. The flood was caused by typical local heavy rains, which concentrated in the northern region of Kumamoto Prefecture. In Saigo-cho, the rain-gauge recorded the daily rainfall as being 1, 109 mm for that day which was an extreme amount compared to the normal daily rainfall of only 86 mm. The construction of flood control like a dam upstream is unsuitable considering the geology formation of the area so consequently, the flood control should be built downstream, and the reclamation project was selected as a solution (9).

On the Ariake Sea, there have been a lot of reclamation projects since the Edo period. Before, the total area was about 260 km squared. About 450 years ago, the first reclamation project was started at Isahaya, and, the number of reclamation efforts is increasing year by year. In the past, the place grew into the largest granary in the

prefecture. However, this area suffered from the natural disasters due to the geographic and topographic features. To deal with those and to produce even more food, the Isahaya Land Reclamation Project began. The total planned reclamation area was about 942 ha. The total regulated pondage area planned was about 2, 600 ha (Fig. 1.6). In actual fact, the reclamation area has been reduced by half, due to an environmental problems and a desire to use the land sooner than planned for. The total cost was 253.3 billion yen. The project included making a new ecosystem inside the dike. The area then became the largest class of wetlands in the Kyusyu region. The land content, by percentage of the size of the catchment area of Isahaya, the river inflow to Isahaya, and surface area inside of the dike compared to the Ariake-sea are 3%, 3%, 2%, respectively (9).

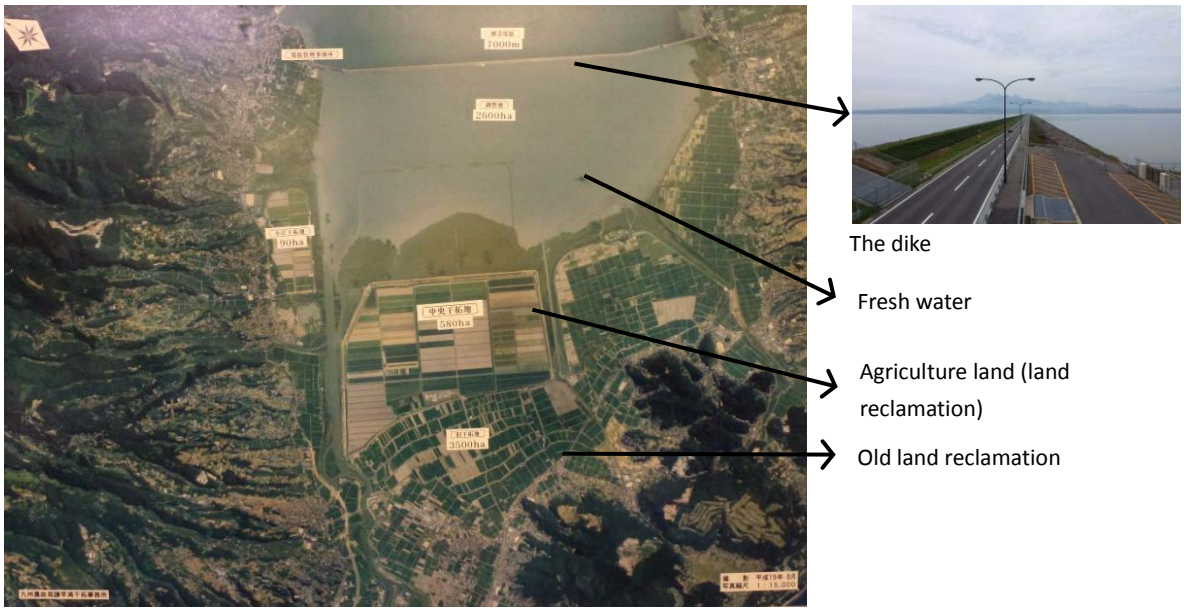


Fig. 1.6 The reclamation project

The Isahaya Land Reclamation Project in the Ariake Sea is one such example of economic development that has led to significant environmental problems including a decline of marine and aquatic species diversity as well. We can cite that the promoters of the reclamation work are the Nagasaki Prefecture, the Ministry of Agriculture, Forest and Fishery, the Nagasaki Great Reclamation Resolution Alliance Association, and the area's farmers. After the reclamation work started in April 1997, and the tideland in the Isahaya Bay dried up, the organisms that lived in the bay were damaged and it was called "the unusual event in Ariake Sea".

The environmental problem became serious and discussion on the appropriateness of

the Isahaya Bay reclamation work increased. For example: the laver industry for the whole Ariake Sea received the biggest damage by the generation of a red tide in 2000 and a sharp decrease in seafood in Isahaya Bay/Ariake Sea. To stop the fishery damage, fishing cooperatives on the Coast of Ariake Sea (Saga, Fukuoka, Kumamoto) who believed that the unusualness of the Ariake Sea was mainly caused by the construction during the reclamation work and demanded the suspension of construction and then took filled suit with the Saga District Court (9).

The law suit has been made by about 2, 500 fishermen from Nagasaki, Saga, Fukuoka and Kumamoto prefectures. Though the Court confirmed that although the Isahaya reclamation project in 1997 caused a slower tide current and environmental degradation in Isahaya including the increase of red tides and severe damage to short-necked clams and the aquaculture fishery, the law suit and negotiations are still continuing today (9).

### 1.2.2 The dissension on the Land Reclamation Project

We went to Isahaya Reclamation Office in Nagasaki city where Mr. Takao Hayashi gave us an introduction about the dissension related to the Land Reclamation Project (Fig. 1.7).

The water gate of Isahaya Bay was closed on April 14, 1997 and the people called it the “guillotine”, which were used for beheading during executions. This view comes from the 293 steel plates that were dropped like dominoes to close off the bay. A lot of people will never forget this image as a detestable memory. The National Isahaya Bay Reclamation Work expected that this project would have some effects on the Ariake sea. Then they found that it had caused a large disturbance of the fishery through a decrease in the laver harvest. Comparing the increases in the agriculture yield by making the new farmland with the transition of a decreased harvest from the sea, there are some comments that it is a failure in terms of being a national work contributing to the upgrading in the degree of food self-sufficiency (10).

Fig. 1.7 Explanation about Isahaya Reclamation Project

On August 26, 2004, Yoshiyasu Enomoto (the presiding judge of Saga Distract Court) initially decided that the further construction would be forbidden. At least a provisional disposition of the suspension of the construction was decided. However, the state objected, as it believed it to be natural to rule according to past precedents of the good done by public works. The sterile combat has continued. The question is “is it possible to stop this project?” The result in May, 2005, was that the court removed the statements of the fishermen because more specific proof was needed to order the suspension of construction. In addition, in Sep, 2005, the Supreme Court rejected the complaints of the fishermen (11).

### 1.2.3 Agriculture development in the “new land”

Nagasaki prefecture requested more farmers to use the reclaimed land the farmers were selected following the six criteria below (Fig. 1.7, 1.8):

1) Age: 20-50 years old

2) Certificate farmer (annual income earn: 6, 000, 000 yen)

3) Eco farmer (ecofriendly agriculture, less fertilizer)

4) Agree with the contract, including unit of contract (100 x 600 m). 5 years Rental fee 1, 300, 000 (100, 000/month), Irrigation

5) Water (pump station) 7, 000 yen/month

6) Contract with government and public organization. Contents of the contract are about restrictions on chemical fertilizers. The farmer have to inform where they will sell their crops (this is only for domestic use).

Fig. 1.8 Field observation at the reclamation project

### 1.2.4 Opinions on the Isahaya Land Reclamation Project

1) Masatsugu Uesugi

I wondered why only this reclamation project has led to the environmental problem mentioned above. The difference of this project perhaps is the scale. I think the scale and the role of Isahaya within the Ariake Sea has caused this problem. I mean, I believed that possibly the scale is too large. So, the amount of tideland which plays a role in water purification has been decreased drastically. Considering the tide, all the tides of the Ariake Sea pass into Isahaya bay, so, its role is big, I think. But, even since this environmental problem has occurred, we cannot blame only the project. Thinking about this problem, we have to make clear the owner of the resource which has the water purification function. I think Nagasaki prefecture has a right to use the area for farmland as other prefectures have. The problem is that the quality of the water from the river inflow gets worse year by year in the Ariake sea area. So, first of all, every prefecture has to improve the water quality of their rivers. I think this is logical. The regards mentioned above the environmental side. I want to now think about the cost side below. This project is above cost, so, in this regard, it is perhaps better to stop this project. There is already some accumulated matter outside the dike, so, within 30 years or so, there will likely be a new reclamation project. However, they should not make such an error again. We should calculate more exactly and research the degree of the purification power of every tideland. The latter point is particularly important to develop a sustainable environment in this area.

2) Yudi Setiawan

I think that this reclamation project demonstrates a property rights problem in Isahaya Bay. The bay was previously common property before a conflict between fishermen and the promoters of the “new land” project took place. With the project, it seems that the farmers in the “new land” have directly benefited by the dike installed on the bay, but meanwhile, the fishermen were disadvantaged as the fish biodiversity was destroyed by the change in the water environment. Of course, removing the dike might not be the right solution. Any analysis needs to focus on what the impact on the public at large will be. We need to find some kind of compensation mechanism. This is where the role of government (both central and local) becomes very important. Unfortunately, even in the government, there is a certain degree of conflicting interests (for example between agricultural and environmental agencies). Thus, the problem is more complicated than just some tension between two groups in a society (fishermen and farmers); as it also

involves bureaucratic and governmental issues.

3) Elwan Abeer

I totally agree with this project. I think the view of this project is graudally moving from dark to light. We must remember the main goal of this project which was the need for agriculture growth in Japan after the Second World War and it was the main governmental plan at that time. Nowadays, this project produces tons of agriculture products. They have reached their goal and they are moving the right way. On the other hand, any human activities must have side effects on the environment. I think it is mostly under control by making many limitations on the farmers in using fertilizers and pesticides and for the fishermen, the sea is still open.

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# Chapter 2 Report of Minamata Disease

## 2.1 Introduction

### 2.1.1 Background


Fig. 2.1 The Chisso factory and its waste water
Source: http://www.eoearth.org/article/Minamata_Disease

Minamata is a small town which is located on the southwestern coast of Kyushu island in Kumamoto Prefecture, Japan (Fig. 2.1). From 1932 to 1968, methyl mercury was produced as a by-product in the process of manufacturing acetaldehyde and acetic acid at the Chisso Company. It was discharged into the sea with the waste water and thus polluting Minamata Bay. Nearly 150 tons of mercury were discharged into Minamata Bay resulting in an accumulation of mercury-containing sludge that reached up to 4 m thick around the Hyakken drainage outlet. In June 1966, due to the construction of a completely new effluent processing system, effluent containing methyl mercury, in principle, ceased to be discharged. In May 1968, the pollution source disappeared due to the discontinuation of acetaldehyde production (1). In fact, it was a human tragedy from environmental pollution in cities and areas designated for development by the government in the 1960s and 1970s (2).

### 2.1.2 Appearance of the disease

In 1956, the first case of an unidentified disease happened in Minamata and then spread throughout the Shiranui region where the people mainly depended on the fishery. Without adequate treatment, the number of fatalities continued to grow. In 1968, after 12 years of investigation, the government acknowledged that the pollution in the effluent from the Chisso factory, through its neglect to control factory effluent, was the

cause of the poisoning. Next, patients who suffered this disease began to fight for a sincere apology as well as compensation from the company. The government also started to take measures to control this event (2).

## 2.2 Signs and symptom of Minamata disease

### 2.2.1 The causes of the disease

Mercury is classified into inorganic mercury and organic mercury. According to statistics, the mercury in the waste water of Chisso is inorganic and it is turned into methyl mercury by microbes at the bottom of the ocean. The microbes are then eaten by fish and shellfish. Mercury accumulates as it works its way up the food chain when people eat these fish (3).

The Japanese are known for eating much more fish than any other nation in the world and needless to say, the people in Minamata are no exception. Minamata disease is a form of methyl mercury poisoning caused by eating large quantities of fish and shellfish containing methyl mercury (Fig. 2.2).

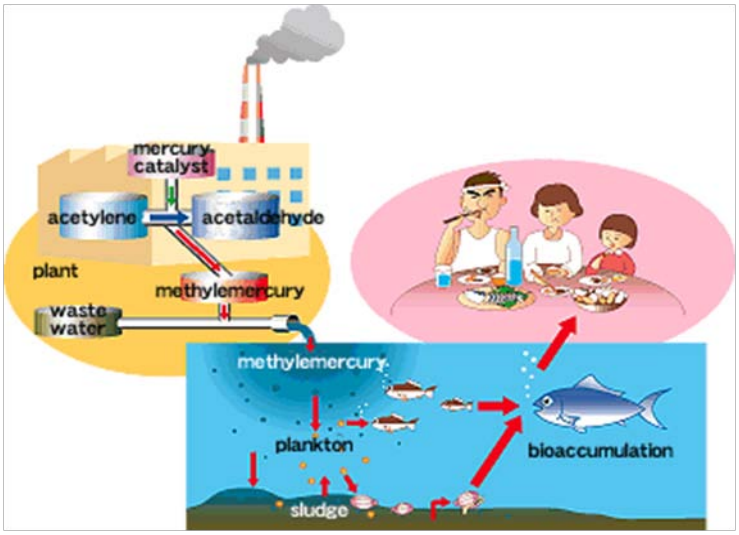



Fig. 2.2 Illustration of the pathway of Methylmercury

Source: MDMM, Minamata Disease Municipal Museum

Methyl mercury has three characteristics as follows: fat soluble, prototype

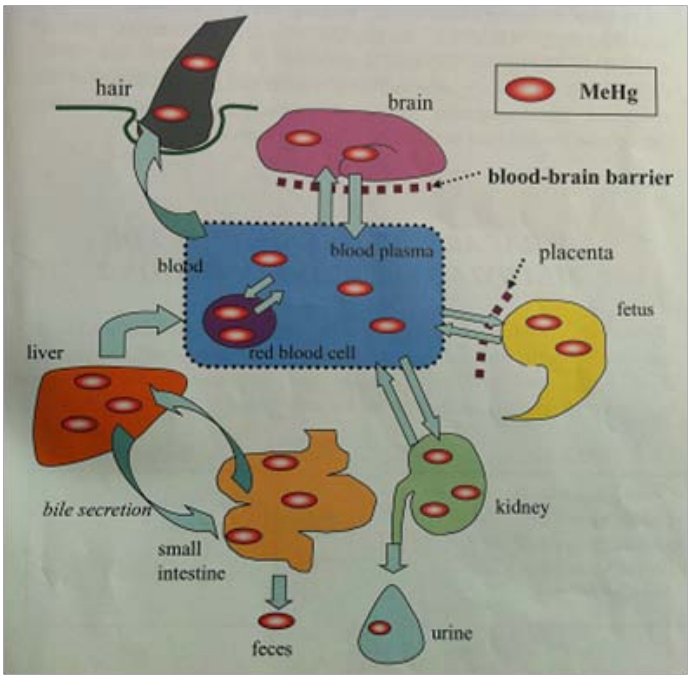



Fig. 2.3 Methyl-mercury in the body

Source: MDMM, Minamata Disease Municipal Museum

accumulation, and high nerve agents. First, methyl mercury gets into the stomach and has a reaction with the stomach acid which produces chlorinated methyl mercury, a form of mercury that is readily absorbed (inorganic mercury is only 5% is absorbed). Then the methy1 mercury combines within the sulfydryl in the red blood cells and hemoglobin molecules, along with the blood moving to different organs. Human organs set up a blood brain barrier in order to protect the brain and to prevent viruses (Fig. 2.3). But chlorinated methyl mercury is unhampered by the blood brain barrier, so it can move smoothly into the brain cells, into the placenta, and thus, into the fetal brain. Brain cells are rich in many kinds of lipids and the fat soluble methyl mercury has a very high affinity to lipids. Therefore, it is very easy for it to cumulate in the brain cells. The Methyl mercury molecular structure is $CH_3$-Hg-Cl and the key between C-Hg is very strong and it is not easy to disconnect. The whole molecule will accumulate and damage brain cells and the damage is an irreversible chemical change (4).

The symptoms of Minamata disease include sensory disorders in the distal portion of the four extremities (loss of sensation in the hands and feet), ataxia (difficulty coordinating movements of hands and feet), and concentric constriction of the visual field, hearing impairments, disequilibrium, speech impediments, and disorder in ocular movement (4).

### 2.2.2 The dramatic face of Minamata disease

Bearing this history in mind can alert future generations. Minamata disease has been tragic lesson for mankind to be frank, touching the scars time and time again may be crueler than the physical pain itself, especially for the patients and their families. But today, some sufferers stand up bravely to tell the world what has happened in Minamata explaining their painful experiences. Their trembling voices and strong willpower make

it so that listeners cannot help but wipe their tearful eyes.

Ms. Ueno, an 84 year old lady, had been employed by Chisso when that disaster happened and has been certified as a victim of Minamata disease since 1971. Because of the disease, she lost her beloved husband and her lovely daughter. One day, in 1958, when she had been pregnant for nine months, her husband suddenly was unable to speak and then his condition became worse and worse. Because of the strange symptoms and a lack of knowledge about what had caused the disease, they were discriminated against by their neighbors, their relatives, and even the hospital. They had to endure not only physical torment but also mental torment. At that time, as a pregnant woman, her abilities were very limited, but she still struggled and tried her best to help her husband. She took her husband to some local hospitals, but they could do nothing for him. At lasts she took him to the Kumamoto hospital. Unfortunately, her husband died in that hospital 3 days later.

After her husband's burial, 6 days later, her lovely daughter came to the world. The baby was very healthy and seemingly had nothing unusual when compared with others at first. However, 3 months later, in 1958, a difference appeared as she didn't grow like other normal children. She then realized the seriousness of the problem which she was most reluctant to see, and unfortunately disaster struck the little baby. She had done everything that she could do to save her daughter's life at that time, including seeking help from hospitals, but to no avail. The indifference and discrimination of the neighbors was really unbearable for her, and she left the Minamata city. In those most difficult times, she realized that the most important thing in life is physical health rather than money. She couldn't stop the deterioration of her daughter's terrible disease alone, and the worst result eventually happened. The little baby left this world. We always say that one the most sorrowful things are parents who have to take part in their child's funeral. But in the face of this illness, she seemed so powerless, and what she could do was to face it?

Today, looking across the clear blue water of the Shiranui Sea, it is hard to believe that people in this place have suffered from one of the most catastrophic incidences of industrial pollution the world has ever seen.

### 2.3 Governmental solution for the environmental pollution

#### 2.3.1 Pollution prevention project

In 1977, Kumamoto prefecture began pollution prevention work to remove the sludge, and it took 14 years, and approximately 48.5 billion yen, to finish the task of dredging

the accumulated mercury-containing sludge from Minamata Bay and reclaiming the land in 1990 (Fig. 2.4). During the course of the project, an extremely strict

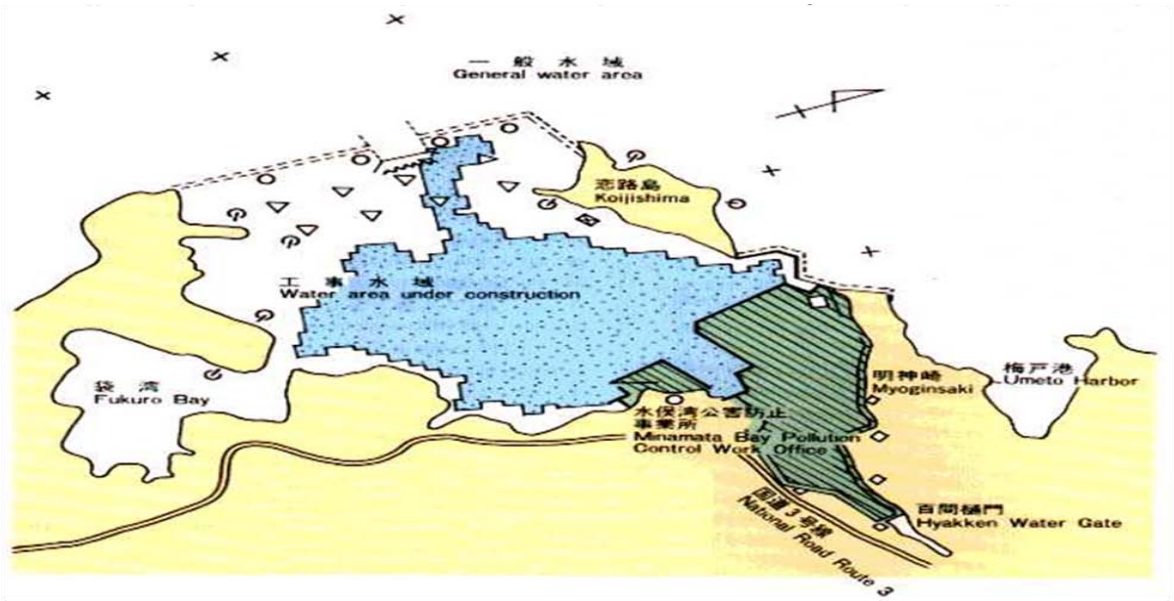



Fig. 2.4 Map of the Minamata Bay Dredging Operation

Source: http://www.env.go.jp/en/chemi/hs/minamata2002/ch4.html

points revealed that the total amount of mercury in the bottom sediment had fallen to 0.06 ppm-12 ppm with an average of 4.65 ppm. At present, treated factory waste water as well as household waste water flows from the Hyakken drainage outlet and monitoring has been carried out to confirm the safety of the fish and shellfish the Minamata Bay (5) (Fig. 2.5).

Fig. 2.5 The present Hyakken Waterway (2011)

In order to resolve an environmental problem such as Minamata disease, there will be

four tasks need to be achieved: the discovery of the cause, the prevention of suffering, recovery from suffering and the learning of a lesson. Funabashi pointed out that there were three fundamental factors that strongly influenced on the solution of environmental problems: an effective and juridical system, a mature public sphere and the ability of individual actors (6).

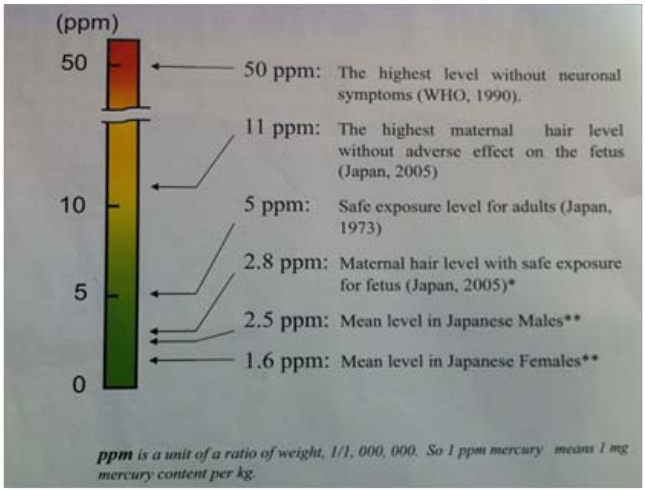
### 2.3.2 National Institute for Minamata disease

Many years of research results had related the disease to methyl-mercury. Therefore, the local government has taken strong measures to monitor the content of methyl-mercury in the bay to assess the impact on the health of local citizens. They constructed a multifunctional research center near the bay named The National Institute for Minamata Disease (Fig. 2.6) in October 1978.

Fig. 2.6 National Institute for Minamata disease

Firstly, the institute conducted routine monitoring and analysis of the mercury concentration in the sea water, fish and shellfish. In order to take accurate measures to control the disease, and make sure the analyzing process was efficient and precise, they had established some analytical methods for sample pretreatment to extract the methyl-mercury, which is the most harmful, and to determine its concentrations in hair. Today, the concentrations of mercury and methyl-mercury are all very low and can meet national standards.

Secondly, they conducted periodic physical examinations of the local citizens by determining the methyl-mercury content in their hair. According to the proposed standard (Fig. 2.7) they could determine whether the person was at risk.




Finally, the research center has been important for worldwide communication on such environmental problems, and they have shared their research with the world (3).

Fig. 2.7 Reference for hair mercury level
Source: MDMM, Minamata Disease Municipal Museum

## 2.4 Conclusion

Environmental pollution can be seen as a kind of cost transformation on the economic side, but this disaster made the local citizens, government, and the company, Chisso, pay a very heavy price. Some victims lost their lives and some patients had to endure endless pain (7). For many years there were appeals for justice and compensation negotiations, and the victims eventually received some compensation from the local government and Chisso. Fortunately, we could see that the government and the company had changed their attitude and both are now playing a more active role to solve the problem than they did. This environmental disaster was a tragic lesson for today's and future generations. We all should keep this tragedy strongly in mind.

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# Chapter 3 Kumamoto Groundwater Report: History and Present of Water Resource Management in Kumamoto Region

## 3.1 Tawarayama Observatory and Hydrogeology of Kumamoto region

Mount Aso is the largest active volcano in Japan. Its peak is 1952 m above sea level. Aso has the largest caldera being 80 km north south and 25 km east west. Aso's caldera also has a circumference of around 120 km. On the inside of the caldera approximately 5 thousand residents live now with government offices, schools, and a hospital.

The present bed rock (low permeability) of the Aso caldera formed as a result of four huge caldera eruptions occurring over 90,000–300,000 years ago. To estimate major aquifers (Pyroclastic flow deposits) in the Kumamoto area, the geologists separated into them into Aso 1-4 which was decided through 4 main eruptions. Eruption Aso 1 was active approximately 280 thousand years ago. Eruption Aso 2 occurred 135 thousand years ago, Aso 3 was 120 thousand years ago. The most recent eruption of Aso 4 was 8 thousand years ago. The geologists declared Aso 4 as belonging to the 1$^{st}$ aquifer and Aso1-3 belong to the 2nd aquifer. The 1$^{st}$ aquifer consists mainly of an Ariake clay layer and unconfined groundwater. The 2$^{nd}$ aquifer consists of confined groundwater. The 1$^{st}$ aquifer has a sand/ gravel layer which has a high permeability, and is the cause of the high capacity infiltration from surface to groundwater in Kumamoto (1). Between the 1$^{st}$ and 2$^{nd}$ aquifer is a Hanabusa layer which has a low permeability. However, the Shirakawa River catchment did have not show the distribution of this low permeability thus, and the groundwater from the surface and the1$^{st}$ aquifer have infiltrated into a deep aquifer well.

Regarding the groundwater flowing system in the Kumamoto area, the Shirakawa River plays the most importance in the distribution of groundwater to the Kumamoto area. The rainfall on the west of Mountain Aso will infiltrate into the groundwater through the forests and fields. Over the years, that groundwater has become clean and consists of abundant minerals; then it flows to Kumamoto city. The Kumamoto city area has an especially hydrogeological structure due to the Togawa lava layer keeping the groundwater from flowing into the sea. Almost all of the groundwater is pumped up in

Kumamoto city comes from this layer.

A cross section showed that the water from upstream and the mountain flow downstream mainly through the Shirakawa River basin. The forest, grass lands, and paddy fields in the middle of the Shirakawa River basin act as a recharge area for the groundwater, and then the groundwater will flow downstream and bring an abundant amount of groundwater.

According to the investigation reports on geology, groundwater consists of the pyroclastic sediments and andesitic lava of aquifer with hydraulic conductivity more than 1.0×10 super (-1) m/sec. The sources of groundwater are originated from infiltrated rainfall and irrigation water in paddy fields. It was estimated that the total amount of the annual recharge was 701 million $m^3$, in which 323 million $m^3$ came from paddy fields, that is equivalent to 46 % of the total (1). Consequently, the total volume of shallow ground water was estimated to be 3.6 × 109 $m^3$ in a distribution area of the oldest pyroclastic flow deposit (2).

The groundwater simulation result shows that the groundwater in some areas may decline due to the increase of water use and decrease of recharge, which leads to unbalance of groundwater in the whole area. However, Kumamoto prefecture is making more efforts to conserve it, not only by taking administrative measures such as the promotion of infiltration, water saving, rationalization, and the prevention of pollution. Government works together with the residents engaged in various types of business such as agriculture, commerce, and industry. They believe that the stable use of groundwater will be possible in the future (Fig 3.1) (1).

Fig. 3.1 The Kumamoto area view from the Tawarayama Observatory

### 3.2 Seta-Uwaide zeki (Historic intake weir for agricultural water supply)

After leaving the Tawarayama Observatory, we went to visit Uwaidezeki. Uwaidezeki is a very famous and historic hydraulic structure in Japan, so it can be a very good example that can help us to understand the hydraulic works widespread throughout Kumamoto.

When talking about Kumamoto, a city well-known for its historic hydraulic works, we have to mention General Kato Kiyomasa (Fig 3.2) (1562-1611) (3), who contributed a lot toward the constructions of the hydraulic structures in Kumamoto. Uwaidezeki is just one of them, having a history of more than 400 years since it was completed.

Uwaidezeki is actually a feed canal project, a kind of irrigation works. It's located in the Otsu region and built beside the Shirakawa River on the north bank. It was built in 1588. Through the gates of this canal, the water in the Shirakawa River can go northerly into a large area of paddy fields north of the Shirakawa River. Using the Uwaidezeki, the people living in Otsu-machi and Kikuyo-machi can use the Shirakawa River for irrigation for the local agriculture. According to the introduction at the site, the length of this canal is around 24 km, and an area of about 460 ha profits from this hydraulic system.

Fig. 3.2 The statue of General KATO Kiyomasa

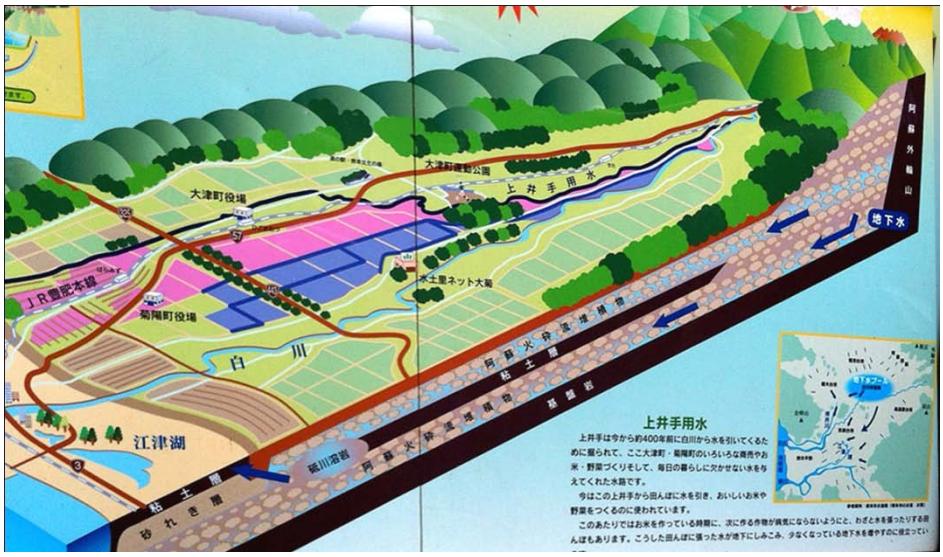


Fig. 3.3 A overview of Uwaidezeki (The light blue line indicates the Shirakawa River, and the gray line shows the location and flow path of Uwaidezeki canal)

Uwaidezeki is renowned and respected not only for its contribution toward agricultural irrigation, but also for the human intelligence which conceived in it. Aso Mountain, a famous volcano standing near the city of Kumamoto, has erupted several times throughout history (4). A large amount of volcanic deposits come out with the eruption and then fell down on the surface of the soil. These kinds of deposits are usually large grained which means that the water can easily infiltrate through them. Due to this, the region of Kumamoto, with a thick cover of volcanic deposits, should not be suitable for rice farming because the water can't be conserved above the soil. However, the truth is different because of Uwaidezeki. The water flows continually from the Shirakawa River into paddy field areas through the canal and rice farming became possible (Fig 3.3).

One more thing we should talk about is the discharge of irrigation water. Some parts of this water go outside through the gate at the end of this canal and return into the river water again. And parts of water infiltrate through the soil and become groundwater, and then take part in the cycle system of groundwater. Think about this, we can't help but admiring the Uwaidezeki project, not only for its contribution to human development, but also for its smart design which was adapted to the local situation.

### 3.3 Hanaguri-Ide (Historic channel for water supply)

We EDL members visited the Hanaguri Ide, the one kind of artificial water way located upstream of the Kumamoto area (Fig 3.4). This was constructed in the 17 century, and even now, continues to supply irrigation water to 181 ha of agricultural land.

Fig. 3.4 The Hanaguri Ide

The main water resource, the Shirakawa River coming from Mt. Aso, includes a large amount of volcanic ash, which accumulates in the irrigation water way and could stop water flow. However, Kiyomasa Kato, the brilliant warlord of this area, constructed a very unique water way, the Hanaguri Ide. Hanaguri means “the nose ring hole of cow”. Ide means “artificial water way”. The water way has some bulkheads which have holes like Hanaguri at 4-5 m intervals. These holes create a vortex which can remove volcanic ash automatically from the water way. Additionally, upstream, there is a drainage canal to discharge the superfluous water during heavy rainfall. This kind of structure is very unique in Japan, and deserving of an architectural study. This needs no fuel for pumping and no man power to remove the soil. This is a very remarkable ancient technique we can apply today for sustainable society.

### 3.4 Kengun water source

The Kengun water source is located in Kumamoto city. It began producing water in 1949, and then had a pump building completed in 1999. There are 11 wells with a depth from 39 m to 60 m. 7 of the wells are distributed in a shallow aquifer, while the rest of the wells are in a deep aquifer. Thus, 7 wells are flowing artesian, and 4 wells are pumped up using the intake pump with 140, 000 $m^3$ pumping capacity per well. The intake capacity is about 61, 600 $m^3$ per day. Kumamoto city has 220, 000 $m^3$ of average water supply per day currently, of which approximately one-quarter is covered by the Kengun water source. The pumped up groundwater is collected and then the water is sent to two concrete ponds with a total storage capacity of 24, 000 $m^3$. The site area is about 29, 394 $m^2$.

To prevent disasters and earthquakes Kengun is equipped with distribution reservoirs. If there is intensity 6 quakes, one of the two ponds are automatically activated by an

emergency shutoff valve to ensure water as an emergency water tank. If 3 liters of water per day are required to maintain human life, this emergency distribution reservoir can supply up to 670, 000 citizens for 6 days. In addition, the pump in the water source, since it is powered by electricity, it automatically senses a power outage and the emergency generator to cover all of the campus electricity. Furthermore, in order to overcome a disaster, the campus water sources, Kengun, has been installed at two locations; the water tower and the parking lot of the Zoo and Botanical Gardens using adjacent hydrants (for an emergency water supply outlet). Attached to the two sites is a temporary water supply system that can be used as emergency water stations. This groundwater is very clean, and thus, Kengun water source's staff let us drink the fresh water which was taken directly from the well (Fig 3.5) (5).

Fig. 3.5 Drinking directly the groundwater of the Kengun water resource

### 3.5 Suntory Manufactory Inspection

#### 3.5.1 Background

Kumamoto city is famous for its enriched groundwater resource, and the groundwater




Fig. 3.6 The Suntory Factory

completely covers the drinking water for the citizens of Kumamoto. The quality of the groundwater is very high, and the groundwater resource also plays an important role to a company named Suntory (Fig. 3.6). Suntory is famous for its drink products including soft drinks and alcohol. The company uses the groundwater for its drink products. People trust the quality of the company's products and purchase them, so it can be said that Suntory is directly supported by the groundwater resource.

### 3.5.2 Positional relation between Suntory and Groundwater Springs

The location of the Suntory factory in Kumamoto is surrounded by many springs. Fig. 3.7 shows positional relation of the factory and the springs.

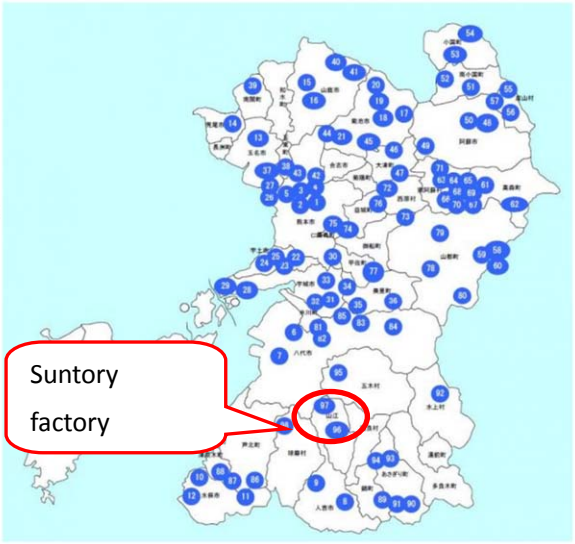


Fig. 3.7 The positions of the factory and the Best quality 100 springs (Blue Circle) in Kumamoto prefecture

Source: the Suntory factory in Kumamoto

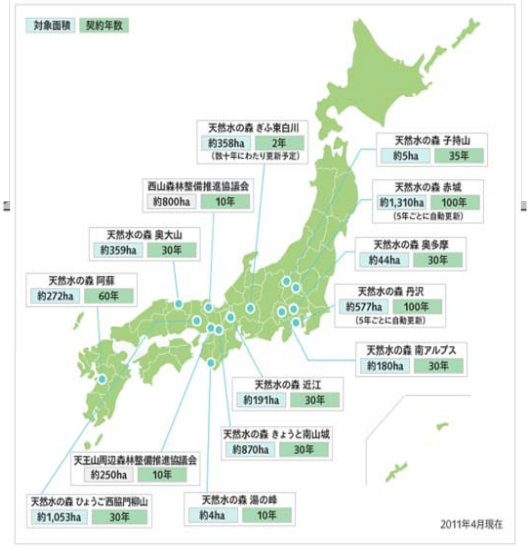


Fig. 3.8 Suntory's 12 forest conservation sites in Japan

### 3.5.3 Suntory's Environmental Conservation Actions

Suntory has been conducting forest conservation which plays an important role on recharging the groundwater all over Japan. In 2011, the area of forest which is needed to recharge more than the amount the factory uses reached about 7 thousand ha. Forest conservation is done at 12 sites in Japan and enough observations, considerations against harming both the environment and biodiversity are administered before any action is taken (6). Suntory tied up with a hydrology research institute. It observes the geological and terrestrial conditions as well

as the groundwater level, and the quality of groundwater. Based on these hard observations and analysis, Suntory's forest conservation actions are complete (Fig. 3.8) (7).

### 3.5.4 Discussion

In conclusion, it was a great achievement that the forest conservation was conducted by the company. Suntory uses nice quality groundwater for its drink products, and it also considers the sustainability of groundwater use. Furthermore, Suntory is making huge efforts to maintain the sustainability of groundwater use by conserving forests, and the action is closely based on hydrological analysis and observations. I think this is an ideal aspect of CSR.

## 3.6 Paddy field in mid river basin of River Shira (Artificial groundwater recharge)

River water from the Shirakawa River is led into the fields through the canal system which was solidly built with the concrete. When we went there, the paddy fields were dormant and only carrot fields were irrigated. However, the water is still led to the paddy fields to recharge to the groundwater (Fig 3.9).


Fig. 3.9 An artificial groundwater channel and the field

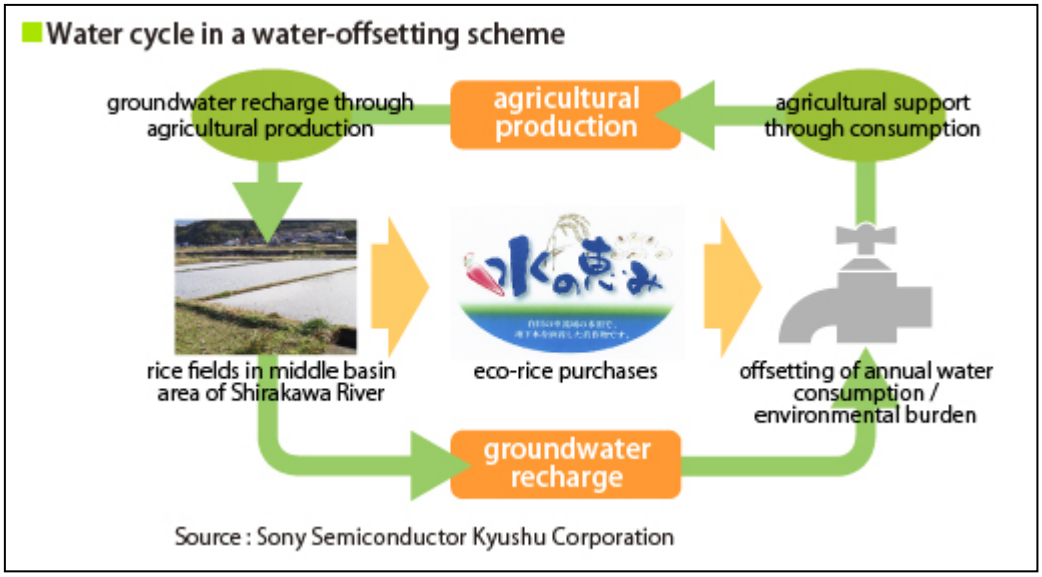


Fig. 3.10 Water cycle in a water-offsetting scheme

How to create more the groundwater? According to the investigations of geology, groundwater, the middle basin area of Shirakawa River (Kikuyo Town and surrounding areas), in particular, can recharge 5 – 10 times more water than other areas. To recharge water to their groundwater reservoir, they take measures to increase water recharge through rice paddies in the middle stream area of the Shira River, where the largest volume of water is recharged into the reservoir (8). The consumers, as well as citizens and corporations, need to communicate and collaborate with those in the upper stream areas, as well as farmers. All of them should have the sense of gratitude to the blessings of water, and understand well about farming and forest industries in the upper stream areas. The innovative groundwater recharge scheme was launched in cooperation with Kumamoto Environmental Net-Work, a local agricultural cooperative and land improvement districts, and has successfully evolved into covering a wider area, involving other local firms as well as the Kumamoto City government, which has incorporated it into the municipal water conservation program (Fig 10) (6).

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# Appendixes

**1. The Time Schedule of Domestic Internship**

| Date | Time | Location | Activities |
|---|---|---|---|
| 27, Nov | 6:40 - 8:42 | Tsukuba | Moved from Tsukuba University to Haneda Dai-ichi Terminal |
| | 10:25 - 12:20 | | Moved From Haneda to Nagasaki |
| | 12:30 - 13:30 | Nagasaki | Lunch |
| | 13:30 - 15:45 | | Visited Nagasaki Atomic Bomb Museium |
| | 15:45 - 20:00 | | Visited Glover garden and Oura Church |
| | 20:00 | | Back to Hotel |
| 28, Nov | 8:00 | | Departed from Hotel |
| | 8:50 - 12:00 | Isahaya | Visited Isahaya Social Welfare hall, Listened to the lecture presented by Mr. Ryoji Tokitsu |
| | 12:00 -13:30 | | Visited Isahaya Bay Wetland |
| | 13:30 | | Lunch |
| | 14:00 -15:00 | | Listened to the lecture presented by Mr. Takao Hayashi |
| | 15:00 -16:00 | | Observed around land reclamation areas |
| | 16:00 -20:00 | | Moved to Kumamoto by ferry |
| | 20:00 | Minamata | Arrived at Hotel (Yunoko Onsen, Minamata) |
| 29, Nov | 8:00 - 8:30 | | Departed from the hotel Yunoko Onsen and bus transfer |
| | 8:30 - 9:00 | | Observed around Hyakken exhaust port |
| | 9:00 - 10:40 | | Visited Minamata Disease Municipal Museum |
| | 10:40 - 11:30 | | Visited Minamata Disease Information Center |
| | 11:30 - 12:00 | | Visited Memorial Square |
| | 12:00 - 13:00 | | Bus transfer to the National Institute for Minamata Disease and lunch |

| | | | |
|---|---|---|---|
| | 13:00 - 17:00 | | Visited the lab of the National Institute for Minamata Disease |
| | 17:00 - 19:00 | | Bus transfer to the hotel Chisun in Kumamoto city |
| 30, Nov | 8:00 - 8:25 | Kumamoto | Arrived at Kumamoto University |
| | 10:00 | | Started the symposium |
| | 12:15 | | Lunch |
| | 13:00 | | Continued the symposium |
| | 18:30 | | Dinner party |
| | 20:30 | | Back to the hotel |
| 1, Dec | 8:30 - 8:45 | | Introduction at Kumamoto University (Overview of this excursion) |
| | 8:45 - 9:45 | | Bus transfer to Tawarayama |
| | 9:45 - 10:15 | | Tawarayama Observatory (Learning Hydrogeology of Kumamoto region) |
| | 10:15 - 10:25 | | Went to the nearby supermarket |
| | 10:25 - 10:40 | | Break at Tawarayama Moenosato |
| | 10:40 - 11:10 | | Went to Seta-shimoide zeki |
| | 11:10 - 11:40 | | Observed Seta-Uwaidezeki (Historic intake weir for agricultural water supply) |
| | 11:40 - 12:00 | | Went to Kikuyo town |
| | 12:00 - 12:20 | | Lunch at community center in Kikyo town |
| | 12:20 - 12:40 | | Heard an explanation of the hystory of hanaguri Ide |
| | 12:40 - 13:10 | | Observed Hanaguri-Ide (Historic channel for water supply) |
| | 13:10 - 14:20 | | Observed Kengun wate source (Present water supply in Kumamoto city) |
| | 14:20 - 16:15 | | Observed Suntory beer factory (Utilization of groundwater resource) |

| | |
|---|---|
| 16:15 - 16:55 | Observed the paddy field in mid river basin of River Shira (Artificial groundwater recharge) |
| 16:55 - 22:00 | Moved From Kumamoto to Tsukuba |

**2. List of Participants (Alphabetical order)**

Professors:

Endo, Takahiro
Sun, Xiaogang
Tsujimura, Maki
Wakasugi, Naomi

Students:

Abeer, Elwan (Egypt)
Chen, Jie (China)
Ding, Dahu (China)
Fakir, M. Munawar Hossain (Bangladesh)
Huang, Wenyu (China)
Ishwar, Pun (Nepal)
Li, Shuhong (China)
Nguyen, Thi Thu (Vietnam)
Setiawan, Yudi (Indonesia)
Shimizu, Tatsuki (Japan)
Shi, Wansheng (China)
Uesugi Masatsugu (Japan)
Wang, Shuozhi (China)
Yamada, Wataru (Japan)
Zhang, Jie (China)