Addis Ababa, Ethiopia, 4-6 November 2008

INTERNATIONAL SYMPOSIUM ON MULTIPLE-USE WATER SERVICES

Multiple Functions of Water Management in Paddy Fields

H. Furihata [Japan]

Water for agriculture in the paddy area of Asia monsoon regions is not just considered as an economic resource of individual farmers, but is thought to be a common resource shared by a whole rural community and a part of the people's lives. Paddy field irrigation has characteristics not only of negative externalities but also of positive externalities, such as flood prevention and ground water recharge. This paper introduces the multiple uses and functions of water for agriculture in the paddy area of Asia monsoon regions. It maps the high value generated from paddy farming in Asian countries and how this is critical for many communities in addressing the challenges of "Food security and Poverty Alleviation" and "Sustainable Water Use".

Asian Rice Based Systems and World water issues

In the Asian monsoon regions, populations have been dramatically increasing and a consequent increase infood production is urgent and important. Rice is the staple food in the region and has supported the population for long years. However, since available fresh water for the increase of rice production is limited by competition for water with other sectors, sustainable water use should be promoted and more efficient management with better governance introduced at local level.

It is now widely recognized that paddy fields are fully part of the wetland realm. In the Ramsar Convention classification they are classified as human-made wetlands (Ramsar, 2006). This recognises that the beneficial outputs generated by rice based aqua-ecosystems go much beyond crop production (Renault and Facon, 2004) to providing various functions including other productive function such as fisheries and perennial home stead vegetation, support to the environment, flood mitigation, recharge of groundwater, purification of water and conservation biodiversity. In the Asian monsoon regions, paddy farming and its water use not only contribute to food production but also provides broad-based services for communities, traditions and culture and environment.

These multiple roles of paddy farming should be properly recognized and appreciated. Moreover, it should not be overlooked that paddy farming is mutually dependent with local communities, culture and environment. Those features should be naturally taken into account in managing and developing water resources. These recognitions and considerations should lead to the sustainable development in agriculture and rural areas.

Ways of farming and irrigation in the world are diverse. However, there are always common features; that is, an established farming style is closely associated with the indigenous climate, nature, communities and culture in each region. Therefore, it is important to understand the features and the background of the irrigation style in each region when we discuss water issues.

Multiplicity and complexity of uses in rice-based system

Past international water debates on paddy farming have often been loaded with incomprehension, many pointing out the high water withdrawals of rice systems without taking into consideration the return-flows of the paddy cascade system and the dimension of multiple services in rice-based system. A fundamental of rice systems is that out of the withdrawal the fraction which is really consumed by the crop through

evapotranspiration is minimum, figures as low as 25 % are not unusual which means that a large part of the withdrawal goes to uses other than the crop including of course drainage return to natural streams.

Thus the use of water in rice based system is diverse and complex. Of course these specificities complicate the introduction of any modern managerial methods such as water pricing. Questions such as what services to what users at what cost, are not as straightforward as compared to single use systems. The issues of characterization of all water uses, of identifying proper representatives of all users and putting in place effective approaches for participative governance of such complex systems needs to be considered seriously at both national and local levels.

Addressing externalities

As with many other human activities the process of paddy farming generates both positive and negative externalities which need to be fully identified and seized (Boisvert et al, 2003). The multiple uses and functions associated to paddy farming are the positive externalities of the process. Negative externalities can be specific to paddy farming or relevant to agriculture practices in general: indiscriminate use of pesticides, inefficient use of fertilizers, clearing of flooded forests and destructive fishing gear, emissions of carbon dioxide, methane, nitrous oxide and ammonia.

As far as food security is concerned rice development must be approached as an ecosystem that provides the habitat with a variety of organisms (e.g. fish and insects) often used by indigenous people. This multi-product dimension is no doubt an important opportunity to alleviate rural malnutrition and poverty.

In the debate on externalities, talking in general of "paddy farming" is somehow too much a simplifying process, many things depends on local practices and contexts. There are situations where paddy farming causes major problems which need to receive proper treatments (e.g. 'water pollution caused by Rice Farming in Thailand' see INWEPF 4th Steering Meeting and Symposium, 2007). There are other contexts where the overall balance is much more on the positive side and that needs to be accounted for when it comes to decision on agriculture and water management.

Paths for water management improvements in rice-based systems

Discovering and recognizing the diversified values of rice ecosystems is no reason for complacency. There is room for improving water management in both technical and economic terms. In fact, MUS is a very important opportunity for most rice-based systems to find various ways of valuing water and to come up with acceptable solutions for bearing the cost of the operation and maintenance of water management.

As mentioned previously, however, the systems of paddy farming are complex and very diversified and thus do not require the same path of modernization. In simple terms, a modern water management service is one adapted to users' demands and to their willingness to pay. Thus the first step in embarking toward modernization is to acknowledge or identify the various functions or services that the rice system already provides or is expected to provide and corresponding users.

The second step would be to improve the capacity of stakeholders in valuing and planning techniques; defining the management objectives related to the various roles and values of water; setting water management strategies; operating rules; management arrangements (including contributions by various stake-holders); and design features.

In a sense, the recognition of these different values of water in the rice systems is a pre-requisite for moving towards integrated water resources management.

Features of Asian monsoon regions

Important features of Asia monsoon regions and rice cultivation are summarised below.

High precipitation

The top ten rice-producing countries in the Asian monsoon regions have more than 1500-mm of annual precipitation while many of the Western countries and upland farming regions have less than 800-mm. The rainfall in the Asian monsoon regions is not constant throughout the year but extremely fluctuating seasonally.In these regions, the season is clearly divided into rainy and dry. Excessive rainfall and runoff in the rainy season brings about flooding and a broad swath of inundation, which recharges groundwater and river flow and thus forms distinctive and sound water cycles of the regions.

High rice production

With the above-mentioned features of rainfall and flood, paddy farming has been dominant agriculture in the regions. The ratio of rice producing area is very high and the area occupies 75 percent of the total grain producing area in the fourteen countries of the regions. Rice production in Asia amounts to 600 million tons and occupies 91 percent of the total rice production of the world. Paddy farming has been historically maintaining the water cycles which were originally formed by inundation under the natural conditions through seasonal flooding. It has coincidentally sustained the rich aquatic environment of the regions.

High population

The population of the fourteen INWEPF member countries in the Asian monsoon regions is about 2.1 billion and occupies about 30 percent of the world. Meanwhile, the cultivated area per capita of Asia is only 0.15 ha while that of the world average is 0.25 ha. These figures show that the paddy farming has good capacity in supporting population.

Multiple functions of paddy farming

Multiple functions of paddy farming which has been made by the climate, nature, communities and culture are as the follows.

Rice production

The primary task of the paddy field is, naturally, rice production. In other words, paddy fields have sustained high productivity for thousands of years. In order to maintain this high productivity, farmers have tactfully utilized rainfall which varies short to excess throughout the growing season of rice. Stored water in the paddy field also prevents salinization and accelerates fixing nitrogen from the air.

Fisheries production

Many rice based system are associated with fish production either in the field itself or in the water infrastructure (reservoir and ponds). This additional production represents in some cases a significant source of protein for the population and complement well the nutrition inputs from the rice (Halwart and Gupta, 2004), as well as a source of incomes for fishermen. In one of the well referenced rice based system in Sri Lanka (Kirindi Oya) fish activity represents about 20 % of the rice production gross value (Renwick, 2001).

Domestic water

In many rural areas of Asian developing countries there is no domestic water network, and thus irrigation canal water or shallow groundwater are the only sources of domestic water for people living in the area. Clearly in these contexts, irrigation water and paddy farming contribute to support population access to domestic water. In this contexts the closure of canals generates deterioration of the sanitary conditions of the population.

Sustaining homestead garden

Some irrigated rice based systems have progressively allow the development of a very rich perennial vegetation in natural landscape as well as in homestead garden within the command area which would not being possible with rainfall only. Although not often converted into monetary terms, the associated values are of high importance for the population (cool air – medicinal trees – construction material – food – biodiversity- etc.) (Renault et al, 2000).

Flood mitigation

A large amount of rainfall and the runoff caused by the heavy rains in the upstream is trapped in the paddy fields downstream and run down very slowly from them. Stored water in paddy fields could mitigate damages caused by flood and protect human lives and properties in the downstream act as a dam.

Prevention of soil erosion and slope failure

Since the surface of paddy field is quite even and covered with the stored water, soil erosion scarcely occurs in paddy fields, which is usually caused by rainfall or shallow flows on the field surfaces. The paddy fields of which ridges and slopes are well taken care prevented from soil erosion and slope failure.

Recharge of river flow and groundwater

Stored water in the paddy fields gradually permeates into ground or through out to the river. Thus, stored water in the paddy fields functionally recharges groundwater and stabilizes river flow, resulting in sound water cycles.

Formation of aquatic environment

Paddy fields, surrounding reservoirs and canals should be considered to form "wetlands" as aquatic environment, linked with rivers, lakes and ponds. These wetlands formed by the paddy fields provides rich habitats for the living things concerned, such as freshwater fish, insects and birds, together with the adjacent forests and country areas.

Formation of culture and traditional events

Farmers living in the same paddy farming area have historically had to cooperate with each other, effectively using irrigation water from the paddy field upstream to downstream for transplanting, harvesting and so on. Their water management, such as allocation of water and maintenance of irrigation structures, has inevitably formed their own communities. The water management has also brought about the traditional events and ceremonies through which farmers pay great respect to or worship the nature bringing rain and floods. In some villages, the rules of the society and/or the roles of farmers in the society have been established through those customs of water management. Thus, the paddy farming not only established modern paddy farming but also formed communities and cultures in the regions.

The economic evaluation of those multiple functions of paddy fields in Japan

Part of the result is shown inn the table, which was under consideration by a special committee of Science Council of Japan. The evaluation shows that it seems to be huge economic value in the multiple functions of paddy fields. It is important to evaluate the multiple functions of paddy fields, therefore, we think that it should be considered more detail from now on.

Function category	Annual cash value (billions of yen)	Evaluation method
Flood mitigation	3,498.8	Evaluation of cost of flood mitigation dams to achieve same effect(substitution method)
Prevention of soil erosion	331.8	Evaluation of cost of Sabo mitigation dams to achieve same effect(substitution method)
Prevention of slope failure	478.2	Evaluation by the amount of damage prevented by cultivation (direct method)
Recharge of groundwater	53.7	Evaluation of cost of water relative to ground water (substitution method)
Restoration of body and mind	2,375.8	Evaluation of expenditure from household budgets for travelling to, from the city, other locations (substitution method)

Source: Science Council of Japan

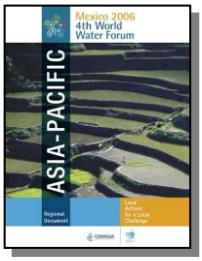
Activities of INWEPF

Finally, we introduce the International Network for Water and Ecosystem in Paddy Field (INWEPF) established in 2004 in Asia region. INWEPF has provided International forum to realize the three challenges of the Ministerial Recommendation on Water for Food and Agriculture in WWF3 by promoting dialogue, exchanging knowledge and experiences, creating synergy among existing forums and strengthening capacity building in agricultural water management in paddy fields with due consideration for environmental aspect.

Specifically INWEPF attended international conference such as 4th World Water Forum, 1st Asia-Pacific Water Summit, and has done transmission of information to all over the world.

4th World Water Forum in Mexico

INWEPF participated in the forum convening topic session titled "Sustainable paddy water use and its multi-functionality with better governance" held at March 20 of 2006, 4th day of the forum, chaired by Dr. Keizrul bin Abdullah. And the message from INWEPF to 4th World Water Forum was reported.



> Protecting zones at the land-water interface like mangroves, paddy fields, wetlands, and forests not only increases ecosystem health, but may also provide extra protection against some disasters and saline intrusion, help groundwater recharge, and improves quality of life.

A part of report on 4th World Water Forum

1st Asia-Pacific Water Summit

INWEPF participated in the forum at the priority theme C "Water for Development and Ecosystem," over the last decade, more emphasis has been placed on establishing sustainable water management practices. The delegate of INWEPF published the message from INWEPF at the forum.

Policy brief which is the result of summit includes the importance of multiple functions of paddy fields.

Delegates published the message from INWEPF

> 70. Recognizing and managing the multiple roles of irrigation water. In addition to food, irrigation systems in the region also provide water for farmhouses, habitats for fish and other aquatic resources, rural enterprise water supplies, domestic water, hydroelectric power, and navigation. It also supports important cultural values that are essential for local wellbeing and livelihoods. Ecological benefits include flood control, groundwater recharge, water purification, biodiversity conservation, and climate adjustment. Policies that recognize and promote the multi-functionality of irrigation water can improve food security, health and sanitation of local communities, and benefits to society as a whole.

A part of Policy brief

Conclusions

Positive multi-functions of paddy farming are introduced in the paper while also recognition is made of possible negative impacts to the environment. The important point is to recognize and appreciate these externalities both positive and negative, and to enhance to preserve the sustainability of paddy farming by achieving sustainable, effective, and equitable water allocation.

Improving the performance of these rice based system is often possible as long as we consider the full dimension and complexity of multiple uses. The paradigm shift is from "Crop per Drop" to "Multiple Values per Drop". This certainly does not simplify the task of the decision makers and developers confronted to investment in water and natural resources, but obviously the high efficiency of these multiple uses of water system has to be fully considered. The challenge is how to put these sometimes quite long history sustainable practices into a world of competition on natural resources and environmental concerns and to serve properly and in the most cost effective way an ever increasing population.

INWEPF created in 2004, will keep trying to collect and disseminate the information needed for sustainability of paddy farming, modern management approach as well as good governance of such multiples uses systems. INWEPF will continue to emphasize the multiple values of paddy farming in particular for rural poor contexts where generating all the values provided by paddy farming by other means would be by far too costly and thus out of reach. INWEPF believes that MUS in rice based system is a chance for the most vulnerable people of rural areas and for modern countries to preserve a system that provides usually a positive balance of services.

References

Boisvert R., Chang. H, Baker R., Levine G. Matsuno Y. and D. Molden (2003) *Water Productivity in agriculture : Measuring the Positive and Negative externalities of Paddy Rice Production.* In: Proceedings of Sessions on Agriculture, Food and Water. 3rd World water Forum March 2003 Kyoto Japan

Halwart and Gupta, (2004) *Culture of Fish in rice fields*. FAO and the World Fish Center. available at http://www.apfic.org/apfic_downloads/partners_downloads/Culture-of-Fish.pdf

INWEPF 4th Steering and Symposium document (2007),"*Water Pollution caused by Rice Farming in Thailand ", p1-09*

Science Council of Japan (2001), *Evaluation of the multiple functions of agriculture and forestry that are involved in human life and the global environment.*

Ramsar (2006) *Strategic Framework for the List of Wetlands of International Importance*, edition 2006 available at http://www.ramsar.org/key_guide_list2006_e.htm

Renault D., Hemakumara M.H. and D.W. Molden (2000) *Importance of water consumption by perennial vegetation in irrigated areas of the humid tropics: evidence from Sri Lanka*. Agricultural Water Management. Vol 46 Issue 3, January:201-213.

Renault and Facon (2004) "*Beyond drops for crops: a system approach for assessing the values of water in rice-based systems"* . Proceedings of the FAO Rice Conference **"***Rice is Life"* Available at http://www.fao.org/docrep/008/y5682e/y5682e09.htm

Renwick, M. E. (2001) Valuing water in a multiple-use irrigation system: Irrigated agriculture and reservoir fisheries. In: *Irrigation & Drainage Systems* **15 (2): 149-171**

WWF4 Regional Document, Asia-Pacific, *p.8* http://www.worldwaterforum4.org.mx/uploads/TBL_DOCS_107_35.pdf

1st Asia-Pacific Water Summit, Policy brief, *p.15* http://www.apwf.org/archive/documents/summit/Policy_Brief_2007_080124.pdf

Keywords

Asian monsoon regions, Rice based systems, Wetlands, INWEPF.

Contact details

Hideki FURIHATA
Ministry of Agriculture, Forestry and fisheries,
Kasumigaseki 1-2-1, Chiyodaku, Tokyo
Tel: +81-3-3502-6246
Fax:+81-3-5511-8252
Email: hideki_furihata@nm.maff.go.jp
www:http://www.maff.go.jp/inwepf/index.htm