6. Demand and Allocation of Water Resources in Japan

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I. INTRODUCTION

Water resources allocation in Japan has special characteristics, which come from both its natural settings and historical background of development. Japan is located in the Asian monsoon region, which allows Japanese farmers to grow rice as the staple food for the people. However, rice cultivation requires a lot of water for stable and high yields. After full development of paddy fields, which occupied the base flow in the rivers, the country experienced an intensive industrialization and modernization of people's life.

Japan 100 years ago was an agricultural country that used water mainly for paddy production. It has been developing and managing water resources both for agriculture and cities by introducing water right system and participatory irrigation management as well as reservoir construction and other facility development.

The water resources management was one of the most important issues of this country and raised a lot of interesting discussion points; how the conflicts among farmers and between farmers and cities have been raised and solved, and how the responsibilities are shared with water users and governments. This report focuses mainly on the institutional aspects of water resources management in Japan

II. WATER RESOURCES OF JAPAN

2.1 Settings and basic information

Japan is a long, narrow island country stretching from north to south. It has a total area of 37.8 million ha. Forest occupies 2/3 of its land (24.9 million ha). The agricultural land is 4.83 million ha (12.7% of the total area), of which rice paddies occupy 2.64 million ha. The rest of the agricultural land is assigned to upland crops and pasture.

The total population of Japan was 126.9 million (47.0 million. households) in 2000. The population is expected to start decreasing in 2006 The number of farming household was 3.12 millions and the agricultural labor force was 3.89 million persons, of which 1.87 millions were constantly engaged in agriculture (as of 2000). It means that more than half of the Japanese farmers are part-time farmers. The production in agriculture, forestry and fishery occupies 1.9 % in GDP of Japan.

2.2 Climate

A year in Japan is divided into four seasons: spring, summer, autumn and winter. Figure 1 shows the monthly temperature and precipitation in Tokyo. Due to low temperatures during late autumn to early spring, rice can be grown only once in summer (from May to October), which has an average temperature of 22.2°C (in Tokyo). The temperatures during the rest of the year are lower than 15°C, the lower limit for growing rice plants.

The average precipitation in Japan is 1,718 mm per year, of which almost two thirds occurs during the irrigation season or monsoon season in the eastern region of the main island as shown in Fig. 1. The monthly average rainfall of 150 mm during the irrigation season seems to be enough to grow rice without irrigation. However, due to the rainfall fluctuation during the time, the farmers suffer from dry spells that sometimes exceed one month as shown in Fig. 2 and paddy producing farmers rely on irrigation systems, which take water mainly from rivers.

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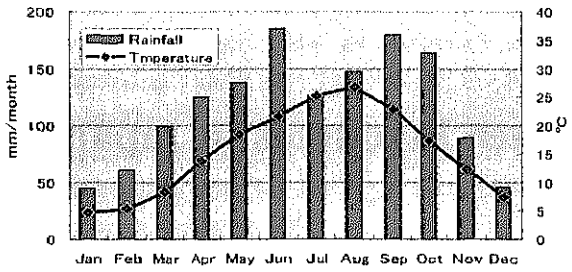

Fig. 1 Monthly temperature and precipitation in Tokyo

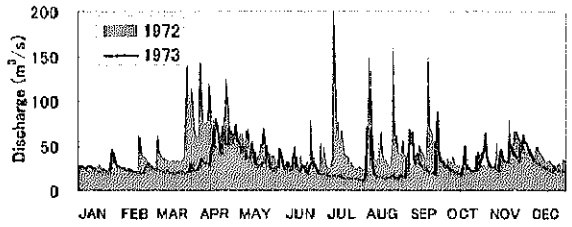

Fig. 2 River discharge at Funadabashi station, the Kitakam river (catchement area: 868.1 km²), in 1972 and 1973

2.3 Water resources

The annual precipitation on the national land is **650 billion m³** in volume, which gives the annual net precipitation at 420 **billion m³** as shown in Fig. 3 (Ministry of Land, Infrastructure and Transport of Japan 2001).

Total water volume used in Japan in 2001, of which Agricultural sector occupies about 2/3 and the urban sectors (industry and domestic water supply) do about 1/3. The agricultural water is mostly used for paddy irrigation with the share of 95%, and thus having a big seasonal change in demand, while the water demand in other sectors is rather constant through the year. Since the paddy irrigation season in Japan is just 4 months during monsoon season, the water demand of agricultural sector is concentrated in the season, thus occupying almost 85% of water use during summer season, when the most water shortage problems take place.

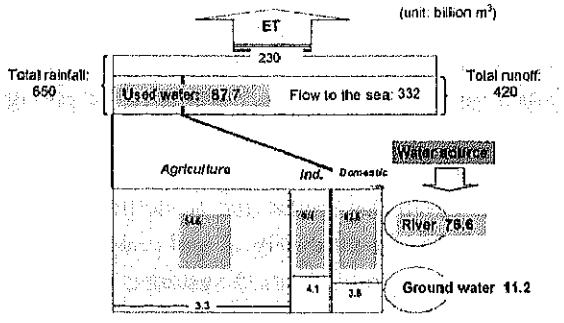

Fig. 3 Water resources and its use in Japan

2.4 Short history of water demand and supply in Japan

Since rice was the most important and productive crop for the country in feudal times (especially in Edo Era, 1603-1867), the government at that time tried to develop paddy fields as much as possible. Eventually all the river flow during drought times became allocated to rice irrigation and water conflicts among farmers were inevitable. Japanese farmers have a long history of struggle and compromise over water use.

The water demand of cities after Meiji Restoration in 1867 tried to get water from rivers. However, the farmers could not allow cities and factories to get water from the rivers because it was clear for them to get damaged by the water sharing with city people. The urban water sectors had to rely on the ground water. It eventually caused, after a substantial increase in demand, a serious problem of land subsidence in the coastal regions of this country; it reached 4.2m in Tokyo and 2.5m in Osaka. This situation required intensive construction of reservoirs after World War II. There has been constructed more than 400 multipurpose dams in Japan

Recent movements in ecological conservation have been influencing the new construction of large scale reservoirs both in the mountainous areas and the estuary areas. Together with the situation that no trend of water demand increase are seen in Japan, the more emphasis has been placed on the better management of existing water resources.

In the agricultural sector, the total agricultural land has been decreasing because of the urbanization in the rural area. The planted area of wet rice also shows a rapid decrease because of the decreasing consumption of rice and the gradual opening foe the international rice market. It will result in the decrease in the water demand for paddy production, while the government is extending its efforts to upland irrigation.

Industrial sector and domestic water supply sector seems to have almost reached the fulfillment of water demand. Under the situation of

decreasing population and restructured economical structure of Japan, no increase in the water demand is expected in the near future.

III. WATER DISTRIBUTION BY WATER RIGHT SYSTEM

One of the special characteristics of Japanese water allocation system is an established water right system. According to the system, water users or water users' group can use their water in a stable manner. An irrigation system that first started using water gets the priority to use water, but is requested to share water with domestic water.

The modern water right system of Japan started in 1896 when the River Law was enacted. During the long feudal system of the Tokugawa era, many paddy irrigation systems were developed and competed with each other to get more water out of the limited river flow in cases of long dry spells. The law stated that the water resources in rivers were public assets and anyone who wanted to divert water from the rivers had to get permission of the related prefectural government. However, it also stated that water users that had already existed should be regarded as the water users permitted by the law. The government supposedly wanted to keep out of the traditional water conflicts among water user groups. The water right permitted in this way is called "the customary water right" This attitude of the government to the water users still continues in the revised River Law in 1964, under which the major rivers (class A rivers) are managed by the central government and the customary water rights need to be registered in the ministry.

These customary water rights have been changed to ordinary water rights (the permitted water right) when irrigation projects took place in which the hydraulic works for diversion in the river were improved. In these cases, water users are requested to give up the right to get a new permitted water right. Most of the customary water rights of the major irrigation systems, in this way, have already been changed. In 1999, the total number of water rights for irrigation projects was 50,000, of which customary water right occupied 50% in number and 20% in irrigated area.

Japanese irrigation projects, both new development and rehabilitation projects, are mostly planned and managed by the central or prefectural governments depending on their beneficiary areas, although the farmers cover some part of the project cost. In a governmental project, the government will officially own the new water right in place of the irrigation association of farmers (Land Improvement district, LID). However, it is believed that the substantial owner of the water right is the LID. The entire irrigation facilities including the diversion dam are turned over to the LID after the project, and the LID decides and performs everything under the given conditions of the water right.

On a new request for a water right in a river, the ministry of construction will study the river flow regime and issue the water right as long as the water river flow is sufficient for the water demand of all water users including the newcomer. In this process, the probability of a 10-year return period is employed. In case the water resource is not sufficient, the government requests the newcomer to construct new reservoir/reservoirs or participate in a water development project. In any case, the new water right is issued normally on the condition that the newcomer should not disturb the existing water users; In other words the priority is given to the existing water users.

The water right consists of the seasonal pattern of maximum available flow rate, the structure and operation rules of hydraulic facilities and other miscellaneous conditions. After getting permission from the ministry, water users are requested to operate the facilities by themselves under the given conditions. Regarding irrigation projects, the water right normally needs to be renewed every 10 years, and the necessity of water should be explained then; the change in the command area and the unit water requirement based on the cropping pattern is the main point of the explanation.

The water rights in a river system are given so that the total water requirement does not exceed the available water in the river at certain probability of low flow recurrence; reservoirs are constructed if necessary. However, water shortage problems naturally happen, and the allocation of water comes into question. According to the

River Law the ministry of construction, the responsible body of river management, has a basic attitude that it should not directly order how to allocate among water users although it supplies them with scientific and technological information. The allocation is left to the negotiation of related water users.

IV. WATER MANAGEMENT BY FARMERS

Construction and rehabilitation projects for irrigation facilities in Japan are conducted by public works sections of central and local governments just like those in most of other countries. In the procedure of these projects, Japanese farmers are totally responsible for the operation and maintenance of their irrigation facilities, from diversion dams in the source rivers to field ditches, and are doing well overall. They establish their irrigation associations and collect fees from the member farmers, which cover all O&M costs. They are also deeply involved in construction and rehabilitation projects of governments. These farmers activities should follow the Land Improvement Law that was enacted in 1949.

4.1 Typical layout of irrigation facilities

Large-scale irrigation systems in Japan, which have a command areas of some 3,000 ha or more of paddy fields, typically consist of reservoirs upriver, a diversion dam in the river, and main canals, lateral canals, tertiary canals, and field ditches. Drainage systems are also components. Most paddy fields in Japan have been consolidated in governmental land consolidation projects. The standard plot size of 0.3 ha (100 m × 30 m) was applied in these projects (Fig. 4); a broader paddy plot has been recently adopted as the standard size in order to raise the labor productivity by introducing bigger agricultural machines. All the consolidated plots in the projects are planned to have independent access both to the field ditches and field drains. Almost all irrigation canals at all levels are paved with concrete or made of concrete flumes.

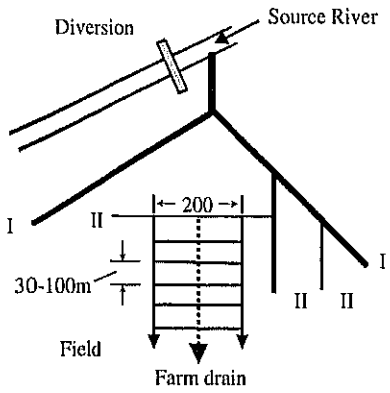

Fig. 4 Standard Layout of Irrigation and Drainage System in Japan.

4.2 Managing bodies

Large-scale, multipurpose reservoirs are operated and managed by central or local governments. However, the irrigation facilities, including reservoirs for agricultural purposes constructed in governmental irrigation projects, are mostly managed by the farmers or irrigation associations. Only the main facilities are managed by governments or a public corporation in a limited number of large-scale irrigation projects. A Land Improvement District (LID), an autonomous farmers' irrigation association, normally is responsible for operation and management of every irrigation and drainage facilities.

Although the LID is responsible for all the facilities, it operates only the main parts of them, such as the reservoirs, diversion dams, and major facilities that deliver water to the main canals. The remaining parts of the system are operated and maintained by local traditional communities called *Muras*. If a lateral canal irrigates paddy fields in the territories of several *Muras*, the delegates from the relevant *Muras* establish a committee to operate and maintain their common canal (Fig. 5).

Tenders for gates and lateral canals are des-

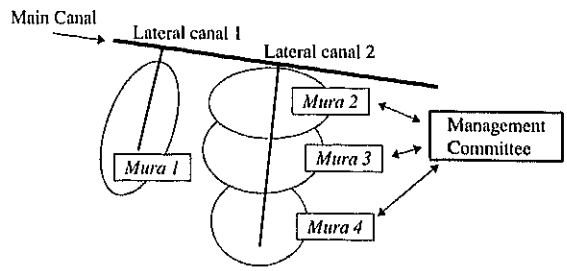

Fig. 5 Establishment of Management Committee for Common Lateral Canal: *Mura* is a basic unit for irrigation management in Japan.

ignated by the relevant *Muras* or united *Muras*. They usually get an allowance from the LID for their activities. However, they are not under the full control of the LID, but rather work for their regions.

V. FUNCTION OF LAND IMPROVEMENT DISTRICT

The primary organization for irrigation management is the Land Improvement District (LID). An LID is generally established for each irrigation system. In 2002, there were **6,816** LIDs in Japan, of which only 188 (2.7%) had command of areas larger than 3,000 ha, whereas 4,872 LIDs (72%) had command of areas smaller than 300 ha.

LIDs are farmers' autonomous irrigation associations, and established based on the Land Improvement Law enacted in 1949, just after land reform in Japan. Since an LID covers the command area of irrigation system, its boundary coincides with the system's boundary, not with the administrative boundary. Therefore, command areas of large LIDs may include many cities and villages, while the area of a small LID may just cover a part of a village territory. Most of these associations were established several hundred years ago, when irrigation systems were first planned and constructed. Most present LIDs are those irrigation associations as they were, though they have changed their legal status and names.

Members of an LID today are mostly farmers who cultivate fields within the district by themselves, while only land owners and owner farmers were qualified to be the association member before land reform. After land reform, all tenant peasants became owner farmers with small farms, and they became association members. The average farm size in Japan is about 1 ha, and thus even a small scale LID involves a large number of member farmers.

LIDs have two major functions in relation to water management:

1) Project promotion and applications for project implementation,
2) Operation and maintenance of irrigation systems

5.1 Project Formation

A rough sketch of the procedures in irrigation and drainage project formation in Japan is presented in Fig. 4. Based on the Land Improvement Law, there must be an application by an LID to start a new irrigation project or the government cannot begin the new project, even if the engineers appreciate it and the budget allows it. After the government approves the application and the detailed plan for the project, the LID must get written approval with a seal from more than 2/3 of all beneficiary farmers or LID members. While approval is being obtained from the members, meetings are held in every *Mura* to explain and discuss the new project.

Despite the formal criteria of 2/3, the government will not risk starting a new project unless more than 90% of the beneficiary farmers agree to the project plan; otherwise, great difficulties and inefficiencies would arise in the actual implementation. Therefore, the leaders of the farmers and the government engineers must design the project plan so that they can obtain approval from most of the beneficiaries. Once these conditions are satisfied and the project starts, member farmers are obliged to participate in the project and pay a portion of the project cost. The farmers also have to allow some percentage of their lands to be used for common facilities.

In this way, farmers are deeply involved in irrigation projects undertaken by the governments. However, the farmers have an opportunity to make the projects reflect their opinions through the procedure. This process can be also an oppor-

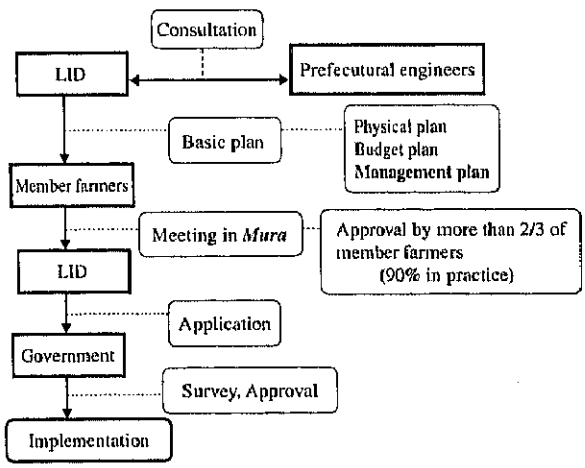

Fig. 6 Procedure of Irrigation and Drainage Projects Formation in Japan

tunity for all the farmers, upstream and downstream, to discuss and negotiate the water distribution among them.

5.2 Operation and maintenance cost

LIDs do not receive subsidies from the government for operation or maintenance. Necessary income must come basically from the member farmers. Therefore, an LID levees the association fee on the members on an acreage basis. A typical fee is US$ 500 /ha/year, which is equivalent to 0.4 ton of paddy per ha or 4-5% of the standard paddy yield (8 ton/ha). LIDs can presently gather organization fees without fail; more than 99% of the members are usually willing to pay. The Land Improvement Law also states the farmers' duty of payment.

5.3 Management of the Land Improvement District

The legislative organization of an LID is the representative meeting. The representatives are elected by all member farmers with equal voting rights, one vote per member. According to the LID rules, the representatives elect the directors, and the board of directors chooses the president among them (Fig. 7). Electoral districts are set based on regionally grouped *Muras* for the election of representatives. Therefore, elected representatives are delegates from the *Muras* and work for the benefit of the region. They not only attend the representative meetings, but also take care of irrigation facilities in their regions or negotiate with other representatives for water delivery.

Every important matter is discussed and decided in the representative meeting, and all written material necessary for the discussion is

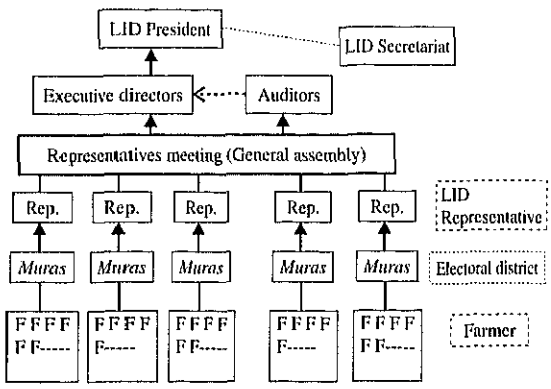

Fig. 7 Election System of a LID

presented at that time. Periodical leaflets describing the result of the decision and other important information are distributed to all members through the representatives and the *Mura* system. Thus, accountability and information disclosure are realized in LID management.

VI. WATER DISTRIBUTION IN LID SYSTEM

6.1 Water Distribution

Each irrigation system that abstracts water from a source river has a water right granted by the government. The water right is expressed as a maximum diversion flow rate in each stage of an irrigation season, which is divided into several stages based on seasonal irrigation requirements. In normal years the river flow, augmented by reservoirs if necessary, is sufficient for every LID to get enough water. Excess irrigation water in the paddy fields is in no way harmful to the plants, and it also saves the farmers' labor for managing their plots and is helpful in case of subsequent drought. In that event, it is very difficult to prevent farmers from taking excessive water, especially in the upstream part of an irrigation system, where water is abundant.

Most irrigation facilities are freely operated by the farmers themselves as they want, leading to uneven water distribution during ordinary times. It is very difficult to deliver water evenly over the command area of an irrigation system; farmers in the upstream part tend to get more water than those in the downstream part do. This is almost inevitable as long as the farmers participate in water distribution activities, legally or illegally. Since uneven water distribution implies excess and unnecessary water in the upstream part, great efforts have been made to reduce partial water delivery.

One practical way to solve this uneven water distribution is the development of water reuse system (M. Satoh et al 1999). The excess water applied in upstream part and the water percolated in the paddy plots will appear in the drainage ditches. This return flow is widely reused in the downstream area. This kind of water reuse is normally promoted systematically by the LID, which pays the cost fully or partially. Such expense by an LID needs approval in its repre-

sentative assembly. There are normally no problems in this process because the representatives have a common idea that the LID members have an equal right to get water and its realization is the duty of LID. The water reuse practically expands the water availability under the given water resources condition.

6.2 Water distribution during droughts

When a long dry spell occurs and the source river flow is reduced, each LID tries as hard as possible to get more allocation of water. This sometimes causes strong conflicts among LIDs who obtain water from the same source. There is usually uneven water allocation among LIDs during droughts. LIDs in some river basin temporarily transfer a part of their water right to city people to reduce the drought damage on city life. As for the water delivery within an LID, they usually change water distribution system temporarily to realize even water distribution. A typical change is from continuous and simultaneous distribution in all irrigation canals to intermittent and rotational irrigation (Satoh, *et al.*, 1990). This change in water distribution is performed according to the decision of LID on the request of representatives from the downstream areas. This change can avoid drought damage on yields over the command area, including the downstream areas.

As an example of temporary change of delivery system, the Meiji Yosui LID is introduced. The LID in Aichi Prefecture, central Japan, with 41 staff members, diverts water from the Yahagi River at the maximum flow rate of 30 m^3/s to irrigate 6,500 ha of paddy fields. The canal system is made up of 3 main canals, which have 140 outlets for lateral canals. The total length of irrigation canals managed by the LID is 315 km, and another 1,000 km of small scale canals are managed by *Muras* and united *Muras*.

Before 1969 all outlets in the main canals were managed by local farmers' organizations. Under normal conditions they freely took water in order to maximize the yield and minimize the labor requirement on their farm plots. During droughts, however, water distribution was to be changed temporally in three stages as the available river flow decreased, according to the Meiji LID rules.

a. The first stage (water master control): lateral water masters, designated by the farmers or related *Muras*, put all the outlets under their control at the request of the farmers at the tail end. This allowed more water to be delivered to the tertiary canals in the lower part of the lateral canal.

b. The second stage (small-scale rotation): farmers performed rotational delivery within a lateral canal. The command area of a lateral canal was usually divided into two to three blocks. This required farmers to expend labor to deliver water to both the lateral and tertiary canals in order to receive water at their paddy plots. The rotational delivery of water among lateral canals was also included in this category.

c. The third stage (large-scale rotation): rotational delivery among main canals was performed under the supervision of the LID. The small-scale rotation took place accordingly.

Once this water distribution is agreed, no member farmer dares to interfere the LID activity. The violation of the decision will be suppressed by the local groups.

6.3 Water distribution problems to come

The traditional water management system has been totally dependent on the rural system of *Mura*. However, LIDs can not rely on the system anymore because of reducing number of farmers and urbanization in their regions. In addition, people have begun to think that more water should be allocated to sustain an ecosystem that has been formed in a traditional irrigation and drainage canal system. This idea also goes to the minimum flow in the river system. These new social requests should be met by technological improvement and institutional reforms in the water resources management.

VII. CONCLUSIONS

1) Irrigation of paddy field is the major water user in Japan. The low flow discharge in major rivers has been totally allocated to the irrigation since the feudal time of Japan.
2) To regulate the water uses after Meiji Restoration, the government introduces the water right system in 1896. However, the customary water right existed and applied to the existing water users.

3) The water right in Japan is issued to each water user group under the strict control of the government based on water balance analysis in each river. However, the actual water allocation follows the decision by the water users, and the government does not directly order the water users.
4) Japanese farmers are totally responsible for operation and maintenance of their irrigation systems. They establish an LID, an autonomous organization, for this purpose according to the Land Improvement Law. They manage it through a representative election system. Since every important matter is discussed openly in the representative meeting, the member farmers get transparency and accountability on LID management.
5) The government cannot start an irrigation and drainage project unless most of the beneficiary farmers agree to the project plan. Farmers must pay some part of the construction costs. In return, they are given the opportunity to express their opinions on the project plan, including the method of water management after construction. The government engineers try to plan the project so that even the downstream farmers will agree to it.
6) Uneven water distribution occurs in Japanese irrigation systems, especially during normal times, due to the upstream farmers' activities. However, during severe droughts, farmers in an LID can agree to change the water delivery system to avoid drought damage in some parts of the area. Water recycling by LID is another way to solve uneven water distribution problem.

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JAPAN: DISCUSSION

Question: A certain amount of water has been already allocated for irrigation, but half of the paddy field land is idle. In this situation, farmers still experience the serious drought?
Answer: Yes, they suffer from water shortage in drought years, for example in 1994 and recently. The water applied to paddy fields contributes to the evapo-transpiration in other land uses in the area.
Question: Farmers have the paddy land idle by their own decision or my enforcing order of LID? Farmers pay water fee even if they are not cultivating?
Answer: Japan employs a capitalistic system. Japanese farmers have the right to grow what they want. Thus, no planting paddy by farmers at almost same ratio in Japan is not by their own decision, but by a strong guidance by the government. The government pays some amount of money to the farmers who are cooperative to the guidance. They think that the payment includes the water fee for LID.
Question: What is the structure of river basin water management committee? How is the water right to be viewed, especially during drought?
Answer: All the related water users participate in a river basin committee, where they decide the water saving ratio of each water user by themselves with scientific and technological information and advice as well as guidance. However, the decision will be different from basin to basin according to the situation and history in the region. For example, in the lower reaches of Kiso River basin, traditional irrigation associations refused to sacrifice their water right to nearby cities before 1994, but now they give some of their water to city people during drought. In Tone River all water users in the basin adopt the same water saving ratio.
Question: Why agricultural water use is expected to decrease in the future in Japan?

Answer: Japan has a problem of over-production of rice. This year almost 40% of rice production was suppressed by the government policy. Under the WTO talk situation, more open market of rice will be realized in the future. The Japanese government is trying to expand upland irrigation. But its water consumption rate is not much as that of paddy irrigation. The expected area of upland irrigation is not comparable with that of reduced paddy field, too. Thus, in the future less water in irrigation sector will be used and consumed

Question: Recycling of water is only for industry, or is it for domestic use also?

Answer: No. Water recycling is performed in all the water use sectors. The flushing water in the toilet of our University is water recycled, for example. However, the rate of recycling in domestic water use is supposed to be not so high at this moment and there is no national survey for it.

Question: Is there any farmers' conflict during severe drought?

Answer: Yes. It can be commonly seen everywhere in Japan when a long dry spell occurs.

Question: Is the rice field drained for certain period during growing period, or kept flooded continuously for the full growing period?

Answer: Basically the paddy field is kept flooded during the growing season. However, farmers perform mid-summer drainage for aeration of soil in the mid-season, and drain water 10 to 14 days before harvesting. The number of days before harvesting depends on the soil type because farmers want to get enough bearing capacity for combine harvesters.

Question: What is the status of agro-environmental education in Japan?

Answer: There has not seen a standing system for the education so far. However, MAAF of Japan has introduced some kinds of project aiming to improve agro-environmental conditions in the rural areas. In such occasion farmers have opportunities to get educated about it.