Policies and Strategies on Irrigation Charging Systems for Rice Paddies in Japan and the Asian Monsoon Region

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1. Preface

Most of the world's irrigated agriculture is concentrated in Asia, particularly in the Asia monsoon region. Therefore any discussion of the world's water problems cannot afford to overlook that part of the globe.

But international debate on the issue has failed to take into consideration the status and characteristics of irrigation in this humid region, in part because monsoon Asia itself has neglected to disseminate its own point of view. Instead discussion tends to get carried away with promoting simplistic market models of the economics of water resources, which are formulated based on the experiences of arid and semi-arid climates.

In the Asia monsoon region, as it receives ample precipitation during rainy season, rain-fed and irrigated paddy rice farming has been developed for centuries and the most part of water use is dominated by paddy field irrigation, which requires considerable amounts of water per unit yield of rice. The international debate sometimes critically concludes paddy field irrigation as terrible wasteful forms of water use and takes it granted that the save water through pricing or other means is absolutely important.

However, the inhabitants of the Asian monsoon region do not generally think of paddy field irrigation as a waste of water but as economically and socially useful, sustainable and efficient systems. They also attach its greater importance to the multi-functional roles, which arise from the considerable amounts of water used to irrigate paddy fields.

With these deficiencies in mind, this paper examines the issue of water pricing which defines water as an economic asset and involves assigning it a price such that it can be freely bought and sold between a possessor (dealer) and users. We will review the course of debate to date and summarize what points should be taken into consideration when applying the idea of water pricing to the regions with wetter climates. It will also offer specific proposals on an excellent alternative better adapted to the peculiarities of the wet climate in terms of economic efficiency, equitability, and sustainability. In addition, it will identify and examine several points relating to water pricing that have not been adequately discussed.

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2. Characteristics of Paddy Rice Farming and Water Management in the Asian Monsoon Region

(1) Immersion Cultivation under the Ample Water Conditions

The Asian monsoon region embraces the Indian Ocean to the south, the expansive region of Tibet, the Himalayan mountain mass and continental China to the north, and the Pacific Ocean to the east. Most of it consists of high-precipitation warm regions that have annual rainfall in excess of about 1,500 mm, influenced by low pressure and monsoons accompanied by westerly winds. Moreover, the amount of rainfall in this region concentrates in the rainy season due to typical monsoon climates. It exceeds 125 mm per month and may come up to 500 mm per month in the rainy season which lasts for several months even in major cities in this region. In contrast, no major cities in a Western country have monthly rainfall of more than 125 mm throughout the year (Fig. 1, Fig. 2).

![Fig. 1. The rainy and dry season and annual precipitation in Cities in the Asian monsoon region and western countries](image)

![Fig. 2. Monthly precipitation in cities in the Asian monsoon region and western countries](image)

The Asian monsoon region is characterized by large seasonal and short-term fluctuations in the supply of water resources, as is evident in the distinct dry and rainy seasons. Such a great amount of rainfall during rainy season and inundated plants can normally result in oxygen starved soils and waterlogged roots. However, 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. Paddy rice allows cultivation known as "immersion cultivation", whereby the entire field is continuously covered with water. This method represents a fundamental difference from
water management of dry field soil, as a standing pool of water is created by leveling out a field and building levees around it, and formulates several advantages described below.

(2) Wide-ranging Substitutability between Water and Labor

When we turn the viewpoint to the water balance in a field level, the great part of agricultural water taken from a river for rice paddy irrigation is not consumed, i.e. evapo-transpired. Figure 3 illustrates the water balance in typically irrigated rice paddies in Japan. This model shows that paddy fields can receive 900mm of direct precipitation and paddy rice requires 600mm of water consumption as evapo-transpiration during four months of cropping season. However, farmers need more amount of water to be taken into paddy fields in order to maintain a standing pool of water because the field soil allows water permeation. Moreover, water management in advanced paddy farming practice such as puddling of paddy fields and draining excess water after that, intermittent irrigation, and deeply flooded water management against cold-weather damage requires more water use by irrigation. Finally the model illustrates that farmers introduce 1800mm of irrigation water to the paddy fields.

Sometimes paddy field irrigation is critically concluded as terrible wasteful forms of water use and takes it granted that the save water through pricing or other means is absolutely necessary.

However, inundated paddy rice cultivation has many advantageous effects in reducing usage of land, labor and other resources by substituting ample and relatively low-cost water resources (Table 1). 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

![Fig. 3. Water balance in paddy (Japan)](image-url)

Source: Maruyama, T. & R. Nakamura et al.
using cheaper and ample water resources in the Asian monsoon region.

<table>
<thead>
<tr>
<th>Items of advantages</th>
<th>Explanation on advantages of paddy rice agriculture with ample water use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing management in distributing water (off-farm)</td>
<td>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.</td>
</tr>
<tr>
<td>Reducing management in distributing water (on-farm)</td>
<td>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.</td>
</tr>
<tr>
<td>Reducing weed control</td>
<td>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.</td>
</tr>
<tr>
<td>Preventing soil erosion</td>
<td>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.</td>
</tr>
<tr>
<td>Reducing fertilization</td>
<td>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.</td>
</tr>
<tr>
<td>Reducing plowing</td>
<td>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.</td>
</tr>
<tr>
<td>Preventing a fall in yield by repeated cropping</td>
<td>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.</td>
</tr>
</tbody>
</table>

In contrast to this, irrigation systems for upland crops (e.g., wheat), provide just enough water to supplement the moisture in the soil because of relatively high cost of water resources; 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 (Fig.4).
(3) Providing Ecosystem Services through the Water Cycle Systems in a Basin

The water taken from a river and not consumed in paddy fields contributes to enhancing ecosystem services in two ways: a) Water in the total paddy irrigation and drainage system serves as a network of wetlands and water ways, and creates another excellent secondary natural environment outside the river with an enriched flora and fauna, b) Water drained from paddies and returning to the river reinforces the ecosystems inside the downstream rivers and marshes.

Most of the water introduced in excess of the moisture to be consumed by crops is returned to groundwater and the downstream river via percolation and surface outflow to drainage channels leading to the river. The proportion of water consumed for evapo-transpiration differs from region to region, but in the example of Japan, it is said to be 25–50% of the water introduced into paddy fields and the rest of it, 50%–75% of the water, returns again to the water cycle system in a river basin. In this manner, by repeating the cycle within a river basin, of initially extracting water from rivers, temporarily inundating paddy fields via water supply channels, then slowly accumulating groundwater or returning the water to rivers and reusing it downstream, water resources can be retained on land for as long as possible and used efficiently. This use and reuse of water is important in areas with many rivers with short courses and fast currents because of steep topography, where water resources might otherwise be immediately released into the sea without realizing their full potential value.

This system makes paddy fields stretching along a river serve as a retardant reservoir that once receives outflow from the mountainous hinterlands and irrigated water drawn from the river and that gradually supplies the water to groundwater aquifer and the downstream river. Figure 5 shows a schematic drawing and Figure 6 shows a diagram explaining the contribution system of rice paddy irrigation to ecosystem services.

Fig.5. The role of paddy fields as a reservoir promoting a sound water cycle in a basin scale
This system is widely observed in humid regions such as the Asian monsoon region. **Figure 7** shows a diagram explaining the typical arguments advocating a competitive relation between agricultural water use and ecosystems where water is constantly scarce. It contrasts the contribution system in humid regions with the competitive nature of water use in arid and semi-arid regions.

Paddy field irrigation in the Asian monsoon region improves the utilization efficiency of water resources throughout the river basin, and contributes greatly to the formation of healthy water cycles in river basins. In many instances, paddy field irrigation using this ample water also has the "knock-on effects" of recharging groundwater, mitigating floods, providing a domestic water supply and water for fish farming, shipping and other industries, passing on traditional culture, protecting biodiversity, forming aquatic landscapes, and other socio-economic effects and environmental services, in addition to its benefits for agriculture. The functions that give rise to these benefits are generally known as the "multi-functional roles of irrigation". With paddy field irrigation in the Asian monsoon region, these various socio-economic and environmental benefits are considerably large.
(4) Frequent Outbreaks of Abnormally Dry Spells

The existence of ample water enables water to be sent from higher-elevation fields to lower-elevation fields by introducing water into upstream paddy fields, cutting a part of the levees surrounding paddy plots, and letting the excess flow to downstream paddy fields. With this system, called "plot-to-plot irrigation", the fields themselves serve as irrigation canals. It does not matter if tens or 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 management of water as well as investment in facilities to be reduced. Therefore, this is widely developed, naturally in rain-fed paddy areas, and around the tips of traditional irrigation networks and also even in the periphery of modern irrigation systems in developing countries.

However, even in the Asian monsoon region, water is not always ample even in the rainy season, and unforeseen abnormal water shortages occasionally happen. In general such an abnormal condition lasts for a couple of weeks to months. At such times, just as in arid and semi-arid regions, the absolute volume of moisture needed for the growth of crops tends to be in short supply. Furthermore, "plot-to-plot irrigation" tends to allows upstream farmers to have a strong priority in taking water during the period of water shortage. Most of the downstream farmers with lower priority are reconciled to taking the drainage water released from upstream paddy plots.

During abnormally dry spells, all water users want additional supplies of water. The scarcity (i.e. value or shadow price) of water will temporarily soar in response to the tightness of demand and supply of water, and will go back to normal level in a couple of weeks to months. To cope with this situation, farmers can temporarily reduce amount of use of costly water by substituting relatively low-cost extra labor for water management. In this case, the most important point is harmonized and collective labor investment among farmers in a cooperative way because selfish actions may lead infestation of free riders and unfairness in resources allocation.

Therefore, good governance and equitable distribution of water through a Participatory Irrigation Management (PIM) is considerably important during abnormally dry spells. 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.

3. Principles in Allocating Water Rights to Users of Paddy Field Irrigation in Japan

The River Act in Japan provides that a minimum river flow to keep the healthy river performance should be regulated when a water right is authorized to water users. Water users should release the amount of water designated as a minimum river flow to
the downstream river whenever they take water from the river. The minimum river flow comprises flow for maintaining an appropriate downstream river flow performing for fishery, bio-diversity and navigation as well as flow for permitted water rights of the downstream water users. **Figure 8** illustrates a system of conditionality for obtaining a water right. When a river authority entitles a water right to a water user for extracting water from a river, the authority strictly limits the amount of water which can be drawn from the river with calculation of subtracting the minimum river flow from the 355th largest river flow of 365 daily flows in the drought year that statistically appears once per decade. In consequence, almost 100% of the length of rivers in Japan has respectively been defined, under the River Act, an amount of minimum river flow for maintaining an appropriate downstream river flow function for ecosystems including bio-diversity (**Table 2**).

![Fig8. Conditionality for allocating a water right in rivers in Japan](image)

**Table 2.** Lines, length and authority of rivers controlled by the River Act in Japan

<table>
<thead>
<tr>
<th>Class</th>
<th>Lines</th>
<th>Authority</th>
<th>Length</th>
<th>ratio</th>
<th>Minimum flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1 River</td>
<td>13,979</td>
<td>National Government</td>
<td>10,553km</td>
<td>7%</td>
<td>Regulated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local Governments</td>
<td>77,008km</td>
<td>54%</td>
<td>Regulated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>87,560km</td>
<td>61%</td>
<td></td>
</tr>
<tr>
<td>Class 2 River</td>
<td>7,071</td>
<td>Local Governments</td>
<td>35,934km</td>
<td>25%</td>
<td>Regulated</td>
</tr>
<tr>
<td>Quasi-class River</td>
<td>14,113</td>
<td>Municipalities</td>
<td>20,032km</td>
<td>14%</td>
<td>Regulated</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>143,528km</strong></td>
<td></td>
<td><strong>100%</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: River authority in Japan (2002)

When farmers as users of paddy field irrigation make application to a river
authority for allocating a water right, they need to calculate the amount of water for paddy field irrigation based on the formulation set in the official standard for planning. One of major characteristics of paddy field irrigation in the Asian monsoon region is reuse of irrigation water among paddy fields from upstream to downstream. This fact must be properly considered when we form a plan for an irrigation project. For example, the amount of water for paddy field irrigation in Japan is calculated according to elements shown in the following diagram (Fig.9.).

**Fig.9. Structure for calculating the amount of water for paddy field irrigation in Japan**

![Diagram](source)


4. **Concepts of Water Pricing Respectively Adaptive to Arid and Humid Regions**

   (1) **Classified Water Pricing Methods Adaptive to OECD Countries**

   The normal concept of water pricing treats water primarily as an economic asset, in other words, as simply 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, sustainable fashion by charging users a sensible price for the water they use. The OECD, which is engaged in research on the subject, classifies the water pricing mechanisms currently in place in member states into the eight types listed in Table 3.

   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 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. The OECD's classification fails to take into account this
situation that is so characteristic of monsoon regions with their heavy rainfall.

Table 3. Water pricing methods classified among member countries of OECD

<table>
<thead>
<tr>
<th>Water pricing method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Pricing method by land area</td>
<td>Fee structure based on irrigated area. There are also cases in which fees are segmented by the crops that are irrigated, irrigation method or season.</td>
</tr>
<tr>
<td>(2) Metered pricing method</td>
<td>A method in which usage volume or time is calculated and fees are charged accordingly</td>
</tr>
<tr>
<td>(3) Dual pricing method</td>
<td>Pricing method in which usage fees are charged by annual fixed facilities expenses and unit water usage</td>
</tr>
<tr>
<td>(4) Pricing method by use</td>
<td>A different pricing method is applied for different uses. This is also known as block rate pricing.</td>
</tr>
<tr>
<td>(5) Improvement charged pricing method</td>
<td>Pricing method of fees levied against agricultural land based on the increase in land value due to the supply of irrigation water</td>
</tr>
<tr>
<td>(6) Incentive metered pricing method</td>
<td>Pricing method in which extra fees are charged for exceeding a given volume of water and incentives are provided for conserving a given volume</td>
</tr>
<tr>
<td>(7) Passive water intake method</td>
<td>Pricing method in which pricing is proposed that permits a balance in overall water supply and demand in an irrigation district and farming families use the water freely according to their needs. Averaged pricing per unit is charged for the total water usage rights per family and, if water is conserved, rebates are paid.</td>
</tr>
<tr>
<td>(8) Water market pricing method</td>
<td>Pricing method in which pricing is set by voluntary payments for marginal water volume units of farming families.</td>
</tr>
</tbody>
</table>


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 are said to correspond to what in the OECD's classification 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 not as a
form of water pricing as defined by the OECD but rather as something quite different, an "area charge" accompanied by the respective combination of rights and obligations for normal periods and abnormally dry spells.

**(2) 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 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 scarce 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, 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.

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, the Land Improvement Districts of Japan, the Muang-fai of Thailand, the Kanna that form part of Sri Lanka’s Cascade Systems, and the Subak of the island of Bali in Indonesia.

5. Irrigation Charging Systems in Japan and the Asian Monsoon Region

(1) Area Charge Systems

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. This method of charging for water use is different from the concept of water pricing under discussion at the OECD. 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 4. Basis for charging regular levies in Land Improvement Districts in Japan

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

(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.

As already noted, in humid climates, because the shadow price of water is in normal times extremely low, water is used in large quantities but recycled over and over, being channeled into upstream paddies first and then gradually trickling down to those further downstream. That saves manpower for operation and reduces capital spent to irrigation facilities. It makes more economic sense to cut spending on labor and facilities than to save water when it is much cheaper. Condemning this practice as a waste of water misses the point. But an abnormally dry spell can in an instant send the shadow price of water soaring, in which case all concerned pool their labor (share manpower costs) and rigorously save water under mutual supervision. If water were priced volumetrically such that you could use as much as you wanted, there would be less incentive to save during abnormally dry spells unless the unit price were set extremely high.

Thus in these humid regions a virtually homogeneous agriculture tends to be practiced, and even under normal conditions water use is carefully managed in a collective fashion, enabling farmers to respond flexibly as a group during abnormally dry spells and other emergencies. In the case of paddy irrigation in humid climates, area charges thus constitute a rational method of charging for water use. During abnormal water shortages they allow for a more realistic response than does volumetric pricing, since they entail arrangements on distribution of water and provision of labor during such shortages. And in normal times they alleviate the transaction costs such as efforts of collecting fees.

On the other hand, volumetric pricing is generally held to provide incentives to save water. But it is not well suited to times when the shadow price of water skyrockets. Moreover, volumetric pricing inevitably entails the cost of metering water, and it has been pointed out that, especially, when large numbers of small-scale users are involved, those costs can easily balloon. Below we examine special cases where volumetric pricing has actually been implemented in the Asian monsoon region.

(2) Volumetric Pricing in Groundwater Irrigation Areas

Groundwater irrigation involves pumping water from subterranean aquifers up to the surface to irrigate farmlands. It is well suited to volumetric pricing since the volume of water pumped is simple to meter and the costs of fuels or electricity providing to pump is proportional to the volume of pumped water. Groundwater can be regarded as private water source under the individually owned ground which it is less susceptible to fluctuation in supply than surface water and is easily monitored. It can also be sold or
leased at the will of the landowner. As a resource, therefore, it is conducive to
distribution in accordance with market mechanisms for adjusting supply and demand.
Even in Asia there are countries, such as Bangladesh, where groundwater is broadly and
freely traded and leased and supplying irrigation water is a business in its own right.

(3) **Volumetric Pricing in Surface Water Irrigation Areas**

Volumetric pricing is also found in upland field irrigation areas. For example,
there are cases in China and India as well as Japan of upland field irrigation areas where
charges are levied volumetrically by irrigation block (Fujimoto, 2001-1). Ideally
speaking, upland field irrigation is intended to supply crops with the amount of water
they need (i.e., the amount lost to evapo-transpiration.) and no more. It is in essence a
form of irrigation that makes limited use of water, since over-watering can lead to
deterioration in crop quality.

In countries like Australia where each paddy field covers a large area with only a
few intake points for irrigation water, fees are levied volumetrically using flow meters
like the Dethridge meter wheel (Fujimoto et al., 2002). There are similar but minor
cases in Japan of volumetric pricing being applied in areas where spring water is
pumped into the fields (Fujimoto, 2001-1).

6. **Institutions and distinctive features of the irrigation project in Japan**

(1) **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. 10)

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.

Fig.10.Facilities constructed by each project management body under the Land Improvement Law of Japan

※( )=management body
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.

The outline of operation and maintenance systems for irrigation and drainage projects by the distinguished project management bodies is as follows (Fig. 11);

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.

(2) 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 publicised as an institutionalised 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 institutionalised, 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 maximised. 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 realise 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 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 by facilitating the sustainable accumulation of social capital, at least up to the minimum level nationwide. Most especially, 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 labourers 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

Water pricing is an important concept in reassessing the value of water, one of our most precious resources. But there is no guarantee that simply bringing in water pricing will all on its own result in fair and efficient distribution of water resources. Just because this approach has worked with irrigation systems in arid and semiarid climates, which does not mean it can be applied equally well to paddy irrigation in the Asian monsoon region. Not only will it be difficult to implement, but also rather will it obstruct the development for the efficiency of water resource distribution, with no demonstrable gains in equitability and sustainability.

In arid and semiarid climates water is simply consumed by a single user, but in humid climates it is reused constantly by multiple users. Moreover, in the former the shadow price of water hardly fluctuates at all, while in the latter, it is extremely low under normal conditions but skyrockets when an unexpected dry spell hits.

It also makes perfect economic sense that the two climates should have different systems. Therefore, in bringing in any system, it is important to consider carefully the method of implementation and approach to pricing water and collecting fees best suited to each region, fully factoring in local characteristics like geographical, hydrological, and historical conditions.
The choice should not be restricted to the concept of water pricing under discussion at the OECD, which involves assigning a price tag to water so that it can be freely bought and sold. Instead we should add to the list of options under discussion the system of area charges, which entails a set of rules on water use embracing both rights on water distribution and obligations on water management procedures such as labor investment for ensuring equality among users as much as possible during abnormally dry spells. This is an excellent system better adapted to the peculiarities of the humid climate in terms of economic efficiency, equitability, and sustainability.

Moreover, a necessary prerequisite for the introduction of water pricing is the existence of clearly defined rights to water use. In countries and regions where that prerequisite is not yet fulfilled, water rights will need to be clearly defined in a manner acceptable to the parties affected, taking into consideration customary water use practices and what arrangements are most reasonable. To that end, swift action should be taken to establish the necessary legislative infrastructure.

Water pricing also assumes that there is some type of institutional or organizational framework in place to regulate use of water. But there is no guarantee that the transaction costs involved in setting up that framework, along with other long-term expenses, are going to be less than current costs, which are kept down thanks to the organization of water users into communal associations. Therefore, the first priority is to work to establish organizations capable of properly levying fees and managing the water supply (Fujimoto et al., 2001-2), in which we regard the possibility of making use of the aforementioned existing water users associations should be kept in mind.

References:
- FUJIMOTO Naoya et al.(2003): Heisei 14 nemdonougyousui Monndai Kenntoukai Siryou — Nougyousousui Kinnri niokkeru Mizu no Paraisinngu no Itiduke
- JIID(2001): ”Suido no Chi”wo Kataru.
- MASE Tooru(2001): Suiden Kangai to Hatachi Kangai niokkeru Saiirtu Haitei no Soui, JSIDRE dai


Ministry of Agriculture, Forestry and Fisheries (1998): Mizu to Daichi no Megumi wo Towa ni, Koukyoujigyoutuusinnsya Tokyo

OKAMOTO Masami (2002): Nougyousuiri to Kasennsuiri no Syomonndai(sono 5), JAGREE 64, pp.16-23

Postel S. (2000): Mizubusoku ga Sekai wo Obiyakasu, Ienohikarikyoukai, Tokyo

TABUCHI Toshiio (1999): Sekai no Suidenn - Nihonn no Suidenn, Noubunnkyou, Tokyo


Zennkokotchikairyoujigyoudanntai Renngoukai (1999): Totikairyouka Unnei Jittaityousa houkokusyo, pp.95-97