SYNERGY EFFECTS OF INVESTMENT OF FARMERS AND GOVERNMENTS ON IRRIGATION COMMONS FOR SUSTAINABLE MANAGEMENT

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ABSTRACT

In Japan, a narrow islands country which has achieved high level of industrialization, a 400,000km-long paddy irrigation and drainage canal network exists just like as sophisticated arteries and veins in our body. And that amazingly it is still managed collectively by farmers throughout almost the whole of its length, and it still waters some twenty million rice paddy plots every spring, making more than two million ha of artificial wetland appear. We can also observe similar scenes all over the Asian monsoon region with various economic development stages. Why has this practice been maintained across our generations? What type of economy underpins it? No research has been done to answer these questions.

This paper seeks to feature substantial debate on the question of water for food and the environment in the Asian monsoon region by proposing a spontaneous and collective management on social overhead capitals and discussing what form good governance over it should take. It consists of two main bodies and a conclusion. Part 1 presents overview of the characteristics of ecosystems and economy in multi-functioned irrigated paddy rice agriculture in the Asian monsoon region. Part 2 discusses the socio-economic mechanism of a sustainable management for irrigation and policy implications for designing it across the Asian monsoon region. It stresses the importance of good governance. The case studies and policy analysis on public works projects leads to highlight the importance of social capital in achieving good governance and discover the synergistic effects.

Finally this paper concludes and recommends that we need a policy renaissance to appreciate and support the management of irrigated paddy rice agriculture collectively run by farmers in the Asian monsoon region for cumulative experience of governance and persistent build-up of social capital, for implementing an optimal policy on water for food and ecosystems in this region.

Keywords
Asian monsoon region, Water management, Good governance, Social capital, Policy design

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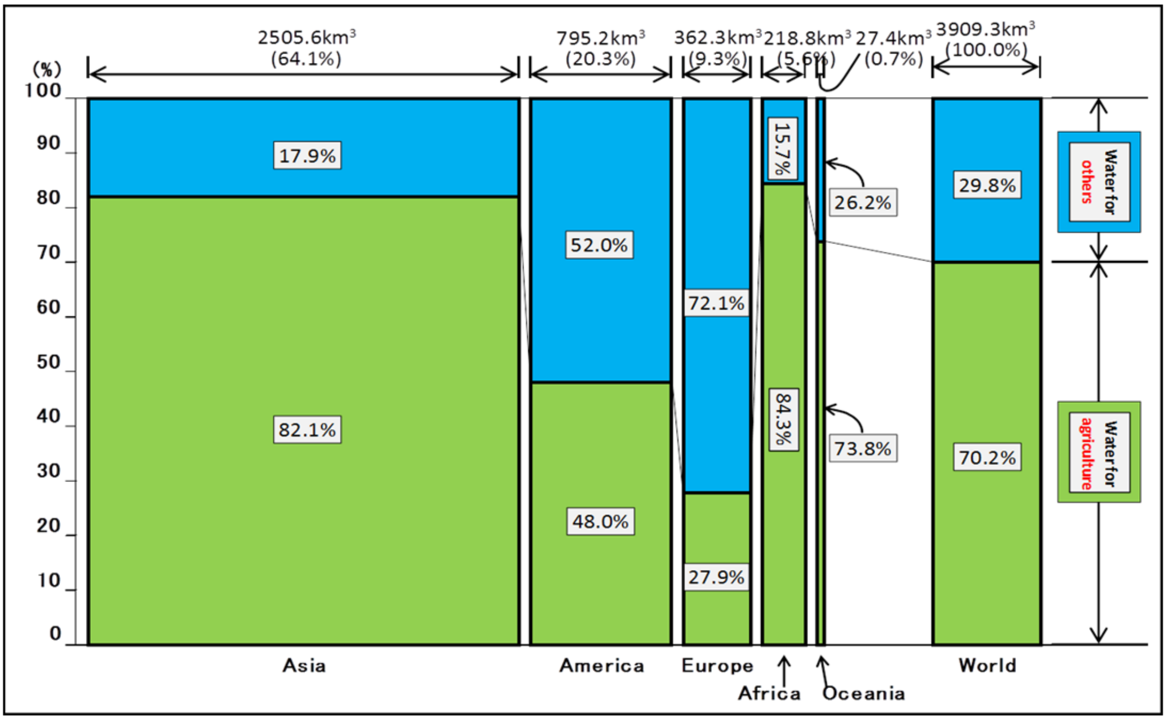
1. WATER AS AN ESSENTIAL RESOURCES FOR AGRICULTURE AND RURAL SOCIETY

Agriculture – the biggest global water user

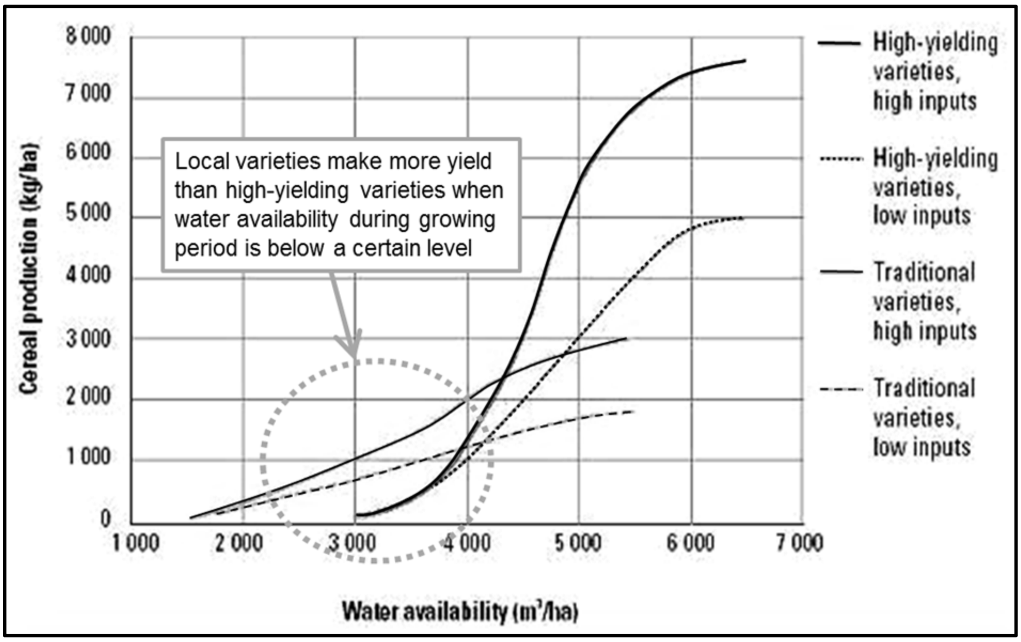
Agriculture inevitably uses 2,504 billion tons of fresh water annually which accounts for 70% of total global water use in the water intake basis. Especially in Asia where 60% of world population survives amount of water use for agriculture accounts for 82% of total water use in this region as shown in **Figure1**. Most of the water use is for paddy field irrigation necessary for rice production in an advanced way. The amount of water use only for agriculture in Asia accounts for about half of total water use including for hydroelectric power, industrial and city use in the world.



Source: FAOSTAT, Food and Agriculture Organization (FAO)
http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/

Fig.1 Annual water withdrawal and proportion of water use by continent

Introducing a high yield variety under the rain-fed condition is so risky that it cannot apply without anxiety. Crop yield can drastically increase only under the irrigated condition where farmers can introduce high yield variety with effective fertilization with a sense of security. **Figure 2** shows such a risk that farmers meet a poor water condition after introducing a high yield variety with a substantial cost. The high yield variety makes a very poor harvest under the condition of limited water availability. Green revolution can take place on the premise that an irrigated agriculture is managed well. Actually, though irrigated farm land accounts for only 20% of total arable land in the world, it accounts for about 40% of world production of cereals and supports human food demands. It is indispensable for human being to make further development of irrigated agriculture in order to increase and stabilize capacity for global cereal production to feed their next generations.



Source: International Rice Research Institute (IRRI)

Fig.2 Relation between water availability and cereal production and difference of response in high yield variety from local one

Investment to social bonds through water dispute in irrigated agriculture

Water governance and irrigation dispute resolution involve a variety of interests at multiple levels. This paper focuses on irrigation systems in paddy fields in the Asian monsoon region. Farmer A and B, who cultivate adjacent paddy plots may have mutual conflicts; but at the same time, they are comrades forming a united front against other groups. A structure of chain links as shown in **Figure 3** is commonly observed in this region.

The typical structure of a water supply system for paddy is an open channel gravity system which provides the most efficient and least-cost distribution of water to the tail-end of the irrigation system under normal flow conditions. Moreover, beyond the network of canal irrigation systems, ample water supplies enable water to be conveyed from higher-elevation paddy plots to lower-elevation ones, thereby extending the effective reach of the irrigation system. With this technique of "plot-to-plot irrigation", the paddy fields themselves serve as irrigation canals. This is widely developed in rain-fed paddy areas, and around the edges of traditional irrigation networks, and also even in the periphery of modern irrigation systems.

This basic structure and climatic characteristics of frequent dry spells exert a strong influence on the accumulation of social capital in this region. Repeated water disputes sometimes escalate into violence, however, repeated experiences of reconciliation among farming families and between villages have led to the establishment of local discipline and norms for collective water management. Moreover, long experience in collective water governance among farmers during abnormally dry spells serve as an investment in the accumulation of social capital, the network of trust, norms, mutual confidence and spirit of reciprocity among farmers. And the accumulated social capital also works as a catalyst to overcome other unexpected events after that, enabling successful experience of water governance next time. This synergistic effect assures a sustainable development of social capital and related activities over centuries.

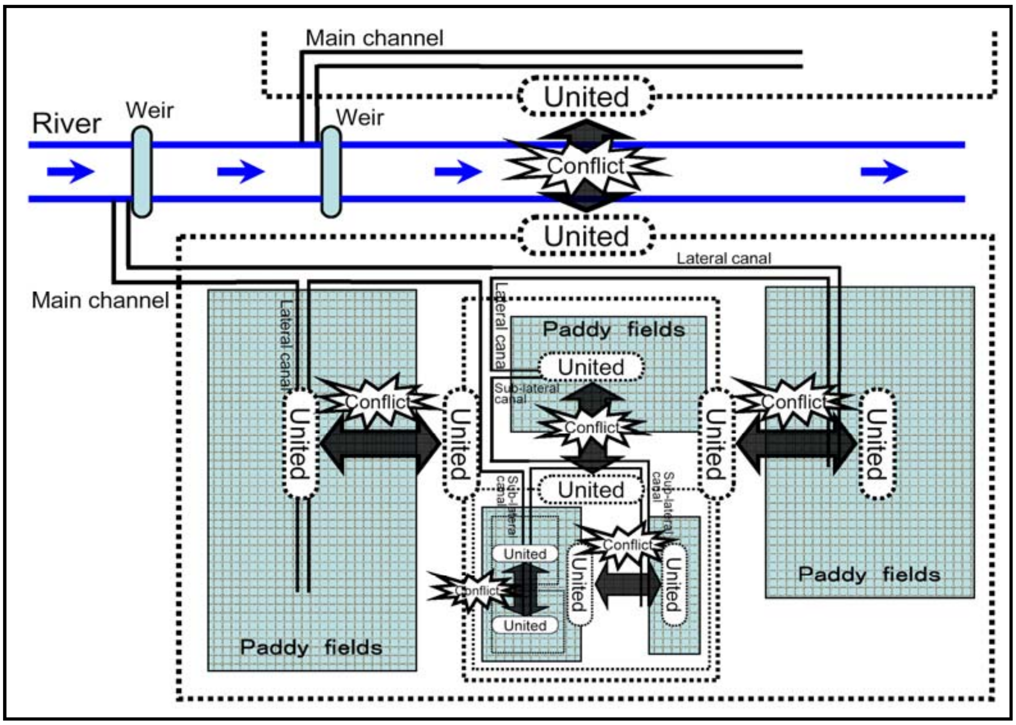


Fig.3 Chain links of united front and confliction in multistage levels on dividing agricultural water

2. PADDY RICE CULTUVATION IN THE ASIAN MONSOON REGION

Advantages generated by most suitable way of cultivation to the climate

Paddy rice cultivation is the most suitable farming method under humid and warm condition with ample rainfall. The world's rice production is about 600 million tons (un-hulled), of which some 90% was produced in the world's top 10 producing countries, all of which have annual precipitation in excess of 1,500 mm, and of which nine are located in the Asian monsoon region. The amount of rainfall in this region concentrates in the rainy season due to typical monsoon climates. It exceeds 125mm per month and may come up to 500mm per month in the rainy season which lasts for several months in major cities in this region. In contrast, no major cities in a Western country have a monthly rainfall of more than 125mm in a year as shown in **Figure 4**.

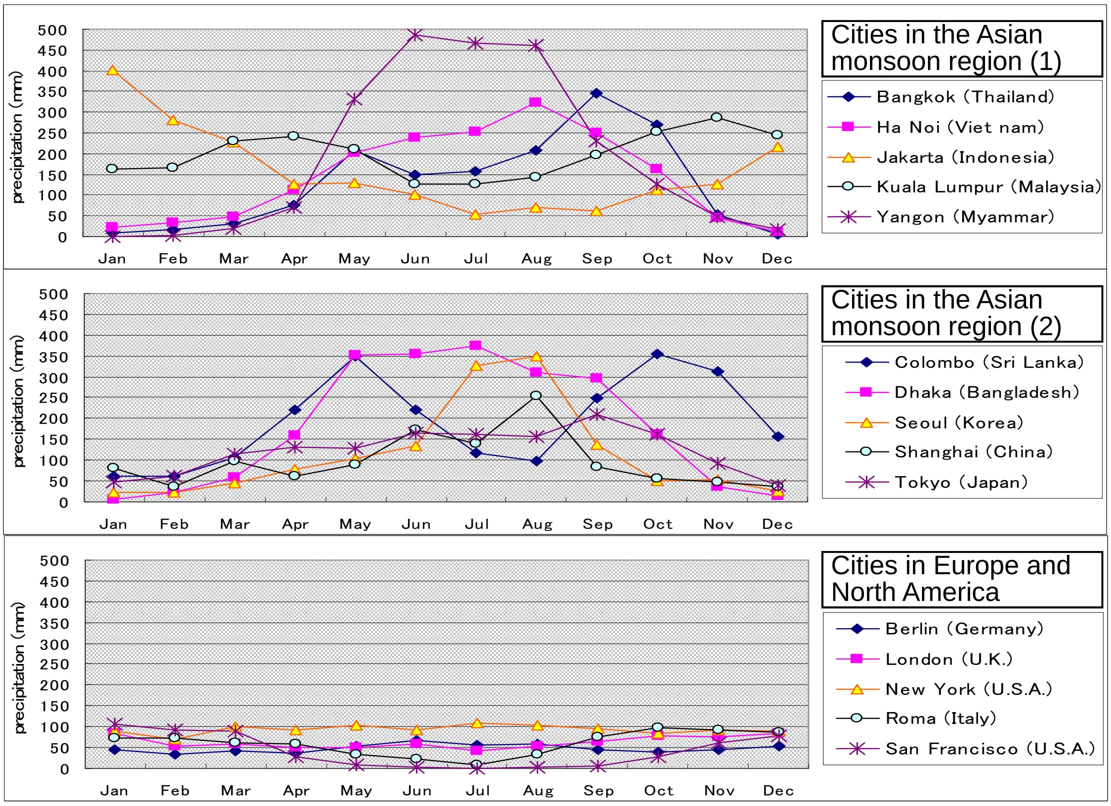


Fig. 4 Monthly Precipitation in Major Cities

Such a great amount of rainfall and inundated plants can result in oxygen starved soils and waterlogged roots. Rice is well adapted to extreme wet conditions because it can provide oxygen into its roots through the plant due to its distinctive body structure with paths for good air passage. Moreover, inundated paddy rice cultivation has many advantageous effects in reducing usage of land, labor and other resources by substituting ample water resources (**Table 1**).

Table 1 Advantages of paddy rice agriculture with ample water use

Items of advantages	*Explanation on advantages of paddy rice agriculture with ample water use*
Reducing management in distributing water (off-farm)	Because ample water is available, it is possible to convey water to all parts of the field with even poorly built canals, and it is easy to manage water distribution at divergence points, and this means that the amount of investment in facilities and labor required for off-farm water management can be reduced.
Reducing management in distributing water (on-farm)	With the system, called “plot-to-plot irrigation”, the paddy fields themselves serve as irrigation canals. This method can be used to supply water to all of tens or hundreds of paddy plots easily. By repeatedly using water (i.e., by introducing it into paddy fields that are located in higher-elevation and letting excess water flow to downstream paddy fields), labor required for on-farm management of water as well as investment in facilities can be reduced.
Reducing weed control	Flooding can prevent growth of weeds, except vascular plants like reeds that normally grow quickly and thickly when the soil is not submerged in the wet and warm

	climate.
Preventing soil erosion	Use of levees around rice fields and a standing pool of water reduce soil erosion losses even during periods of heavy rain. In fact, rice paddies act as a settling basin for suspended sediments in water.
Reducing fertilization	Organic matter in the soil decomposing slowly through anaerobic decomposition when the soil is flooded maintains soil fertility. Organic nitrogen is transformed into ammonia nitrogen while the soil is under reduced conditions and nitrogen is easily taken up by plants and attaches to soil particles. Less phosphate fertilizer is required for flooded soils because soluble, plant-available phosphates are formed while the soil is in a reduced state.
Reducing plowing	Paddy rice cultivation in clay-rich soil involves a year-long process whereby flooding expands and softens the soil (swelling) and drying shrinks the soil, forming cracks. This process increases the pore space between grains of soil, which facilitates movement of water, improves soil leaching that occurs with rainfall and prevents the build-up of salts in the soil.
Preventing a fall in yield by repeated cropping	The soil is under reduced conditions when it is flooded and becomes oxidized when water is drained. This process promotes alternation between anaerobic and aerobic microbes, which maintains bacterial balance and soil fertility and prevents a fall in yield from repeated cultivation of the same crop on the same ground.

For instance, the existence of ample water enables water to be conveyed to the tail end of the irrigable area in spite of poorly built canals with many leaks. The more water that is available in the irrigation canals, the easier it is to manage the water distribution throughout the irrigated area. This means that investment in facilities and labor required for off-farm water management can be reduced. Consequently, the available amount of water use, labor investment for operation and maintenance, and investment for infrastructure can be mutually substituted. An item that is costly can be replaced by one that is less costly. If this practice is employed, it is possible to raise the economic efficiency of water use by using cheap and ample water resources.

In the rainy season, although ample rainfall enables farmers to enjoy rain-fed rice cultivation and floodwaters can be used for floating-rice cultivation in some places, drainage in low-lying flat lands, including arable land, may become a problem. On the other hand, during the dry season, since temperatures are high and potential evapo-transpiration is large in the Asian monsoon region, the land dries out and irrigation is usually required.

Features of rice paddy irrigation and its management

In contrast to irrigation systems for upland crops (which are typical in Western countries), rice paddy irrigation systems in the Asian monsoon region are characterized by the following elements, which are reflected in agricultural water governance:

1) Wide-ranging substitutability between water and labor as a factor of production,
2) Short-term variability in the shadow price of water,
3) Frequency of the risk of abnormally dry spells,

4) Ability to reallocate surface water from one rice field to another in the event of abnormally dry spells,

5) Multi-functionality such as preservation of ecosystems and biodiversity generated by ample water usage for rice fields.

We will omit the last issue since it is discussed in a mass at another opportunity. The first two issues are illustrated below, and the third and fourth issues are discussed at some length in the sections following.

Substitutability between water and labor; Inundated paddy rice cultivation can reduce the use of land, labor and other resources by substituting ample and relatively low-cost water resources. In contrast to this, irrigation systems for upland crops (e.g., wheat), provide just enough water to supplement the moisture in the soil; there is little opportunity to reduce usage of other resources by substituting more water. Inundated paddy rice cultivation allows for a broader range of substitutability between water and labor as factors of production.

Short term variability in the shadow price of water; The basic demand of irrigation water resources in paddy rice cultivation is much higher than that in other crops because the former utilizes water not only for the physiological requirements of the rice crop, but also as a strategy for reducing inputs of other resources. Moreover, rice is a tropical or subtropical plant so that air temperatures are high and potential evapo-transpiration is also high. On the other hand, direct rainfall to paddy plots is a water resource whose shadow price is extremely low, almost zero. Therefore, farmers want to take maximum advantage of the humid environment in the rainy season, and to store rain water in the form of inundated rice paddies. However, fluctuations in rainfall sometimes cause a dry periods of several days even in the rainy season, and the stored water disappears in some plots due to high evapo-transpiration and infiltration. Irrigation water is introduced to supplement and maintain the stored water in the paddy plots. Because farmers in paddy rice areas generally rely on rainfall during the rainy season, the demand for irrigation is affected by the amount of rainfall and fluctuates sharply.

Some periods of dry weather (e.g., up to ten days) during the rainy season drastically increase the demand for irrigation water in comparison with normal conditions. Tightness of supply and inelasticity of demand for water resources can reach a critical stage in a very short period of time, particularly if the source of water from a river decreases at the same time. Reservoirs upstream from river basins usually serve as insurance in these cases. However, in the case of small river basins without large reservoirs in some insular and peninsular countries, the critical stage can be reached in a very short time. These phenomenon are called as “abnormally dry spells”, and the frequency of risks is higher than that in dry regions.

3. CASE STUDY OF AICHI-YOUSUI IRRIGATION PROJECT IN JAPAN

Frequent outbreak of abnormally dry spells making shadow price soar

The following case study of Aichi-Yousui water supply project shows a typical phenomenon in insular and peninsular regions. Makio reservoir, the main reservoir of the project, has recorded during 30 years (1973–2002); a) 20 years when a water-saving ratio was regulated to reduce the amount of water to be discharged from the reservoir, b) 16 years when the water-saving ratio for agriculture exceeded 20%.

Figure 5 shows the price effects of scarcity of agricultural water in Aichi-Yousui waterworks project area in Japan. Makio reservoir was designed as the main reservoir of the modernized irrigation system of this project area. It has 68 million m^3 of storage capacity and discharges a maximum of 29 m^3 /s water for agricultural and non-agricultural use. In **Figure 5**, the X-axis represents the amount of water stored in Makio reservoir. The Y-axis depicts the water-saving ratio, defined as (Im-Ic)/Im where Ic is actual discharged volume of water at a specific period in a year and Im is the mean actual discharged volume of water at the same period for the previous three years.

The water-saving ratio is inversely proportional to the amount of stored water, and shows that the higher the water-saving ratio, the higher the scarcity (i.e. value or shadow price) of agricultural water. On the demand side, the amount of water that farmers are legally allowed to use is fixed at 21.5 m^3 /s during the period of May 1 to October 3. The reduction in the amount of water stored in Makio reservoir means that farmers actually use the full amount of irrigation water discharged from the reservoir. So it is probable that, during this period, the farmers' potential demand for water is nearly the same as the fixed water use right.

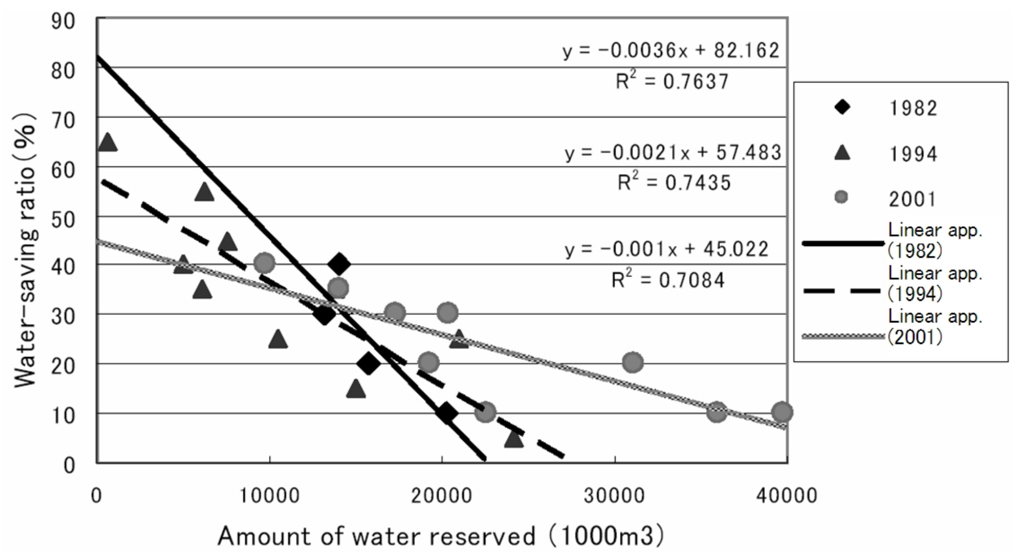


Fig. 5 Relation between amount of water reserved and ratio on reduced amount of agricultural water discharged from Makio reservoir in 1982/1994/2001

Figure 6 shows the change of the water-saving ratio in the same area for the years 1982, 1994 and 2001. The scarcity of agricultural water fluctuates widely during a given crop season. An abnormally dry spell where the water-saving ratio exceeds 30% may extend over three months as in 1994 while less than two weeks as in 1982. This example shows that abnormally dry spells are not predictable. The unknown variables include; a) the date of onset, b) the date and reach of peak water-saving ratio, and c) the total duration.

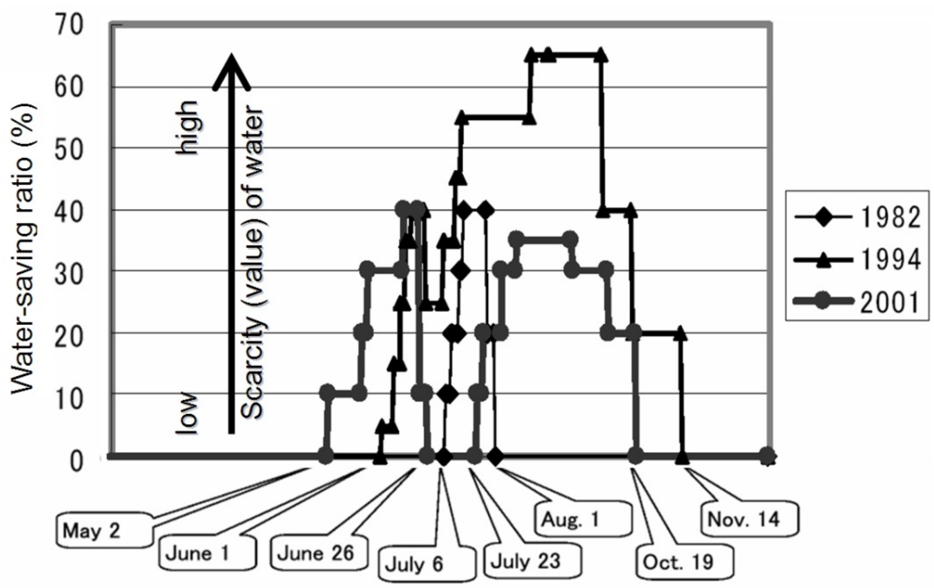


Fig. 6 Change of ratio on reduced amount of agricultural water discharged from Makio reservoir in 1982/1994/2001

Under these conditions of high risk for abnormally dry spells with the shadow price (scarcity) of water fluctuating unpredictably, volumetric water pricing systems are inadequate. In regions with generally ample water resources the price level of water should be low to encourage farmers to use the water resources for full production of crops. In contrast, during an abnormally dry spell, the price should be high to avoid a scramble for securing water under the tight conditions of supply and demand for water resources. The price level must fluctuate to adjust to the changing supply and demand balance. If the price depends only on a market mechanism, it could fluctuate sharply, and the water could become a target for speculative dealing. It is a serious matter to distribute river water regarded as a public good or commons, while it may be allowed in the case of ground water which is considered as a private good. This is why irrigation water for paddy fields under humid climate is usually pricing according to farmland area.

This system allows farmers to use water flexibly. Farmers observe each other, and this serves as a mechanism for adjusting water supply and demand during abnormal dry spells, through local customs and norms about water management.

In dry regions, however, the demand for irrigation is more stable, since it rarely rains. Under these conditions, where the supply and demand for water do not fluctuate and water is generally scarce, volumetric water pricing can work well.

For instance, expected monthly rainfall is only 10mm to 50mm during Summer in paddy fields in California. Nearly all the water needed for rice cultivation derives from the irrigation supply and there is no fluctuation in water demand. The available irrigated water supply also does not change in the course of the crop year because reservoirs have already reserved a huge amount of snowmelt by Spring and no rainfall is expected during Summer. It can be precisely calculated by Spring how much acreage is available to cultivate compared to the amount of actually reserved water, so that water banking systems have evolved. However, the volumetric water pricing systems, commonly observed in the irrigation systems in dry regions and in the water supply systems in urban areas, encourages the use of water as a private good rather than public good or commons. Users are encouraged to act independently based on self-interest rather than collectively based on the local norms about water management. In this sense, volumetric water pricing systems have a disadvantage from the perspective of social capital accumulation.

Repeated water transfer without payment during abnormally dry spells

During the stress of abnormally dry spells, paddy farmers sometimes adapt the counter-intuitive economic practices of water transfer without payment. An enabling condition for this behavior is the fact that dryness affects some fields much more than others, due to soil conditions, micro-topographical features and the theory of water flow under gravity. Thus, there are usually some advantageous plots and disadvantageous ones in terms of water availability. Crop stress from the abnormally dry spell breaks out in the disadvantageous plots first and spreads to the other plots. In this case, farmers can transfer part of the surface water stock that is temporarily enclosed on a paddy plot to other paddy plots by means of plot-to-plot irrigation. Even in rain-fed paddy rice farming areas, negotiations among farmers for water transfer, normally made through bilateral agreement between adjacent farmers, are attempted during abnormally dry spells, and methods of redistributing water stock and local practices of water use are widely developed as traditional customs. If these plots were upland farm fields or pastures, water transfer between adjacent fields never happened because water was integrated with soil as moisture.

“Plot-to-plot irrigation” is the most common technique for distributing water among rice paddy fields. The existence of ample water enables water to be sent from higher-elevation paddy plots to lower-elevation ones, cutting a part of the levees surrounding paddy plots, and letting the excess flow to downstream paddy fields. With this system the fields themselves serve as irrigation canals as well as farm fields. It does not matter if hundreds of plots are involved; if there is sufficient difference in ground elevation, this method can be used to supply water to all of them, enabling the labor required for on-farm water management as well as investment in facilities to be reduced. Therefore, this approach is widely developed in rain-fed paddy areas, and around the edges of traditional irrigation networks. However, this also allows upstream farmers in the plot-to-plot irrigation area to have a strong advantage in using water. Downstream farmers in the area have little choice but to take the surplus or drainage water released from upstream paddy plots. Even in modern irrigation systems, in which water is normally taken into each paddy plot directly from a canal, the custom of plot-to-plot irrigation is sometimes practiced as a response to critical water shortages due to abnormally dry spells. The crisis atmosphere within the smallest unit of the irrigation systems quickly spreads to whole systems through the chain-link structure, and it becomes a touchstone to accumulate social capital within the irrigation society. Paddies joining in plot-to-plot irrigation during abnormally dry spells could be regarded as most carefully operated water diverting devices.

4. AGRICULTURAL WATER GOVERNANCE AS A PUBLIC ASSET COLLECTIVELY MANAGED

When compared to modern city water supply systems (city water supply services), common in urban areas, traditional paddy rice irrigation systems (agricultural water supply services), which are commonly seen everywhere in the Asian monsoon region under the abovementioned conditions, have a relatively high potential for forming agricultural water governance among farmers or between the government and farmers.

These two systems have the common features of social overhead capital: (a) both of them are indispensable assets for city and rural dwellers, i.e. water users, in their lives and production activities; (b) they are also public assets which are developed, maintained and shared by public communities; and (c) they consist of natural capital, infrastructure and institutions. Inevitably, water is the natural capital of these systems and reservoirs, intake facilities (e.g. diversion dams), distribution facilities (e.g. irrigation and drainage channels, pipelines, division work and gates), and management facilities which comprise municipal and agricultural water supply facilities are the infrastructure. The institutions ensure correct operation, based on such capital, providing services by using capital and formulate and implement investment plans to control and restore deterioration of and damage to the capital, which the provision of services generally causes. From a general point of view, such institutions must consist of at least: (a) regulations regarding the identification of particular beneficiary members in the group; (b) regulations regarding the accumulation, retention and management of natural capital and infrastructure; and (c) regulations regarding the allocation and use of goods and services (water in this case).

Generally speaking, compared to economic activities in cities, agricultural activities require vast amounts of low-priced land and water sources, which are cheap due to limited investment. This is particularly evident with water usage in paddy rice irrigation systems (agricultural water supply services) in a humid climate where many farmers rush in, using ample and cheap agricultural water. Furthermore, compared to municipal water, service users in rice agriculture are rather homogenous and fixed regarding who uses water, in what quantity, for what purposes and when. These are more or less consistent. Especially in the case of traditional paddy rice irrigation systems, unlike common water projects in urban areas, it is unnecessary to establish a special agency for water management separately from users. In most cases, farmers feel comfortable where they can involve themselves directly in the accumulation and management of social overhead capital, i.e. their agricultural water distribution systems, accompanied by public financial and technical support. That is to say, the key player in establishing and operating the abovementioned system should be a group that is formed voluntarily and operated by farmers. Government bodies therefore play a supporting role through rather indirect involvement. Such a group may employ experts, but in practice, the users' participation in group decision-making, facility management and the coordination of agricultural water distribution is normally substantial, which results in a significant overlap between managing people and users. This is the very basis of agricultural water governance where water is utilized and managed in a collective and systematic fashion through users' cooperation.

With many traditional and collective systems of irrigation management run by farmers, which are commonly seen everywhere in the Asian monsoon region, agricultural water governance is already in place from the outset of system establishment. For farmers, agricultural water governance is an indispensable asset, not only in the productive aspect of rice cultivation, but also in terms of ensuring secure and comfortable rural community life. Agricultural water governance is also a public asset that is developed, maintained and utilized in a collective manner. It also retains the farmers' strong awareness of their rights while it relates closely, not only to the coordination of water distribution and the management and maintenance of facilities, but also to traditional, ritual and religious events that are held in a community. It often takes part in the actual formation of rural society.

Typical examples are seen in Japanese Land Improvement Districts and their predecessors, *"sou"* and *"igumi"*, the Korean *"hungnongkye"* (the basic unit into which farmland improvement districts are organized), the Taiwanese *"p'ichen"* (the basic unit into which farmland irrigation associations are organized), the Chinese *"weitian"*, the Philippine *"shianfela"*, the Indonesian *"subak"*, the Thai *"muang-fai"*, the Cambodian *"samakum"* and *"colmatage"*, the Laotian *"nawan"*, the Bangladesh's *"Comilla"*, the Nepalese *"toris"*, the Indo-Pakistani *"walabandi"*, and the Sri Lankan *"kanna"*.

5. WATER PRICING SYSTEMS TO FACILITATE WATER GOVERNANCE COLLECTIVELY RUN BY FARMERS

Water pricing systems adaptable to humid climates

When farmers’ organization wants to make a sustainable management autonomously, water pricing systems are indispensable to charge a proper management cost to beneficiary farmers. The normal concept of water pricing treats water primarily as an economic asset, in other words, as a simple one of resources invested into economic activity just like land or petroleum or any raw material. It aims to create appropriate incentives to distribute and utilize water resources in efficient and sustainable fashion by charging users a sensible price for the water they use. However, in humid climates, agricultural water is sometimes more than merely an economic asset; it is often at least as valued as a kind of communal ecological asset, as it were, for its role such as in recharging groundwater aquifer and promoting biodiversity. Moreover, when severe water shortages strike, it tends to be regarded as the communal economic property of a particular group of users to be distributed equally as much as possible among them rather than the private property to be used by a single economic player on his own initiative.

In Japan, for example, farmers commonly pay a fee to water users' associations, namely Land Improvement Districts (LIDs), for the use of water to irrigate their paddies. But for paddy irrigation, nobody here considers water as a saleable commodity with a price tag attached, of which users can buy as much as they want as long as they lay down the cash. Rather, farmers are charged a levy as their fair share of the cost of maintaining the necessary public facilities and managing the water distribution both during normal periods and abnormally dry spells, so that water can be equitably distributed as a communal asset based on a fixed set of rules under given conditions.

This system of levies is called "area-pricing". But one should note that it constitutes a unique approach to collective water use with a long history, one that treats agricultural water as so much more than just an economic asset and recognizes these other functions as well. The system of levies on irrigation access observed in Japanese paddy farming is an integral part of a mechanism of water use, embracing both rights and responsibilities, and that adapts flexibly in response to the variable state of water resources. It differs from pricing water for sale as a mere economic asset. In the following analysis, therefore, we treat the assessment of fees for managing paddy irrigation systems in Japan as an "area charge" accompanied by the respective combination of rights and obligations for normal periods and abnormally dry spells.

Distinct differences in adaptability of water pricing and trades between arid and humid regions

Water pricing is predicated on the assumption that the unit shadow price of water remains unchanged over a certain fixed period - say a year - or, if it does fluctuate, does not do so suddenly or dramatically. Here, “shadow price” refers to the increase in profit or economic welfare (surplus) obtained when the amount of a particular resource increases by one unit under ideal conditions allowing optimum distribution of that resource. It implies the potential value of goods differing from the price actually realized on the market. Where that assumption holds, as in arid and semiarid regions, the pricing practices work well from the viewpoint of the saving scare resources of water and efficient allotment of them.

In arid and semiarid regions, where virtually no effective precipitation can be expected during the crop growing season in the spring and summer, when agricultural demand for water is highest, for example in California in the USA, the total quantity of water available for use during the period can be determined in advance based on how much water is collected in reservoirs at the beginning of spring. There are heavy snowfalls in northern part of California in winter. In a case like this, an efficient water use plan can be formulated by using price signals to adjust demand to available supply to the Central Valley, which is already fixed. It is just a matter of applying basic economic theory: if the price is high, demand will fall; if the price is low, demand will rise. To look at it another way, experience teaches that, as the shadow price of water resources will hardly fluctuate at all, supply and demand can be fairly easily adjusted with minimal transaction costs. Hence not only are there no obstacles to introducing water pricing systems in the volumetric basis, even trading systems for water resources or water rights, so called water bank schemes, are actively established and perform efficiently.

However, in the Asia monsoon region, a typical example of the region in a wet climate, the situation is different. Normally peak agricultural demand for water may coincide with the rainy season. In river basins where irrigation farming is highly developed, crops are planted accordingly and demand for agricultural water surges during the rainy season. As long as precipitation is normal, a bumper harvest can be expected, but if the reasonable amounts of precipitation fail to arrive on time and a prolonged dry spell occurs, the crops may suffer drought damage, especially since levels of evapo-transpiration are so high in summer. Meanwhile rivers can dry up and water levels of reservoirs can become dangerously low, since they depend on seasonal rains. So, while supply dramatically drops, there is little way to cut demand, resulting in a scramble for scarce water despite rainy season. If water could be freely bought and sold then, higher bidders would get all the water, while the economically disadvantaged, unable to secure the water they needed. It may be dangerous to leave the water distribution to market mechanisms during abnormally dry spells because speculation and cornering may happen and disturb people’s access to water.

Better mechanisms for adjusting supply and demand of irrigation water in abnormally dry spells in the Asian monsoon region

On the other hand, farmers take advantage of the extremely low shadow price of water resources during a typical rainy season to be able to withdraw far more water from the river than their crops physiologically need. Since there is plenty of water, it can easily be diverted wherever an irrigation channel forks, which reduces the amount of labor required for off-farm water management in water conveyance systems. In addition, water can be channeled into paddies lying upstream, with any leftover being drained off for reuse in paddies further downstream in a constant process of recycling; that reduces the amount of on-farm labor and capital investment required in water distributing systems.

The farmers in the Asian monsoon region know from long years of history and a wealth of personal experience that, under normal conditions, using large amounts of water allows them to reduce labor and capital spending. They are also aware that:

a) If a severe drought hits, the shadow price of water resources will soar in an instant.

b) It is difficult to reach agreement among large numbers of small-scale farmers every time a drought occurs (considerable transaction costs are involved).

c) It is difficult to predict when and with what severity a dry spell will strike.

The experience of farmers in the Asian monsoon region has taught them that mechanisms for adjusting supply and demand through price signals are not the best way to deal with the wild swings in supply of water resources characteristic of humid climates. Instead, they know that the most successful approach involves:

a) Boosting economic efficiency by using water liberally in normal times, when its shadow price is extremely low.

b) Tiding themselves over during times of abnormally dry spells, when the supply of water drops and its shadow price shoots up, by supplying labor (to cover costs) on a communal, rule-governed basis to ensure equitability and keep transaction costs to a minimum.

Effective ways of ensuring that communal action goes smoothly in times of abnormally dry spells are to set up an organization to manage the water supply collectively run by farmers on a regular basis and agree beforehand among them within that organization on a set of arrangements on water management procedures to be followed during water shortages. Even if a situation occurs not covered by those arrangements, a solution can be found through discussions within the group. Examples of such organizations can be found throughout the Asia monsoon region, such as listed in the previous section.

Irrigation Charging Systems in Japan and the Asian Monsoon Region

In Japan the general practice is to charge water users for paddy irrigation not volumetrically - i.e., according to the amount of water they use - but according to the area of paddy fields. In specific terms, farmers to be water users must establish a Land Improvement District (LID), legislative water users association, to which they themselves compulsorily belong. These LIDs maintain and manage the irrigation facilities and operate the distribution of water, charging the farmers a consideration known as a regular levy consisting of operating fees and maintenance and management fees.

According to a 1999 survey by the National Federation of LIDs, 16 out of a total 5,279 LIDs, or 0.3%, charge the portion of the operating fees volumetrically, i.e., in proportion to the quantity of water used. Similarly, 81 of a total of 6,232 LIDs, or 1.3%, charge the portion of the maintenance and management fees volumetrically. Conversely, 96.8% of LIDs that charge the operating fees and 94.0% of those that charge the maintenance and management fees do regular levies in the form of area charges, i.e., in proportion to paddy field area.

Table 2 Basis for charging regular levies in Land Improvement Districts in Japan

District	Operating costs (no. of areas)	Operating costs (%)	Maintenance and management costs (no. of areas)	Maintenance and management costs (%)
By land area	5,108	96.8	5,857	94.0
By ranking	52	1.0	108	1.7
By water volume	16	0.3	81	1.3
By operating costs	17	0.3	41	0.7
By elevation	2	0.0	12	0.2
Other	84	1.6	133	2.1
Total	5,279	100.0	6,232	100.0

(National Federation of Land Improvement Associations, Survey on management of LID, 1999)

Area pricing or area charge systems often come in for criticism that they generally lead to waste of water because they fail to provide users with any incentive to save water. But, while this criticism may apply to arid and semiarid regions, it is illogical jumped conclusion for humid regions.

6. INSTITUTIONS AND DISTINCTIVE FEATURES OF THE IRRIGATION PROJECT IN JAPAN

The principle and institutional features of the irrigation project

Almost all the government-support irrigation projects in Japan have been executed under the systems of the Land Improvement Act which came into force in 1949. This Act enabled tenant farmers to become official applicants of irrigation projects and land consolidation projects while the conventional laws had allowed only land owners. Under the conventional systems, Water Users Association Act enacted in 1899 and related regulations, land consolidation projects, in contrast to irrigation projects, were unpopular with the so-called parasitic land owners who had no interest in improving labor productivity on the fields.

The Land Improvement Act, in conjunction with drastic agricultural land reforms from 1947 to 1950, helped the emancipated farmers to collectively set up land improvement projects, i.e. irrigation projects for main and lateral canals and some of the smaller sub-lateral (tertiary) canals and land readjustment project for the enlargement of farmland lots. The epoch-making policy was the establishment of the comprehensive land consolidation project which had been institutionalized since 1963 as a reaction to the Agricultural Basic Law enacted in 1961, which has enabled the farmers to construct systematic sub-lateral (tertiary) canals and ditches with land readjustment and enlargement simultaneously. Since then, the consistent construction and management of total irrigation systems from main facilities such as dams and head works to terminal ones in paddy fields level have been successfully realized in Japan.

The Land Improvement Act provides that an irrigation and drainage project should be implemented by the proper project management body in accordance with the beneficiary area of the project and the degree of technical difficulty. There are i) national projects implemented by the Ministry of Agriculture, Forestry and Fisheries (MAFF), ii) prefectural projects implemented by prefectural governments, and iii) communal projects implemented by municipalities or Land Improvement Districts (LIDs). (Fig. 7)

The important features of the procedures provided by the Land Improvement Act for implementing irrigation projects are as follows;

a) Implementation based on farmers’ own initiative (application) and corresponding share of expenses for project

Though an irrigation project is a public investment for the formation of a social infrastructure in rural areas, the Land Improvement Act requires farmers to share a part of expenses for the project as they are direct beneficiaries of that and stipulates in principle that 15 cultivators or more should initially apply on their own initiative.

b) Implementation based on beneficiary farmers' consent and obligatory participation/cost sharing for the project

The Land Improvement Act requires obligatory participation and cost sharing to all farmers within the project's settled beneficiary area if more than two thirds of them consent to the project because it is necessary for them to include certain contiguous areas in which lands and water ways are connected.

c) Establishment of water users' association namely LIDs to be responsible for the irrigation management after completion of the project

The Land Improvement Act requires that facilities constructed through irrigation projects in principle should be managed spontaneously at their own expense by LIDs to be established by farmers using the facilities. It is because the management of irrigation facilities aims not only to maintain and manage the efficient function of facilities, but also to distribute water to beneficiary areas effectively through the services and operation of facilities and it is deemed extremely important to distribute water fairly to all farmers in the assigned beneficiary area. Therefore the LID organized by beneficiary farmers carries out all of the planning, implementation, dispute settlements, assessments and collection of fees for water distribution.

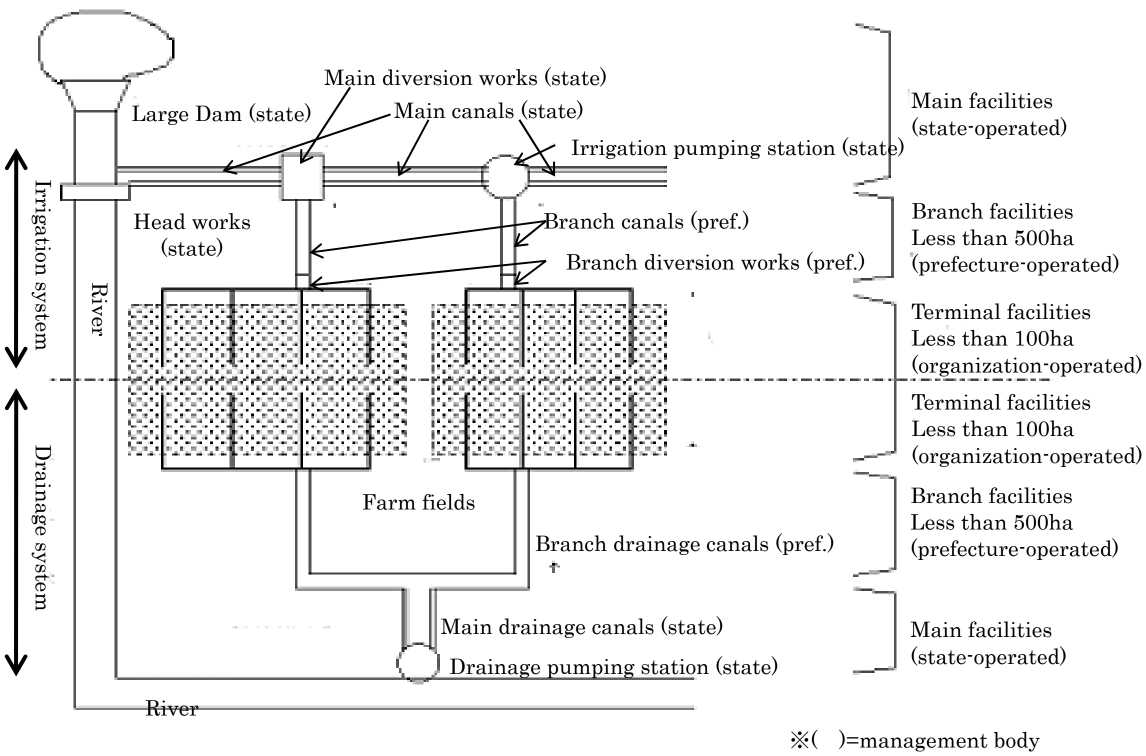


Fig. 7 Facilities constructed by each project management body under the Land Improvement Law of Japan

The outline of operation and maintenance systems for irrigation and drainage projects by the distinguished project management bodies is as follows (Fig. 8);

a) Facilities constructed under national projects

Following the completion of a national project, the national government can entrust the management of the facility to the LID, municipality or prefectural government (with the national government retaining possession of the proprietary rights) or transfer the facility to them (including proprietary rights). The national government can also manage the facility under its direct control when beneficiary farmers apply to the government.

b) Facilities constructed under prefectural projects

Following the completion of a prefectural project, the prefectural government can entrust the management of the facility to the LID or municipality (with the prefectural government retaining possession of the proprietary rights) or transfer the facility to them (including proprietary rights). The prefectural government can also manage the facility under its direct control when beneficiary farmers apply to the government.

c) Facilities constructed under communal projects

In principle, the communal project management body takes care of the management.

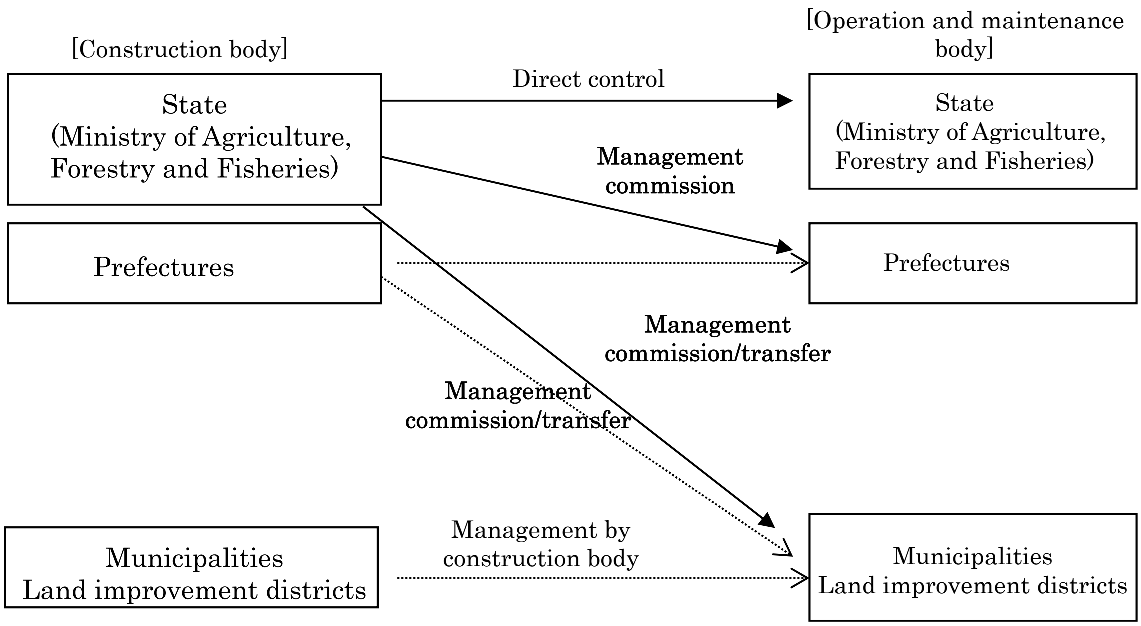


Fig. 8 Relationship between construction bodies and operation and maintenance organizations for irrigation facilities under the Land Improvement Law of Japan

Advanced features and effects of irrigation projects compared to other general public works projects

In this way, requirements stipulated by Japan's Land Improvement Act implementing the irrigation projects are: (a) A project must involve at least fifteen cultivators of agricultural land owners and tenant farmers, (b) A certain beneficiary area should be fixed and the project must be agreed upon by at least two thirds of the people in the area that will be benefited by the project, and (c) The beneficiary farmers in the project area must establish a Land Improvement District that is responsible for the operation and maintenance of irrigation facilities and the management of water distribution services. It suggests that these indicators work in three stages, verifying that the project has conditions suitable for building governance, i.e. the cooperative management of public space, between governments (central and local) who are owners of the main project and the beneficiaries in the project area.

To specifically explain the distinctive aspect of this Land Improvement Act system, the Act provides a mechanism that initially verifies the accumulated level of social capital, i.e. a social platform consisting of mutual trust, norms and networks, as a necessary condition in maintaining collaborative actions such as the sound implementation of participatory irrigation management, in order to facilitate the achievement of land improvement policy objectives, which includes among others the improvement of agricultural productivity in harmony with the environment and sustainable development of rural areas. Moreover, this is a project implementation procedure based on the Land Improvement Act, in which substantive enactments were publicized as an institutionalized system where the requirements are clearly set out by the Japanese government prior to the approval of each land improvement project, ensuring the consistency of the system, without any exception, in implementing government-support projects continuously and throughout the country.

As described above, although land improvement projects are one of the major public works projects in Japan, the Land Improvement Act has always made it clear, since its promulgation in 1949, that the obligatory participation and involvement of the non-government sector in projects are institutionalized, thus ensuring that potential government failure caused by the government's absolute control is diminished, while establishing a system whereby policy objectives are achieved more effectively and efficiently and the promotion of democratic values and public interests is maximized. Land improvement projects have already been implemented for more than half a century since just after the Second World War, and they have attained many notable achievements. It is correct to say that when comparing these with other general public works projects, which are led by the public sector in a monopolistic fashion, the irrigation projects under the Land Improvement Act have two superior and significant effects by verifying at a local level that the accumulated level of social capital exceeds the required criteria prior to project implementation and by proceeding with a project in conjunction with the building of the beneficiary farmers' governance.

Firstly, the irrigation projects can realize more effective achievement of policies of this government-support project in each target area, thus ensuring an increase in the cost-efficiency of the national budget that is spent on such projects. For example, as water users who benefit from a project must bear a part of the project cost, government engineering officials have direct accountability to the beneficiaries to fully inform them of the function and design data of facilities provided in their area by the project, as well as how the budget is spent on the project. This means that a moderate tension exists between project beneficiaries and authorities. Public works projects generally create tension between the government and parliament or tax payers but land improvement projects add more direct, tense relationships with project beneficiaries from a different perspective. Moreover, with regard to the purchase of a land lot on a site designated for the project, the land owner is often a project beneficiary, or someone who is close to the beneficiary. This facilitates smooth cooperation and enables the saving of transaction costs on negotiations and site acquisition.

Secondly, land improvement projects contribute greatly, beyond each target area, to national land conservation and social stability nationwide by facilitating the sustainable accumulation of social capital, at least up to the minimum level required by the Land Improvement Law. During the period of rapid economic growth in the 1960s and 1970s, urban-rural income disparity widened and the rural workforce, especially the young generation, continued to pour into the cities. Under these circumstances the effect of maintaining land and water resources conservation and social stability in rural regions by the local communities, accompanied by the forming of governance between them and the public sector, was significant. Furthermore, during an economic slump, it is possible for many laborers in cities, who periodically return to their rural hometowns, to feel reassured by their local background. Those effects were becoming more significant because land improvement projects were implemented as fundamental public works throughout the country - from north to south, from suburbs to mountainous areas and in every rural village.

As explained above, social capital, which is accumulated simultaneously with the implementation of public works projects, has the potential to generate substantial public benefits, depending on how projects are implemented. Therefore, it can be concluded that there is a certain significance and necessity in the government's support in facilitating the formation and accumulation of social capital through public policies as a key source of public goods for sustainable rural development.

7. CONCLUSIONS

Social capital has been the unseen force underlying the successful management of paddy rice agriculture in Monsoon Asia during many thousands of years. The norms and traditions that have evolved during this time, and as the result of facing many hardships ranging from floods to droughts, offer an invaluable storehouse of management resources that still has relevance today. This paper has shown how social capital allows farmers to cooperate during periods of drought in a way that not only solves the immediate crisis of efficient water distribution, but which also strengthens the social fabric in the process, in preparation for facing the next crisis when it occurs.

The dynamic of self-generating social capital can also be applied to the challenges of governing large-scale, highly technical irrigation systems. The experience of participatory irrigation management (PIM) points to the potential for addressing irrigation development as an integrated challenge where the infrastructure improvements (new dams, canals, automated gates, etc.) are not viewed as management solutions in themselves, but as the physical dimension of an integrated socio-technical development. The process of how the infrastructure improvements are introduced determines how successful the long-term governance will be. When physical improvements are introduced with social capital in mind, the end result is a better functioning technical system embedded in a strong management system that continuously strengthens the stock of social capital on which the management system is based. Investing in social capital can yield valuable returns.

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