OECD WORKSHOP ON AGRICULTURE AND WATER:

SUSTAINABILITY, MARKETS AND POLICIES

14-18 November, 2005:

- **14-16 November – Adelaide Convention Centre,**

  North Terrace, Adelaide, South Australia

- **17-18 November – Barmera, South Australia**

SESSION N°2

Japanese Water Management Systems from an Economic Perspective: The Agricultural sector

Hiroaki Kobayashi

Faculty of Economics, Wako University, Japan

Information on the Workshop is accessible though the OECD Password Protected website at: http://www.oecd.org/agr/env See under "What's new" then click on *OECD Workshop on Agriculture and Water* and Login under: **water** and Password: **australia**

Japanese Water Management Systems from an Economic Perspective:
The Agricultural sector

Hiroaki KOBAYASHI
Faculty of Economics, Wako University

Abstract

Japanese water management is characterised as that of a property rights regime. Several instruments have had decisive roles in improving economic efficiencies, securing effective and equitable cost recoveries, and abating conflicts between non-agricultural sectors, under the legislative framework that prohibits explicit trading in water rights. Each LID, voluntary farmers' group is entitled with water rights and is responsible for the management of its irrigation water. More than the marginal cost recovery is secured and effective water use is expected at the same time. The area pricing commonly applied in the LID management is supported taking into considerations the technical aspects and transaction costs. The LIDs, in some cases, conserve watershed areas for the purpose of stable water flow to be extracted. Facing the occasions of serious water shortage the government provides quasi-markets in water realising intersectoral transfers between non-agricultural sectors, and among LIDs, to improve economic efficiencies. Serious water shortages take place only once every ten years on average, in limited areas and during limited periods. The community-like decision making of water allocation in the quasi-markets would help to abate the social conflicts. The permanent transfer of water rights is also managed. The Japanese systems of agricultural water management could be leading examples for developing countries under the monsoon climate, where small holdings of paddy field agriculture dominate.

Keywords: Japanese water management, paddy field irrigation, property rights regime, irrigation water pricing, voluntary farmers' association, environmental conservation, quasi-market in water

Contents

Note: The author is grateful to Dr. Yasuhiro Nakashima, Associate Professor of the University of Tokyo, Dr. Mikitaro Shobayashi, Senior Technical Director of the Department of Agriculture and Fisheries, Shiga Prefecture Government, Mr. Akihisa Nakano, Deputy Regional Planning Director, Rural Area Policy Planning Department, Rural Development Bureau, MAFF, and Dr. Hisashi Yamada, a colleague of the author and a member of the Mont Perelin Society, for useful comments and suggestions. However the author is responsible for any remaining errors or omissions.

1. Introduction

(1) Efficient water use is studied throughout the world for the purpose of expanding agricultural productivity to cope with increasing population, and for poverty alleviation. The lack of environmental concerns in groundwater use, irrigation in arid/semi-arid areas causing soil degradation such as salinity, inefficient uses of irrigation water, etc. all require effective countermeasures for sustainable development. Conservation of watershed areas and groundwater recharge enhancement are also important (Reddy, 2005). Particularly in the case of surface water use, conservation and proper management of forests are essential for stable supply and better quality of water.

(2) Not only investments in irrigation facilities and technological progress for an efficient water use, but also the conservation of watershed areas and improvement of economic efficiency are needed particularly in developing countries. Food production should catch up with the increase in domestic demand. Although the situation in most OECD countries seems to be improving, water pollution, soil salinity in agricultural areas and decreasing in groundwater levels in several countries, and other environment-related problems excluding deforestation are relatively important. Challenges to improving water-use efficiency and equitable cost recovery could be yet to be solved. Both require effective and pragmatic instruments in government policy and social infrastructure.

(3) This paper aims at evaluating agricultural water use in Japan from economic perspectives, focusing on paddy field irrigation that demands vast amounts of water and requires collective management and allocation among a number of farmers with small holdings. Infrastructure development in the post-war period has attained stable water supply for rice production, at the same time avoiding serious stress on the environment and conflicts between non-agricultural sectors. Japan's experience could be a good example for many developing countries depending heavily on paddy production under a monsoon climate to establish management systems for sustainable, efficient and socially acceptable water uses.

(4) In the following section, we show the history and overall situation of agricultural water use in Japan. Section 3 summarises an economic theory and recommended policy measures for effective use of irrigation water. The Japanese case of agricultural water use is discussed from the standpoint of economic efficiency in Section 4, and finally we conclude the paper and give some recommendations to developing countries for economically, environmentally, socially and politically sustainable, sound managements of irrigation water uses.

2. Agricultural Water Use in Japan: Situation and Historical Background

2.1 History of agricultural water use

(5) Paddy field agriculture and rice production have had, for more than a millennium, an essential role in the Japanese society. That is the case in many other Asian countries under the conditions of warmer climate and higher precipitation. Paddy field agriculture is resistant to continuous planting of rice in the same ground, and has higher carrying capacity of population. In some cases, the facts reflect a clear contrast among populations in Asian countries and some European countries based on grassland farming or extensive use of upland. For example, the population density in Viet Nam and the Philippines was about 1 person per hectare (ha) of total

land area while that in Ireland and France was 0.4 and 0.8 persons, respectively, in the early 1960s, despite the fact that the former countries were still covered with forests by 44% and 58%, respectively, in that period. Ireland and France had considerable forest loss by hundreds years ago (*FAOSTAT*, FAO, http://www.fao.org & Westoby, 1989).

(6) In most parts of Japan, rice production is restricted by geological and climatic conditions. Cultivation should be completed during the period from April to October due to low temperatures in the other months. The land is mountainous and seasonal rainfalls run very fast along with short rivers into the seas. These features make it easy for floods and droughts to take place. Controlling water supply and irrigation management have been necessary for Japanese rice production, because depending solely on rainfall or natural river streams causes serious uncertainties compared with tropical/semi-tropical countries. Irrigation systems both in terms of physical and social infrastructures have been continuously developed for hundreds of years.

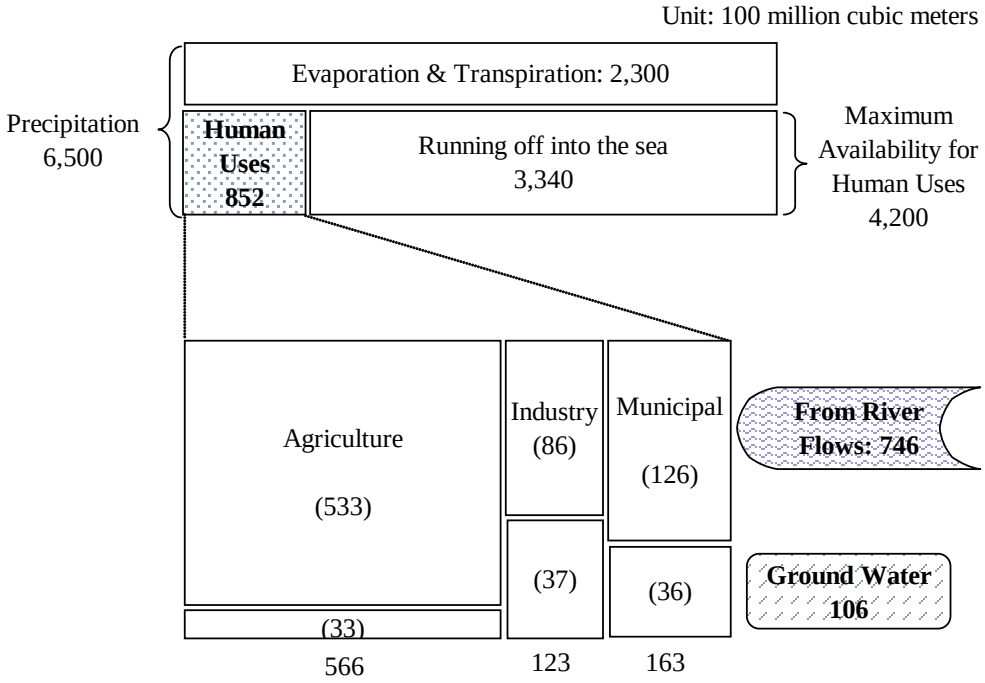
(7) The irrigation systems comprised mainly of canals to deliver water from rivers to the rice production site and to allocate the water inside. From 50 to 500 farmers at the most belong to each production site and make up a community or village. Though water allocation in the community had been managed based on the principle of equal usage among farmers, water battles frequently took place among villages in years of low precipitation. Many efforts were made for efficient use of irrigation water in each community and among villages. Areas that have relatively low precipitation or extremely short rivers often constructed irrigation ponds for supplementary uses. Groundwater use has been very limited in agricultural production in Japan.

(8) The roles of forests both in villages and upstream areas should not be neglected in agricultural production. Forests, well managed ones in particular, have a high potential to buffer rainfalls, stabilise river flows and prevent or mitigate disasters caused by floods, landslides and drought, as well as provide forestry products such as timbers and fertiliser. Japanese society has placed more importance on the roles of forests. The principle of 'replant when cutting' has been widely accepted and the forest cover in 2000 was maintained at 64% of the total land area, while many of the village forests have been converted into golf courses and other non-agricultural uses in recent years.

2.2 States of water use and water rights

(9) Around 420 billion cubic meters (m^3) of water a year is available for human activities in Japan, of which 85.2 billion m^3, or 20% is actually utilised. The annual average precipitation is 1,718 millimeters (mm). Depending heavily on annual rainfall, Japan often faces problems of shortage due to annual and seasonal fluctuations, as well as frequent occurrences of disastrous floods. Agriculture is the primary user of water (Figure 1).

Figure 1. Water Resources and Utilisation in Japan



Source: *Water Resources in Japan* , Ministry of Land, Construction and Transportation, 2004.
Note (1) Precipitation; an average of 1971-2000.
(2) Agricultural uses in 2000 (from river flows) and 1996-98 (groundwater), and industrial and municipal uses in 2002.

(10) Property rights of using water, i.e., water rights, were traditionally established *by community* according to the customs based on preoccupation. Although rainfall and natural water flows from rivers fulfill most of the basic demand for agricultural production in years of normal precipitation, water rights become meaningful mainly when the precipitation is lower than average.

(11) Competition with non-agricultural sectors has taken place since the Meiji Era (since 1868). Industrialisation and the population increase in urban districts expanded the demand for water. Legislation on water rights has been gradually drafted along with capital investment in water resources development to meet increasing demand from hydropower generation, and industrial, municipal and agricultural sectors. Water rights to be newly issued should be connected to the construction of facilities so as to protect historically entitled rights. Water rights have not been free in this sense. They are not considered to be normal private properties from a legal perspective although they may seem to be private properties that are excludable in consumption from an economic point of view. Economies of scale in water management have enhanced multi-sectoral investments. Water rights are to be revised by the water authority every ten years, and commercial trading has been legally banned because of the public nature of water.

(12) In the agricultural sector, community-based water rights are usually issued. The Land Improvement Districts (LIDs), many of which have a historical background as voluntary farmers' associations, are in most cases

required by legislation to be established, endowed with water rights, and responsible for the management of its water use. Each water right, which is a useful tool for protecting the right to use water mainly during years of lower precipitation as stated before, is issued to an LID operating and maintaining a single irrigation scheme comprising dams, head gates, pumping systems, canals and other facilities. The volume of water available for agriculture is set out, assuming the year of serious shortage with a probability of occurrence of once every ten years, with careful consideration to minimize impacts on the environment, to protect the rights of other users as well as local traditions and customs related to the use of water. Water rights are also assigned in detail for each half month and the minimum river flow should always (defined under legislation as at least 355 days a year) be maintained from the perspective of environmental concerns.

(13) For the purpose of utilising possible economies of scale, the area that each LID covers usually includes several, or in some cases hundreds, of community-based irrigation systems. Since many LIDs have merged, their number has decreased from 13,163 in 1961 to 7,004 in 2000, and the average area under management has increased from 245 hectares (ha) to 507 ha in the same period. Roughly speaking, each LID manages one or two head gates, and the dam is shared by several LIDs and sometimes used for other non-agricultural purposes. A farmer should be a member of an LID if he/she would like to have water delivered through the facilities of the LID. The principle of the present regime was established under the River Law promulgated in 1896 followed by the Land Improvement Law enacted in 1949 and other related legislation. Some statistical figures are listed below.

Table 1. States of Land Improvement District (LID)

No. of respondents	Area under Management ('000 ha)				Number of Membership
	Paddy field	Upland	Orchard	Total	
5,431	2,221	425	109	2,755	3.9 million
Average	409 ha	78 ha	20 ha	507 ha	726

Source: A survey by the MAFF in 1998.

3. Economic Theory of Water Management: A Brief Overview

3.1 Efficient and sustainable use of natural resources

(14) Water management has both positive and negative impacts on the environment (OECD, 2001). In general, possible impacts deteriorating the environment and natural resources would be (i) overexploitation of groundwater, (ii) salinity and other soil degradation (not reported in Japan), (iii) capital investments harmful to the natural habitat, (iv) water pollution, and so forth. Paddy field cultivation combined with its water managements is considered to be environmentally friendly and to have some positive impacts on the environment. Paddy field agriculture, which dominates in Japan, is known not to emit nitrous oxides into river flows and aquifers due to the technical reasons. Biodiversity is larger in the areas of paddy fields/forests combinations than in the areas of only forests. Other facts of such positive aspects will be shown in another report in this workshop.

(15) Ground water: In Japan land subsidence has taken places in several areas due to groundwater extraction. The major cause has been industrial use. The agricultural sector has mainly extracted shallower aquifers that are recharged quickly with annual precipitation. For industrial and municipal use, extraction of groundwater

from deeper aquifers is regulated so as not to decrease the water level. The land subsidence was considerably improved in most areas by the 1980s (*States of the Environment 2004*, Ministry of the Environment).

(16) Economic theory clearly distinguishes between water resources that cannot be easily recharged (e.g., groundwater with a smaller rate of recharge) and those that can be recharged such as surface water from annual precipitation. The latter is classified as a *replenishable or renewable resource*, and the former as a *depletable resource* (Tietenberg, 2000). Pollution could also be conceptualised in the same way. We define the cleanness or safety of water as a kind of resource and polluting activities could be redefined as exploitation of that resource. When the pollution is purified relatively fast through the natural assimilation process, temporary pollution can be analogised with exploitation of a renewable resource, and persistent pollution with that of the depletable resource. If the exploitable resource is abundant, we can take as much as we like and no economic challenges would be raised. That is not true for water in most cases, because the final consumption requires many activities that employ other resources not abundant.

(17) Overexploitation and degradation of natural resources such as forests and water usually happens under the so-called *open access* situation, in which excludability in consumption is not established and congestion occurs, leading to deterioration of economic efficiency and sustainability. The failure of users to incorporate into their decision making the impacts of their uses on the resource in question is the source of this "market failure" (or tragedy of commons). How we could convert open access resources into common property resources, in which formal or informal rules among users are established so as to achieve sustainable use of resources, is a major challenge for policy makers.

(18) Proposed remedies from economists' views are those based on market orientation such as internalisation of environmental costs and benefits into decision making and employing market mechanisms to make economic water cost explicit to all stakeholders. Market-based instruments require: first well-defined property rights, second, appropriate pricing that reflects social costs including scarcity rents and environmental burden, and third, establishment of effective markets and institutions. Policy measures to internalise environmental costs, i.e., externalities, involve application of the Polluters Pay Principle for environmental damage and levies on the extraction of groundwater that is in some cases classified as a depletable natural resource like petroleum.

(19) Another source of market failure in the case of irrigation water use is the economies of scale in capital investments. Particularly in the developing countries where paddy field agriculture is dominated by a large number of small holdings, the governments may have to play a significant role in enhancing agricultural productivity by means of infrastructure development, even if that requires a significant amount of financial assistance.

(20) Other problems caused by economies of scale, the analysis of which is a major purpose of this paper, are also discussed in the following sections.

3.2 Criteria in the evaluation of agricultural water management

(21) The Japanese systems of water management stand on intrinsic common property systems with the support of the government as a kind of property rights regime. In the next section, we will evaluate the systems

according to the following interrelated questions: first, whether or not the allocation of water is economically efficient, and second, whether or not the governance is appropriate for securing institutional sustainability. Focus is placed on agricultural sector, paddy field agriculture in particular. Other than the conventional costs of managing the water supply, economic efficiencies should take into account opportunity costs reflecting the scarcity of resource endowments and social costs associated with the burden on the environment, and the costs related to institutional management. Because groundwater use in the Japanese agricultural sector is very limited as explained above in Section 2, we do not have to consider the intergenerational allocation of this depletable resource.

(22) The following criteria are the factors that policy makers would have to consider when they establish strategies for sustainable and economically efficient use of water resources:

(i) **Marginal cost bearing**: If the farmer faces a water price (i.e., the actual payment in any form) that is lower than the unit marginal cost, he/she will waste water, because the marginal benefit of water will be lower than the social cost, and an economic efficiency will deteriorate.

(ii) **Average cost bearing**: Due to the economies of scale associated with the capital investments required for developing water resources, the average cost, which stands for financial cost, is usually greater than the marginal cost. If priority were given to satisfying the first criterion, a financial deficit would therefore be inevitable. On the other hand, when financial stability or income distribution is given a higher priority and users bear the financial costs, it would be likely to violate the first criterion. In other words, there would be a tradeoff between efficient pricing and financial pricing. Economic theory could not provide clear-cut solutions to this problem and who should bear the deficit and to what extent, and how the budgetary allocations should be made are the questions that policy makers would have to face (Lipsey & Lancaster, 1956, Baumol & Bradford, 1970).

(iii) **Marginal benefit equalisation**: If the marginal benefit of one user exceeds that of another user, a transfer of a part of consumption from the latter to the former will improve the economic efficiency in the society. This point is essential for considering the allocation of water between agricultural and non-agricultural sectors in Japanese water management.

(iv) **Transaction costs of the management**: It takes costs to manage the systems themselves, to collect technical, social and economic information necessary for efficient water use, and to change the present institutions.

(v) **Equity and other social justice**: This criterion also relates to the public nature of water and the historical background.

4. Water Management in the Japanese Agriculture: An Evaluation

4.1 The property rights regime

(23) First of all, we evaluate the most fundamental framework of the property rights regime in Japanese water management, compared with a hypothetical arrangement in which centralised institutions, such as the government as the representative of society, manage water resources and charge appropriate prices on users (authority regime). Particularly in the case of surface water use, the latter systems in many cases are not realistic based on the fourth criterion above. Availability, on which the marginal (social) costs of diversion

are partly dependent, fluctuates according to the changes in precipitation and other natural conditions. The scarcity rent is very likely to change every time yearly and monthly, and varies by region and by site.

(24) Appropriate pricing to equilibrate the marginal cost to the marginal benefit is operationally impossible (Sampath, 1992). Another difficulty is pointed out by the World Bank (2004, p. 23): i.e., farmers do not intend to pay the price from scarcity value, namely the opportunity cost, because that is invisible and because the general understanding would be that the water is a common-pooled resource in the society. Farmers resist paying even for the sunk costs from capital investments, because that is beyond their scope as well. In the real world, the government or some other public agencies in many countries often fail to charge even marginal (O&M) costs, which are visible to farmers (Tsur et al., 2004). The last problem is that of sustainable governance of irrigation water managements.

(25) In the context of Japanese history, the centralised supply of water by the government would imply a drastic change in the institution. Confiscation of existing water rights formally issued or even those based on traditions and customs would be politically difficult and cause serious questions as to social equity. As a basic framework, the current property rights regime operated by users' associations and associated with capital investments would be the correct solution.

(26) Actually, the property rights regime, by and large, is common in many other countries. The important question is how it works in terms of the criteria listed above. The following parts are some examples of such consideration in the Japanese case.

4.2 Normal years of normal precipitations

(27) By virtue of higher precipitations and depending on the capital investment to stabilise water flows, water is rarely gets scarce in years of normal precipitation. Economic costs of water consist mainly of actual payments for service rendered, operation, repair and maintenance of facilities, and sunk costs of infrastructures. In a normal year water use in agriculture is not seriously restricted under the water rights bounds, and the allocation between non-agricultural sectors and even among neighbouring LIDs need not be taken into consideration.

(28) The LID that is entitled to the water rights is totally responsible for managing all facilities ranging from dams, head works to lateral canals. LIDs as farmers' organisations are in the best position to efficiently carry out these activities since they have the most knowledge on local and specific conditions (the fourth criterion above). On-farm watercourses are maintained by farmers or village communities

(29) All farmers eligible for obtaining irrigation water through he facilities operated by an LID should have a membership in the LID, and they should bear the related costs. According to the classification by the World Bank (2004, pp. 22-25), farmers in Japan are considered to pay all of the O&M costs because LIDs are in principle autonomous as far as O&M costs are concerned. In addition, LIDs bear most of the costs for repairing equipment as well as some portion of the investment costs (Figure 2). This implies that the farmers are sharing a substantial part of the average costs. LIDs usually collect fees from member farmers for repaying loans payments required for initial investments (Table 2). Scarcity rents, which originated mainly from the capital investments, are incorporated in the entitled water rights.

Figure 2. Average Expenditures by LID, 2000

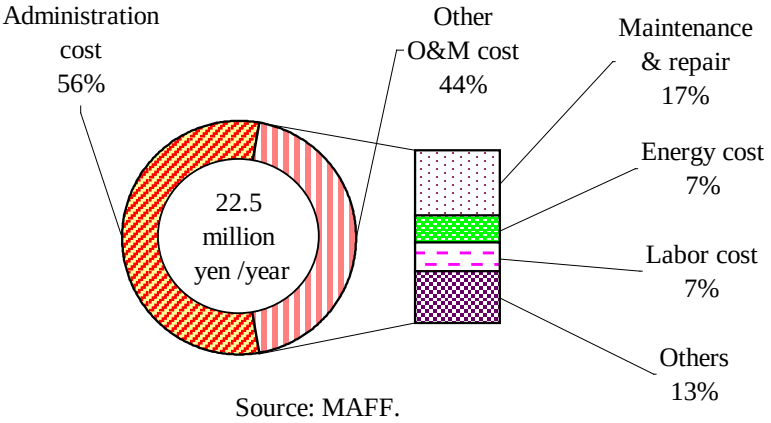


Table 2. Payments for water uses in rice production, 2003

Payment to	(yen/0.1ha)	%
LID	3,808	59.5
Subordinate body	798	12.5
Capital investment loan	2,402	37.5
Individual management	114	1.8
Others	74	1.2
Total payment	6,398	100.0
Percentage of the total production cost		4.2

Source: *Production Cost Survey on Paddy Rice* , MAFF.

(30) LIDs do not allocate water rights for each member or each field under the current legal framework of the River Law. The LID acts as an authorised supplier of water in the corresponding irrigation unit and flat rates per cultivated area are charged to member farmers to recover O&M costs and part of the investments costs (area pricing by flat rates). The basic principle of this charging system lies in preserving equity among members (Nakashima, 1998a & 1998b). How about the economic efficiencies, which mainly reflect the first, second and third criteria above, of the allocation or pricing by the LID (Tsur & Dinar, 1997, Shobayashi, 1988)? To answer this question, we have to reconsider the characteristics of cost components for supplying water and the technical conditions in the paddy field irrigation:

(31) First, the O&M costs would not necessarily be characterised as marginal costs, because most of them, once actually operated, are required regardless of the volume of the water to be delivered in the case of the gravity irrigation system, which is dominant in paddy irrigation. In the normal precipitation situation, increasing a marginal unit of water supply is nearly costless, and its marginal value of water in the agricultural production is also very small. Marginal cost pricing, therefore, implies very low levels of charges, and a large part of the O&M costs should be covered by charges not related to the volume of water.

(32) Second, strict control of water supply by individual paddy field is difficult due to the technical reasons: the paddy fields are separated into hundreds/thousands of patches by ridges, the water to be supplied to a specific

patch must use the canals running through neighbouring upper fields and the water might percolate into the neighbouring fields (or the neighbouring farmer might break a part of the dyke to extract water). Considering the nature of small holdings, it is obvious that volumetric pricing, which requires strict monitoring and metering of the actual water use, even if it is combined with some multi-tiered pricing, is not realistic (the fourth criterion above).

(33) Third, Nakashima (1998b) analyses other important factors that would help to alleviate the inefficiencies sometimes pointed out by theory, i.e., most farmers (i) are uniform in terms of crop (rice) and (small) land holding, (ii) voluntarily save water as traditional community members, and (iii) incur additional marginal costs for effective water use required under the condition of equitable water allocation by the LID.

(34) Therefore, we can conclude that the present scheme of area pricing contributes to achieving economic efficiency while the financial autonomy of LIDs is also preserved.

4.3 Capital investments and average cost bearing

(35) In years of normal precipitations, we can recognise that a kind of scarcity rent is incorporated in the entitled water rights that originated mainly from the capital investments enabling stable water supply, as pointed out above. However in the general understanding, the related costs, which should be financed over a longer term anyway, are counted in the average cost. The Japanese government has subsidised the construction of irrigation facilities, such as dams, head gates, canals, and so forth, as would be the case in most countries. The financial support to each project has been at around 60% and 50% in the case of that under the central government and the prefectural government, respectively (Nakashima 1998b).

(36) The government commitments to these capital investments are based on the following considerations (Nakashima, 1998a, 1998b):

- ☐ The basic nature of economies of scale in the investments (the second criterion above).
- ☐ Collectivity in paddy field irrigation: To exhibit the economies of scale in the investments, many projects should be relatively large and involve all the farmers in the territory. Financial support to some extent is essential to persuade passive farmers to join the project (the second and fourth criteria above).
- ☐ Food security concerns: The nation's support in raising agricultural production can be legitimated to benefit consumers especially in the early stage of economic development.
- ☐ Enhancement of externality: Water facilities and users' activities generate various environmental benefits and land conservation services.
- ☐ Stabilisation purpose: Irrigation water acts as a buffer to cope with the curious needs from the municipal sector during a period of serious droughts (see the following section).

4.4 Water shortages in the years of lower precipitations

4.4.1 Inside of the LID

(37) The equitable allocation of irrigation water to farmers in the territory of each LID and charging based on area pricing are kept unchanged. Major instruments carried out collectively and traditionally by LIDs to achieve efficient water use are: (i) *Bansui*, strict rotation of water sharing by intensive monitoring, (ii) enhancing

repeated uses, (iii) supplementary irrigation from groundwater or reservoirs, and (vi) sacrifice of fields that abandon rice cultivation (*Irrigation Water Use in Agriculture in Japan* The Japanese Institute of Irrigation and Drainage, 2004). The numbering reflects the priority of the application. The last instruments have seldom been adopted because of the difficulty in controlling water by individual patch of paddy field. The LIDs and farmers in conclusion incur extensive costs for these operations.

(38) The economic theory suggests that there might be ex ante deals to make farmers better off. However, water shortages take place in July/August after the paddy is already planted. The marginal productivity of water, or equivalently the marginal cost of missing water is very high for every farmer on such occasions (the third criterion above). In conclusion, few water exchanges occur among farmers regardless of the emphasis on equity.

4.4.2 Among LIDs

(39) Water exchange, normally without monetary payment, has traditionally been carried out among communal irrigation units. Similar customs remain informally in the present day. Programs have been provided under the transfer scheme of agricultural water, though the primary purpose is aiming at intersectoral transfers between non-agricultural sectors as explained in the next part. Transfer or exchange of agricultural water among LIDs has not been officially registered up to the present date. The reason why such transfers hardly occur may be the same as the above-mentioned accounts inside each LID.

4.5 Intersectoral transfers of water, and water rights in quasi-markets

(40) Although droughts have not taken place very often recently, water shortage should invariably be taken into consideration as the social (opportunity) cost of water. Because drought generally hit the municipal sector more seriously, transfers of water from the agricultural and industrial sectors to the municipal sector will be significantly appreciated. According to the economic theory, the perfect property rights regime could naturally lead to an efficient allocation of water through trading in a manner to equilibrate the marginal benefits of water in every place and for every stakeholder (the third criterion above). But the other measures work in reality.

(41) Explicit trading of water rights is prohibited by the River Law in Japan, but the government has established compensatory measures to realise temporary and permanent water transfers, which in conclusion help to raise economic efficiency in terms of the third criterion above, the marginal benefit equalisation. The systems could be called *quasi-markets* in water, and in water rights in cases of permanent ones, which work as the following:

(42) Facing occasional cases of serious droughts, which take place unexpectedly in some regions during the July-August normally, the Water Utilisation Adjustment Councils, under the recommendation of the government, are summoned in the concerned regions. A total of 186 Councils have been established according to the 1991 survey by the MAFF. Chaired by the river administrative agencies, negotiations are carried out among representatives of user groups, and the target of water-saving rate from the entitled water rights in each sector and some intersectoral water transfers in conclusion at the same time are to be agreed upon. Although the agencies are responsible for making the final decisions, a consensus has been achieved in

every case without any compensatory payments.

(43) Among the sectors of municipal, power generation, manufacturing industry and agriculture, the latter two, the agricultural sector in particular, have actually incurred heavier burdens of water savings in many cases, and concluding transfers to municipal sectors should have improved economic efficiencies. Table 3 shows the agreed percentages of water extraction reductions from river flows by sector in competing cases of the 2005 droughts.

Table 2. Rate in restriction of water extraction:
14 cases of drought in 2005

Name of river	Subregion	Percentage of water saving by:		
		Agriculture	Industry	Municipality
Kiso	I	40	40	20
	II	40	40	20
Miya	I	45	(d)	(a)
Yahagi	I	76	(d)	40
	II	30	30	10
	III	30	30	10
Kushida		> 40 (b)	20	5 - 20 (c)
Toyo		10	10	10
Kino		10	10	10
Yoshino	I	15.9	15.9	15.9
	II	35.0	35.0	35.0
Niyodo		20	(d)	20
Shigenobu		11	(d)	5
Yamakuni		0 - 30 (c)	67	10
Simple average		31	30	17

Note: (a) voluntary saving.
(b) counted as 40.
(c) counted as 20 and 30 in calculation of the average, considering the acceptance levels.
(d) no extraction before.
Source: MAFF, http://www.maff.go.jp.

(44) The community-like consensuses above might be based on the commonly shared considerations of priorities (larger marginal benefits) of municipal water use, and on the fact that such droughts do not take place very often. Only a few regions are damaged during limited periods and the serious droughts of 2005 were the first ones since 1994. Taking into considerations of the above conditions and the public nature of water, ad hoc negotiations like the above, compared with fully market-oriented trading, will rather help to minimise transaction costs for efficiency gains and to mitigate social contradictions (the fourth and fifth criteria above).

(45) Permanent transfers, namely the transfer of water rights, have been also carried out in a form of implicit trading under the provision of the Ministry of Agriculture since 1972. The transfer in this case is connected to capital investments to improve efficiencies of water use in a partner LID's territory. The project is managed by the Ministry, but the municipalities concerning to the water rights should pay a part of the investment costs. While demand for water in municipal use has not been increased significantly in recent years, 11 cases of such 'trading', which is equivalent to the demand of 3.3 million people, have been realised up to 2005.

4.6 Conservation of watershed areas by the LIDs

(46)Conserving watershed areas stabilises river flows and stimulates the groundwater recharge. Some of the LIDs join voluntary activities to manage the upstream watershed areas. A famous example is that by Meiji-Yosui Land Improvement District located at the basin of the Yahagi River. People in the basin have been continuously working on effective water management; a large-scale paddy field development was launched in the 14th century, it took about 300 years to complete the irrigation systems for agricultural production, industrialisation and a significant increase in population expanded water demand since the Meiji Era (1868 -), the new water management systems including multi-purposed dams were constructed in 1963, and 28 municipalities established a joint organisation to achieve stable, and safe water supply in 1971. While the Meiji-Yosui LID, the major user of water from the river flows, has joined the organisation, similar activities had already been carried out by farmers and fishermen. The LID has independently owned 520 ha of forests in the watershed area under its conserving management since the Meiji Era.

(47)Many of the LIDs seem to have some role in improving the total system of water management and conserving watershed areas covered by forests. Some typical examples are summarised in Table 3.

Table 3. Conservation of forests in watershed areas by LIDs: Examples

Name of LID	Prefecture	Collaborating organisation	Features
Nanataki	Akita	None	Facing persistent water shortages in the early 20th century, the LID owned 251 ha of upstream forests. Reforestation and managements. Conservation activities since 17th century.
Kawashima-Cho	Saitama	The forestry cooperative	An exchange program. The LID manages the marketing of forestry products and has contributed 100 kg of rice as a gift since 2002.
Meiji-Yosui	Aichi	28 Municipalities & Fishery cooperatives	Continuous activities since the Meiji Era. The LID now owns 520 ha of conservation forests. Research and publicity.
Edashita-Yosui	Aichi	Toyoda-City & the fishery cooperative	Research activities on the environment and cultures related to forest and river, and publicity of environmental conservation.
Kawanishi-	Gifu	A volunteer group	Planting broad-leaved trees and publicity.
Takahashigawa-Yosui	Okayama	Owners of forests	A profit-sharing forestry operation and conservation activities since 1960.
Konomizo	Miyazaki	The forestry cooperative	The LID has owned 125 ha of upstream forests since the Edo Era (1603-1868) and had managed until 1993, and then the management was entrusted to the forestry cooperative. A collaborative activity on education and publicity of the forestry.

Source: Prepared by Mr. Akihisa Nakano (MAFF) from various materials.
Note: Translated and summarised by the author.

5. Conclusions and Recommendations for Developing Countries

5.1 Conclusions of this paper

(48)Overall, the Japanese systems of water management can be characterised as a kind of property rights regime.

In the agricultural sector, several instruments have had decisive roles in improving economic efficiencies, securing effective and equitable cost recoveries, and abating conflicts between non-agricultural sectors, under the current legislative framework that prohibits explicit trading in water rights is prohibited:

(49) The LIDs, voluntary farmers' groups, are entitled to the water rights and responsible for the management of all irrigation water in the corresponding territory. Based on the independency of the organisation and easier access to the necessary information, the marginal (O&M) cost recovery, at the least, is assured and effective water use in terms of both technical and economic efficiencies is mostly expected at the same time.

(50) The *area pricing* commonly applied in LID management is supported compared with other systems like volumetric pricing, taking into considerations the technical aspects and transaction costs under the conditions of uniform, collective and small-scaled paddy farming in Japanese agriculture.

(51) The LIDs, in some cases, have conserved watershed areas for the primary purpose of stable water flow to be extracted. The whole system of agricultural water management in this context realises positive impacts on the environment.

(52) Facing the occasions of serious water shortage, the government provides *quasi-markets* in water implementing transfers between non-agricultural sectors, and among LIDs, to improve economic efficiencies. Recently, serious water shortages take place only once every ten years on average, in limited areas and during limited periods. Explicit trading is prohibited, but the community-like decision making of water allocation in the *quasi-markets* would help abate the social conflicts. The permanent transfer of water rights is also managed under the authorisation of the government.

5.2 Recommendations for developing countries

(53) The Japanese systems of agricultural water management will be leading examples for developing countries under the monsoon climate, where small holdings of paddy field agriculture dominate:

(54) Some form of farmers' organisation should be responsible for irrigation water management. Once well-defined property rights to access irrigation water are entitled to the organisation, securing the marginal (O&M) cost recoveries at the least and efficient water use will be mostly expected regardless of pricing systems actually applied inside. Uniform pricing by any governmental organisation would be inferior. Economic instruments to improve efficiencies can be considered after this kind of institutional problem concerning effective and sustainable governance is solved.

(55) For economies of scale, which will benefit the economy as a whole, be revealed, capital investments may have to be subsidised to some extent. The benefits from productivity enhancement will accrue mainly to consumers in many developing countries. Where the property rights of water use are connected to these investments, farmers might intend to pay part of the sunk costs from the investments (average cost recovery).

(56) Other than the infrastructure developments, the government may have to carry out significant roles facing competitions among different sectors and inside the agricultural sector, taking into considerations of economic efficiencies, equities, the environment and other social interests. Total permissions for trading in water or water rights will contradict the above instruments under the systems in the property rights regime.

Bibliography

Baumol, William J. & David F. Bradford (1970) "Optimal Departures from Marginal Cost Pricing", *The American Economic Review*, June 1970, pp. 265-283.

Lipsey R. G. & K. J. Lancaster (1956) "The Theory of Second Best" *Review of Economic Studies*, 24 (1), pp. 11-32.

Nakashima, Yasuhiro (1998a) "Public Enterprises in Rural/Agricultural Area", Okuno, Masahiro & Masayoshi Honma eds., *Economic Analysis on Agricultural Problems*, Nihon Keizai Shimbun, Inc., pp. 191-226 (in Japanese, translation by author).

Nakashima, Yasuhiro (1998b) "Japan: Sustainable Water Use in Agriculture - Existing Systems and the Possibility of Introducing Market Mechanisms-", COM/AGR/CA/ENV/EPOC(98)87, OECD.

OECD (2002) *TRANSITION TO FULL-COST PRICING OF IRRIGATION WATER FOR AGRICULTURE IN OECD COUNTRIES*, (prepared by Dr. Alberto Garrido) COM/ENV/EPOC/AGR/CA(2001)62/FINAL.

OECD (1999) AGRICULTURAL WATER PRICING IN OECD COUNTRIES, ENV/EPOC/GEEI(98)11/FINAL.

OECD (2001) *Multifunctionality*: *Towards an Analytical Framework*.

Reddy, V. Ranta (2005) "Costs of resource depletion externalities: a study of groundwater overexploitation in Andhra Pradesh, India", *Environment and Development Economics*, 10, pp. 533-556.

Sampath, Rajan K. (1992) "Issues in Irrigation Pricing in Developing Countries", *World Development*, Vol. 20, No. 7, pp. 967-977.

Shobayahi, Mikitaro (1988) *THE EFFICIENCY OF IRRIGATION PROJECTS AND CHARGING SYSTEMS: A CASE STUDY OF JAPAN*, Dissertation Proposal, Department of Geography and Environmental Engineering, The Johns Hopkins University.

Tietengerg, T. (2000) *Environmental and Natural Resource Economics 5th ed.*, Addison Wesley Longman, Chapter 10, "Replenishable but Depletable Resources: Water".

Tsur, Yacov, Ariel Dinar, Rachid M. Doukkali & Terry Roe (2004) "Irrigation water pricing: policy implications based on international comparison", *Environment and Development Economics* 9, pp. 735-755.

Tsur, Yacov & Ariel Dinar (1997) "The Relative Efficiency and Implementation Costs of Alternative Methods for Pricing Irrigation Water", World Bank Economic Review, 11, pp. 243-62, in K. William Easter & Mary E. Renwick, *Economic Water Resources: Institutions, Instruments and Policies for Managing Scarcity*, Ashgate, 2004, pp. 343-262.

Westoby, Jack (1989) *Introduction to World Forest: People and Their Trees*, Basil Blackwell.

World Bank (2004) *Water Resources Sector Strategy: Strategic Directions for World Bank Engagement*.