Report on

Water Use Charging Systems and Available Financing of Irrigation Development Country Case Studies

September 2014

ICID•CIID

International Commission on Irrigation and Drainage
48 Nyaya Marg, Chanakyapuri, New Delhi 110 021, India

Composition of the Task Force

Dr. Gerhard R. Backeberg
Chairman (South Africa)
(E-mail: gerhardb@wrc.org.za)

Dr. Kazumi Yamaoka
Vice-Chairman (Japan)
(E-mail: kyamaoka@affrc.go.jp)

Dr. Sylvain-Roger Perret
Secretary (France)
(E-mail: sylvain.perret@cirad.fr)

Dr. Brain Davidson
Member (Australia)
(E-mail: b.davidson@unimelb.edu.au)

Mr. Ezatollah Farhadi
Member (Iran)
(E-mail : ez_farhadi@yahoo.com)

Mrs. Ananya Ray
Member (India) - not confirmed
(E-mail : fawr-mowr@nic.in)

Mr. Bashir Ahmad Sial
Member (Pakistan) - not confirmed
(E-mail : bashirahmadsial@hotmail.com)

Dr. Vijay K. Labhsetwar
Director, ICID (India)
(E-mail: icid@icid.org)

CONTENTS

Part 1. Mandate of the Task Force and Introduction

1.1 Background for Establishing the Task Force

(Originally September 2007, Active Since December 2009)

In order to sustain food security and the economic contribution of the agricultural sector to society, adaptation of agricultural water management and associated institutions and infrastructure are necessary in many regions, due to the rapidly changing natural, social, economic and political environment.

In recent years it is widely accepted that water management for agriculture must be approached in a holistic way. This starts from the national water system, through the river basin and irrigation scheme system up to the farming system. At each level of complexity different decision-makers have responsibilities which impact on the whole system. These inter-relationships are particularly relevant to the question of sustainable financing of water for agriculture, specifically for the development of irrigation schemes.

Redirection of investments is to take place to meet the MDGs and to face the challenge of population growth, malnutrition and poverty, increasing competition for land and water, and the requirement to protect the ecology. New challenges are appearing that make adaptation to climate change and increasing energy costs essential.

Investors in water supply projects for agriculture are tending to evaluate the complete food value chain (farming inputs-crop production-distribution-processing-storage-retailing-consumption). In addition to traditional markets, potential new markets are emerging, such as consumer driven demand for processed, ready-made food. Apart from farmers and water service operators at the irrigation scheme level, a range of actors are involved through backward (downstream) and forward (upstream) linkages up to the consumer.

Future investments in water for agriculture will therefore be analysed differently than has conventionally been done in the past. This includes the scale of projects, the collective interests which initiate or support development projects and the sources of funding to finance the projects. Clear guidelines for individual/collective action, private/public responsibility and national/international financiers will be useful to direct investments in water for agriculture.

To better understand the above complexity, the Task Force on Financing Water for Agriculture (TF: FIN) formulated three main questions as a guideline for the work plan:

1. What are the priorities for financing infrastructure for agriculture?
   (Expansion or efficiency improvement of irrigated agriculture; small-scale subsistence or large-scale commercial enterprises)
2. Who should pay for these investments?
   (Public or private interests or both)
3. What financing mechanisms are most appropriate?
   (Review of a mix of policy instruments that are complementary but consistent)

The following topics for workshops were considered appropriate:

- **2009:** Principles and approaches to guide development and financing of water supply for irrigation schemes.
- **2010:** Country policies and strategies on financing and implementation of current water use charging systems in irrigation.
- **2011:** Water use charging systems and available financing of irrigation: Case studies and cross-country comparisons
- **2012:** Report by the Task Force on priorities for financing water for agriculture, public or private sources and appropriate financing mechanisms.

For successful completion of these tasks two issues were paramount: First**, all task force members** had to prepare **papers on the country they are representing** for the **specific workshop topic per meeting.** If a specific member was not interested or capable of preparing the paper, they were free **or obliged** to nominate a colleague from that country to do so. Second, the content of the paper for each topic **must be informed by the questions which guide the activities** of the Task Force.

In this regard, the ICID Task Force on Financing Water for Agriculture (TF-FIN) was therefore established with the focus of gaining better understanding and insight of:

(i) the required investments in agricultural water, and the beneficiaries of these investments,

(ii) the presently available financing mechanisms and constraints for maintaining or improving physical irrigation capacity; and

(iii) the expected changes and innovations for more appropriate financing mechanisms to enable sustainable water use for food production.

Based on contributions by the members of the Task Force who actively participated, a final report consisting of 4 parts was completed.

Frameworks, guidelines and responsibilities for papers presented during Workshops were discussed during consecutive Task Force meetings (see Appendix).

1.2 Introduction: Issues and Challenges

The irrigation sector has long been characterized by massive public financing of infrastructures, refurbishment works, operation and maintenance, and water-related services to farmers. The most common perception is that "financing irrigation" merely refers to "budget allocation" by public sector; liberal views (Briscoe, 1999) even see "rent-seeking" by bureaucracies, politicians, and private direct beneficiaries, i.e. the farmers themselves, in such a system.

Such perceptions typically led to little systemic interest on the actual needs for financing, on alternative options and sources for financing irrigation, on the effects of such options on service performance, and on agricultural production performance.

Also, publicly-funded and -managed irrigation systems have long been typically achieving well below expectations in terms of agricultural performance. The unquestioned and consensual diagnosis is that lack of financial contribution and poor social participation by farmers play as deterring factors to developing a virtuous circle linking improved service, farmers' contribution and sense of ownership, to raising an interest in production performances, resource use efficiency and environmental integrity.

Against such background, the 1980s' wind of liberalization over agriculture, followed by 1990's wave of management transfer, modernization and service orientation in irrigation have brought much change into the sector over the last 30 years. Also, the new status of water as an economic good (after Dublin and Rio Conferences in 1992) has been interpreted in irrigation as the need for cost recovery and the application of the "user pays" principle.

In spite of changes and reforms in many countries, the situation remains worrying overall. While publicly-funded and -managed irrigation systems have brought some relief to the rural poor in many developing countries (as compared to rainfed systems), they still fall far short of expected agricultural performances and financial viability, while generating environmental degradation (e.g. groundwater and surface water depletion, salinization). At the same time, irrigation is expected to remain the chief contributor to global food security while using fewer resources in a context of sustained demographic growth.

Such expectations face a two-fold challenge: (i) global economic forces and the global financial crisis makes massive public funding increasingly difficult, (ii) the alternative option of charging farmers for irrigation water use shows contrasted and often disappointing results in developing countries. As pointed out by Backeberg (2006), changing perspectives on irrigation including management transfer and user charging systems have missed crucial supporting actions such as beneficiaries' empowerment, deeper institutional reforms giving real power, clearer property rights, and accountability to users in terms of fee collection, allocation and use, and service-orientation. Also the beneficiaries' actual capacity and willingness to pay for water has been ignored or over-estimated. Further, conjunctive use of groundwater and surface water is common in many arid areas (e.g. Maghreb, Middle East, South Asia), mobilizes private investments by farmers (e.g. tube wells). Also, widespread resort to private pumps in paddy fields fed with publicly managed canals (typical in South East Asia) illustrates the fact that there is no such thing as free irrigation water, from a farmer perspective. All in all, the situation requires a more holistic approach to irrigation management and financing.

With the rise of the "cost recovery" and "financial feasibility" mottos, focus has been put on users' charging systems. Drawing from successes achieved in few cases (i.e. Australia, Mexico, Chile, OECD countries), some insist that farmers should ultimately pay for the full costs of irrigation water supply and services (Briscoe, 1999). A previous ICID Task Force, the position paper (Tardieu et al., 2005; Tardieu, 2005) also focused on users' charging system as a solution, and argued that a virtuous relation should be established between farmer income and irrigation services, with a focus on operation and maintenance costs (O&M costs) as a basis for tariff setting (the so-called "sustainable costs"). Such works initiated a broader outlook on financing irrigation, in recognizing the multi-functionality of irrigated agriculture, the many services rendered to society and the environment, alluding to the fiscal flows and sources involved. Yet, the focus remained on user charging system as a solution to financial viability. This previous Task Force and position paper paved the way to the work carried out by the ICID Task Force on Financing Water for Agriculture.

1.3 Modus operandi and milestones

The Task Force was primarily an attempt to broaden the scope of analysis, to clarify concepts and theories on financing irrigation, to take stock of various experiences through a cross-country analysis of policies, strategies, current situations, mechanisms and practices regarding irrigation financing.

The above-mentioned questions formed the basis for the action plan over the 4 years of TF-FIN activities (from December 2009 to October 2013). In order to effectively perform the tasks, it was agreed during the meeting held in New Delhi in December 2009 to focus on the core issues, and not to duplicate material that is generally available in current literature. Given the nature of ICID's Task Forces and Working Groups, namely representation of member countries, the effective way was (i) to share country experiences (ii) through expert country representatives' written and oral contributions, (iii) by means of annual workshops. The whole contribution would then form the basis for a TF-FIN report, which concludes the activities.

The following topics and workshops were eventually held in this period:

- **2009 (New Delhi):** Principles and approaches to guide development and financing of water supply for irrigation schemes
- **2010 (Yogyakarta):** Country policies and strategies on financing, and implementation of current water use charging systems in irrigation
- **2011 (Tehran):** Water use charging systems and available financing of irrigation: Case studies and cross-country comparisons (workshop postponed to 2012 meeting due to lack of sufficient participation)
- **2012 (Adelaide):** Workshop and draft report by the TF-FIN on "Water use charging systems and available financing of irrigation development: Country case studies"
- **2013 (Mardin):** Final report by the TF-FIN on "Water use charging systems and available financing of irrigation development: Country case studies" submitted for approval by members and Permanent Committee on Technical Affairs (PCTA).

References

Backeberg, G. (2006) Reform of user charges, market pricing and management of water: problem or opportunity for irrigated agriculture? *Irrigation & Drainage*, 55(1): 1-12.

Briscoe, J. (1999) The financing of hydropower, irrigation and water supply infrastructure in developing countries. *Water Resources Development*, 15(4): 459-491.

Tardieu, H. et al. (2005) Irrigation and drainage services: some principles and issues towards sustainability. International Commission on Irrigation and Drainage, Task Force #3 report and ICID position paper, 6p.

Tardieu, H. (2005) Full cost or "sustainability" cost pricing in irrigated agriculture. Charging for water can be effective but is it sufficient? *Irrigation & Drainage*, 54(3): 251-262

❖❖❖❖❖

Part 2. Principle Framework for Financial and Fiscal Feasibility Analysis

2.1 Development and Financing of Irrigation Schemes: Towards a Consistent Approach[1]

Introduction

During all phases for the development and financing of irrigation schemes, a number of key actors or participants are involved. These are mainly the beneficiaries of the development project, government as an economic subject and members of society in general. Furthermore, a combination of political, social and economic objectives typically provides direction for the development process. Success (or failure) should be evaluated against more specific aims of efficient, equitable and sustainable utilisation of irrigation water. For this purpose three types of analysis have to be performed, which are all interrelated. First, investment and cash- flow analysis at farm level; second, analysis of expenditure and revenue by government as a development agent; third, economic and social benefit-cost analysis at the country level. The analysis for development and financing of irrigation projects from the perspective of government is neglected in most cases. This is very often accompanied by assertions that irrigation development is subsidised by general taxpayers since farmers are not paying for the full cost of water. Confusion is heightened by incorrect terminology e.g. interchangeable use of "prices" and charges for water. This workshop by the Task Force on Financing Water for Agriculture is a further step to open the debate between engineers and economists on this subject.

Publicly Financed Irrigation Schemes

The discussion will focus specifically on publicly financed irrigation schemes, which should be distinguished from privately financed irrigation schemes. Typically the former is initiated by government and is undertaken on a larger scale. There are direct beneficiaries (farmers) and indirect beneficiaries (input suppliers and product consumers) linked to the development project. The expenditure made by government is for once-off capital investment in infrastructure and recurrent operation and maintenance. There are three main sources of funds: loans, taxes from the general public and different types of payments by beneficiaries. In order to determine who benefits and who is willing to pay, it is essential to perform a fiscal impact analysis. An assessment must be made as accurately as possible of the above-mentioned expenditure and sources of funds from the point of view of government. This is the only correct way to calculate whether the budget for the development project will balance or not.

For this purpose it is important to clarify some key concepts and terms: In the analysis, water should be treated as a production input for farming. In addition, the provision of water should be treated as a quasi-collective good or service (in contrast to the purely private or purely collective good or service). Consequently the focus should be on the cost of the infrastructure and the cost of the service to supply water. In order to recover these costs, the focus should be on user charges, which are levied from direct beneficiaries and different types of taxes which are collected in the economic system. In this regard it is helpful to remember that financial costs consist of broadly defined fixed cost (capital and interest as well as maintenance and administration) and variable cost (operation and repairs). In practice the challenge is to accurately quantify these costs for investment and operation. Similarly it is important to distinguish between different types of revenue which are available to cover costs. These are mainly user charges; benefit taxes or betterment levies (which are levied from direct beneficiaries); new taxes (which are generated by direct and indirect beneficiaries as a result of the development project) and general taxes (which are generated in the economy and are available as transfer payments or subsidies to the development project). A comprehensive budget must be compiled of all sources of tax revenue, which in practice is a demanding task.

Various costing methods and charging systems are available to design project specific water use charges. These include average and marginal cost; area and volumetric based cost; unitary or tiered/block-rate charges; and two-part charges, consisting of a fixed, area based component and a variable, volumetric component. The important argument is that a correct decision on the level of user

[1] Gerhard R Backeberg, Water Research Commission Pretoria, South Africa

charges can only be made in relation to the level of tax revenue which will be collected (see discussion below).

Cost Recovery for Irrigation Scheme Development

The fiscal impact and financial cost analysis will have to be adjusted according to the type of irrigation scheme which is under investigation. In general this can be surface or groundwater irrigation or a combination thereof; storage and gravity canal schemes; pump and pipeline schemes. It is also important to distinguish the analysis for development of a new irrigation scheme from that of upgrading of an existing scheme. In the latter case previous investment decisions should be considered as bygones and a partial analysis is mostly required.

Different objectives are usually followed with implementation of water use charges as a policy instrument. These are mainly to (1) balance the budget and (2) influence water user behaviour. In order to balance the budget, a comparison has to be made between capital and recurrent expenditure (-); loans (+) and instalments (-); user charges, betterment levies and taxes (+). To the extent that the revenue (+) does not cover expenditures (-), grants or subsidies (+) through transfer payments have to be made from general taxpayers. The key argument in influencing water user behaviour is that a signal is provided to farmers about what it costs to supply water. This message is clearly brought across by both the fixed and variable component of the water user charge. Typically a large proportion (up to 80%) of the costs is levied on an area basis. Volumetric charging is of course only feasible if water use is measured. The choice of a charging system, the structure and level of water use charges is again only possible if a calculation or an estimate has been made of tax revenue. In practice this exercise is more complex, but therefore even more essential, where the operation of public irrigation schemes is transferred to water user associations (WUA). Then it must be clearly specified which of the above expenditure and revenue items must be accounted for in the budget of the WUA.

The requirements for successful implementation of cost recovery are firstly, that these water policy objectives must be aligned to the development objectives in agriculture. Secondly, a balance has to be found between the policy objectives of efficiency (increasing the productive use of water and reducing water wastage with irrigation); equity (trade-offs between rural and urban, agricultural and industrial, small-scale and large-scale farming development); and sustainability (sufficient incentives for investment in farming and food production in response to market demands). It should be acknowledged that by its very nature, agriculture uses relative large volumes of water for relative low value production of raw materials in the food value chain. If the water use charges and taxes are set too high, farming will not be profitable and therefore not sustainable. This will typically be the case where full cost recovery is set as an objective while disregarding taxes as a source of revenue. Above all, the requirement for policy formulation on cost recovery is therefore transparency: Government should take a conscious decision and clearly state whether the objective with development of an irrigation scheme is to generate additional tax revenue or whether socio-economic development in rural areas is promoted with transfer payments or subsidies from the rest of the economy

Conclusion

The challenge is to establish a system of water use charges and benefit taxes that captures an acceptable proportion of the net benefits from direct beneficiaries. Allowance has to be made for errors in the fiscal impact assessment and for the administrative cost to collect taxes and levy water use charges. The upper limit for both is the total net benefits and the lower limit is to recover at least operation and maintenance cost. The most effective approach to satisfy the requirements of applying water use charges as a policy instrument is a two-part charge: The fixed cost and the betterment levy are levied against the land while a volumetric charge is based on average variable cost for the full water allocation. Where practical consideration should be given to introducing tiered or block-rate charges to supply additional water above the official water allocation per ha or per farm. When setting the use charges, important considerations are consistency between different irrigation schemes, ensuring that water use charges are comparable between similar irrigation schemes; achieving independence from external funding to cover operation and maintenance cost; and making effective service delivery possible. Finally, the key issues are clear public policy objectives by government;

coherent water use charges and benefit taxes; and incentives for farmers to make productive use of irrigation water.

References

Carruthers, I. & Clark, C. (1981) The Economics of Irrigation, Chapter 7: Charges for Water, pp. 184-200, Liverpool University Press, Liverpool.

Gittinger, J.P. (1982) Economic Analysis of Agricultural Projects, (Second Edition), Chapter 6: Analyzing Project Effects on Government Receipts and Expenditure, pp. 215 – 240, The Economic Development Institute, World Bank, The Johns Hopkins University Press, Baltimore and London.

Gildenhuys, J.S.H. (1997) Public Financial Management, Chapter 13: User Charges, Consumer Tariffs and Nominal Levies, pp. 361 – 387, JL van Schaik Publishers, Pretoria.

❖❖❖❖❖

2.2 Prices, Costs and Values for Irrigation Water: Basic Concepts[2]

Introduction

The use of economic techniques in water resource management suffers from a number of incongruities, including questions of what economic terms actually mean and how they should be applied. What results from these incongruities is confusion and the mishandling of water resource allocation questions. While there are many reasons for this unfortunate situation, it could be argued that resolving them should start with some understanding of what the basic economic concepts mean. To that end, the purpose in this paper is to review some of the basic economic concepts associated with water resource management decision making. Most of these revolve around the concepts of costs, price and value. It should note that the issues discussed in this paper are by no means extensive, comprehensive or new. They are presented with the sole aim of starting a conversation about the role economic concepts can play in resolving water resource management decisions. For more details those interested in these concepts should consult a text on microeconomic theory. In addition, the issues discussed in this short paper are extended in Davidson (2004), Hanemann (2005) and Young (2005), all of which relate the arguments to water resource allocation issues.

Basic concepts

It is important to understand that the price, cost and value of water are three entirely different concepts. In an economic sense all three can be shown in a simple supply and demand diagram (see Figure 1).

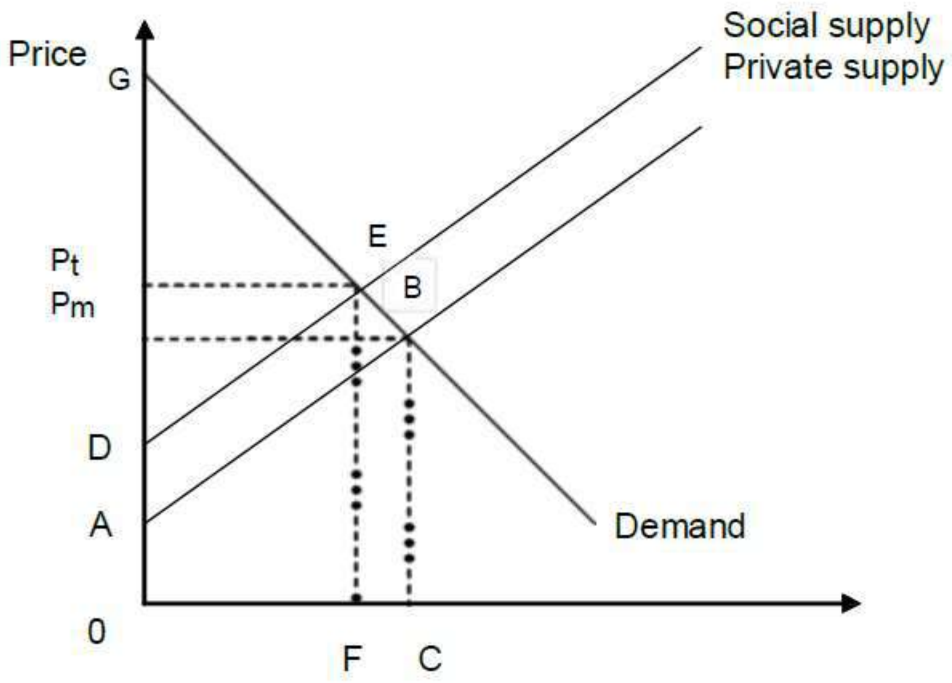


Figure 1. The economic concept of cost, value and price

[2] Brian Davidson, Melbourne School of Land and Environment University of Melbourne, Parkville, Victoria 3010 b.davidson@unimelb.edu.au

A paper presented to the Task Force on Financing Water for Agriculture, 60th ICID Annual Conference, New Delhi, 7th December 2009

As water is an input into a production process, the demand for it should accord with that of an input demand. In such cases the quantity demanded has a number of unique theoretical aspects. First, the relationship between the price and quantity of water demanded must be a negative (downward sloping) one. Second, the price of the output produced from the water, the price of other inputs and the price of substitutes to water are hypothesised to be important in determining the input demand for a good (Varian, 1987). Once the demand relationship is known, the own-price elasticity of demand for water can be determined by computing the percentage change in the quantity demanded divided by the percentage change in price. More typically, transforming the quantities demanded and prices into logs and estimating the relationship by regressing one on the other will yield an estimate of the elasticity (Tomek and Robinson, 1995).

The cost of water can be defined as the actual costs of providing water to its end use point. It should be noted that if this activity is subsidised two different costs may actually exist; the private cost which is the cost to the private end user and the social cost, which is the cost to society as a whole and includes all the private costs as well. In this situation, two separate supply schedules exist and the social cost is the area under the social supply schedule (area DEF0), while the private economic cost is the area under the private supply curve (area ABC0).

The 'value' of water to an individual is reflected in what people are willing to pay for it. This is displayed in the demand schedule for water. By tracing out the different values for water used in different crops the demand for water can be estimated. The assumption is that the average value of water used in different crops is a reflection of what farmers are willing to pay for it to apply to each crop.

From a social accounting perspective, the value of water to society can be defined as the difference between what users would be "willing to pay for it" and what they "actually pay for it" over the whole range of water used. The demand schedule reveals the "willingness to pay" and the social supply schedule reveals what "is actually paid for water" over the whole range of production. Clearly at production levels where the actual costs are greater than the values (beyond F in Figure 1) the provision of the good is economically unviable, as the costs are greater than any benefit derived by a producer. Yet up to that point, the provision of the good (in this case water) is of value to society because what the users would be willing to pay for it is greater than what it costs to provide. This area (GED in Figure 1) is known as the economic surplus. Economic surplus is the value society derives from the production and consumption of a good. This area can be separated in the consumer surplus (area GEPt), which can be interpreted to be the benefits consumers receive by purchasing the good for a price that is less than they would be willing to pay and the producer surplus (area DEPt), which is the benefits producers receive for selling the good at a price which is higher than they would be willing to sell it for.

The 'administered' price of water is the amount actually paid for water use by a user. It is often lower than the market-clearing price of water (Pt), which is what people pay for it in a perfectly competitive market place. In many cases the price of water prevailing in a market bears little resemblance to its cost and the value placed upon it (Hellegers, 2006). It could be where the private supply and demand schedules intersect (at Pm), but does not need to be. Governments administer the price of water for a variety of reasons and in many cases do not consider the market forces embodied in the supply and demand schedules. It should be noted however, that the true price of water, which is the price society would actually pay for water, is where the social supply schedule and the demand schedule for water intersect (Pt).

Some additional considerations

The analysis presented above assumes that water markets function in perfectly competitive ways, something that would appear not to be the case. As Davidson (2004) and Young (2005) suggest, water has a number of issues associated with it that make it difficult to assess and model. They argue that water is mobile; has a highly variable supply; has varying quality aspects to it; has problems that tend to be site specific; exhibits large economies of scale; has multiple market failures; is not traded widely amongst users; has a cultural, religious and social dimension to it; and is provided as a service, yet is traded as a good and treated as a right by users. While all these problems make any sensible assessment of the cost, price and value of water difficult, the basic concepts presented above still apply. What needs to happen is to consider these additional issues in a manner which is logically consistent with the basic concepts. In other words, these extraneous issues need to thought of as part of the supply and demand framework presented above, not as factors that are removed from that framework and therefore devalue it in some way. In this section, some of the most common problems in adjusting the framework with respect to water are discussed.

Price is determined where supply and demand intersects and prices change in relation to changes in the quantity supplied and demanded. The identification problem (i.e. is it changes in supply or demand or both causing prices to change) is avoided in water by assuming that all changes are a result of changes in supply. Consequently movements in prices and quantities will trace out the demand relationship. This assumption is not as unrealistic as it sounds. The quantity of water available to irrigate changes from year to year according to a number of factors well beyond farmers' control, yet the demand for water is fairly constant.

There are numerous methods available to estimate the own-price elasticity of demand for a good, none of which are really amenable to the situation of doing so for water. Most involve the collection of market prices and quantities for a good, or a range of goods, and estimating the relationship between the two. In this case the demand for the good could be expected to be a function of its price, where the slope (the coefficient associated with the price) is negative and significantly different to zero and the intercept term is large and positive. To estimate the own-price elasticity of demand the slope coefficient is multiplied by the ratio of the price to the quantity demanded at any point along the curve. To simplify the situation, if the relationship is estimated in log functional form, the estimated slope coefficient is equivalent to the own-price elasticity of demand.

As the observation of price and the quantity demanded are difficult to quantify, many researchers have set up mathematical programming models whereby a hypothetical farm is assumed to exist and the model is simulated with different constraints to determine the marginal value of water (or the shadow price of water) (Appels, Douglas and Dwyer, 2004). This highly synthesised method is inadequate as it does not allow for the diversity of options open to a range of farmers and enterprises spread over a wide area. It assumes that all farmers will act in the same manner and in a rational way.

An alternative innovative approach is to assess the average value of water used to produce different crops in different regions and in different seasons. By ordering the crops from highest value to lowest and then cumulatively summing the amount of water used for each subsequent crop, it should be possible to trace out the demand for irrigation water in the catchment. These values become the basis for an econometric estimation of demand and subsequently the estimation of the own-price elasticity of demand. In this approach it is assumed that farmers act rationally, wanting to use the first available water to produce the most valuable crop and so on until all water is expended. In addition, it is assumed that farmer's willingness to pay for subsequent quantities of water is equal to the value they place on each additional unit of water (i.e. marginal value of water).

In undertaking this innovative approach to estimating the demand for water, it is necessary to obtain an estimate of the value farmers place on water. Young (2005) outlines the various methods that can be used to obtain an estimate of value of water used for irrigation. Valuing irrigation water is an extremely complex task. Although a few minor exceptions exist, generally irrigation water is not a commodity that is actively traded on a bourse or in a local market. Thus, analysts need to rely on a variety of techniques to infer a value for water, rather than observing one. Young (2005) argues that the methods employed can be segregated into inductive and deductive methods. Inductive methods rely on inferring a value from generalised observations. The techniques involved include taking observations of selected transactions estimating market relationships using econometric techniques, contingent valuation, choice modelling, etc. Examples of inductive methods are observations of water market transactions, econometric estimation of production and cost functions, travel cost methods, hedonic property value method, defence behaviour method, damage method, contingent valuation, choice modelling, benefit transfer. Deductive methods rely on inferring a value from logical processes. Arguably the most used deductive technique to infer values of water are residual valuation methods (something that is employed in this study). Examples of deductive methods are basic residual imputation method, changes in net rents, mathematical programming, value added, computable general equilibrium models and alternative costs.

The choice of the method to be employed depends as much on the data available as anything else. The benefits from allocating water are derived by those who use it. It should be remembered that as water is only one of numerous inputs into a production process it is necessary to only account for the benefits water adds to that value adding process, not the totality of the benefits from that process. In this paper a deductive (i.e. those where a value is implied from logic) method is employed to estimate the values of water to users. This is required because water is not a freely traded commodity where prices and quantity are readily observable.

Summary

The aim in this paper was to provide the basic economic concepts that need to be employed in making any decisions on water resource management. These simple concepts of price, cost and value are based on an understanding of the supply and demand for water and are the same for any product. In other words, there is nothing unique about the economics of water and the principles used to assess water must be consistent with those used in other industries and sectors. The observation was made that water has a number of issues that make the use of these basic economic tools and concepts difficult. However, the existence of these issues does not justify the abandonment of sound economic techniques in the water sector. Rather, what is required is an accommodation of these issues within the supply and demand framework.

References

Appels, D., Douglas, R. and Dwyer, G. (2004) Responsiveness of water demand: A focus on the southern Murray Darling Basin. A Productivity Commission Staff Working Paper, Melbourne.

Davidson, B. (2004) The problems of analysing markets for irrigation water. A contributed paper to the annual conference of the Australian Agricultural Economics and Resource Society, Melbourne, February 2004, 28p.

Hanemann, W.M. (2005) The economic conception of water. Working Paper 1005, Department of Agricultural and Resource Economics and Policy, University of California, Berkeley.

Hellegers, P.J.G.J. (2006) The role of economics in irrigation water management. Irrigation and Drainage 55: 157-163.

Tomek, W. and Robinson, K. (1995) (3rded.)Agricultural Product Prices. Cornell University Press, Ithaca.

Varian, H. (1987) Intermediate Microeconomics: A modern approach, Norton International, New York.

Young, R. (2005) Determining the Economic Value of Water: Concepts and methods, Resource for the Future, Washington.

❖❖❖❖❖

2.3 The financial costs of irrigation services: framework, assessment and meaning. Example from South Africa[3] [4]

Executive summary of paper

Rationale and principles

This paper focuses on the direct financial costs incurred by the development and running of irrigation systems. It presents and exploits an ICID-endorsed methodology on cost evaluation (Rieu and Gleyses, 2003) which draws from previous works and relies upon basic principles of cash flow and cost-benefit analyses applied to waterworks (Rieu and Gleyses, 2003; Perret and Geyser, 2007). The methodology focuses on direct financial costs to economic agents, leaving opportunity costs and second-order effects on employment, prices, and competitiveness out of the analysis. Also, the water supply system under scrutiny is clearly delineated and systematically inventoried, from the abstraction point to the irrigation hydrant; it includes abstraction and storage infrastructures, conveyance equipment, collective pumping and filtration facilities (if any).

The following data and information are necessary to perform the calculations:

- Inflation rate related to public works, in the form of Civil Engineering Index or any other index, which allows for evaluating the present value of assets; such CEI is available in European countries, not in most developing countries

- The discount rate; common financial practices suggest using a discount rate being equal to the borrowing rate, excluding inflation

- The service life, or working life, which allows for estimating the average annual cost of capital; such data vary dramatically depending on type of asset, service and use conditions, etc. It usually is long, up to twenty to fifty years in the case of irrigation infrastructures; in developing tropical settings, service life may de dramatically reduced and show specific characteristics

- Depreciation is an important concept in the long-term management of assets, since it addresses the issue of asset replacements (at the end of the service life); although inaccurate, linear depreciation along the service life (cost / service life) was used in this study since the yearly usage of the assets were not known.

Perret and Geyser (2007) have shown that evaluating O&M and capital costs after these principles is not that straightforward, owing to some specific traits of smallholder irrigation in developing countries, and requires some adaptation. Such issues include the lack of records on infrastructure and initial costs, the multiple purpose and actual uses of certain equipment and infrastructure, the shift in purpose of others over time, the inclusion of certain small, yet indispensable equipment in the calculation, the partial refurbishment works on particular assets, and the lack of a standard basis for calculation under tropical, developing conditions (e.g. on service life, maintenance requirements).

On a case study basis, all irrigation-related assets and infrastructures in one smallholder scheme in South Africa were listed (inventory phase). The current value (year 2000) of these assets was established, along with information such as service life, date of construction, repairs and refurbishment overtime. Since the model requires the initial investment costs and maintenance/replacement costs of the irrigation scheme from construction to 2000, costs had to be discounted back to 1965, the year of construction (Perret and Geyser, 2007) (present-value determination phase). Similar regression is possible in Europe by means of a 'Civil Engineering Index' (Rieu and Gleyses, 2003). In South Africa, such CEI was calculated only until 1970. Alternative indexes or discount rates were therefore needed to fully determine the initial investment costs and maintenance/replacement costs: Consumer Price Index (CPI) or Farming Requisites Index (FRI).

[3] S.R. Perret, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, and Asian Institute of Technology, Bangkok, Thailand

[4] M. Geyser, University of Pretoria, Department of Agricultural Economics, Extension and Rural Development, Pretoria, South Africa

Then, the yearly payment required to cover all financial costs was established (annual cost-recovery rate determination phase).

Various assumptions were made in the development of the model, since limited information was available. A first necessary set of choices refers to the relevant cash flow. Given the nature of the project (government-financed), taxes, as cash outflows, were ignored. Also, another choice was to ignore opportunity costs. It was assumed that the farmers had not given up any existing benefit from usage of the land prior to the irrigation scheme. Changes to net working capital have been further ignored since the crops farmed on the land were seasonal in nature and working capital completed a full cycle within a year. Assumptions were further necessary regarding inflation. Inflation affects the value of a capital investment project by changing the nominal values of the cash flows over the life of the project. The gauge of expected inflation included in these measures is the Consumer Price Index (CPI). If, however, some of the sources of inflation facing the project's cash flows are not CPI related (imported parts), then alternative indexes must be used (FRI).

Assumptions on the discount rate were also made. The general principle guiding the choice of the discount rate is that it represents the expected rate of return required by the providers of the capital used to fund the project. In publicly-financed projects, no lending (borrowing) rates can be used. Perret and Geyser (2007) have drawn from several works and established that negotiable certificates of deposit (NCD) were a better basis in developing context, among other options.

Determining the initial value of the irrigation scheme (at construction date)

Three different inflation-related indexes were used, namely the CPI, the farming requisites index and the civil engineering index, to determine the initial value of the irrigation scheme. Yearly maintenance cost has been adjusted in order to take effect of inflation into consideration, using the following equation:

discounted CF CF.(1i) n (equation 1)

where: CF = yearly cash flow ; i = inflation rate (e.g. CPI); n = number of years

The gauge of expected inflation included in these measures is the CPI. Complete information on annual maintenance rates (percentage of present value) and service life (replacement date) and the calculation of the total yearly maintenance cost and replacement cost under the three different initial investment scenarios may be found in Perret and Geyser (2007).

Determining the net present value of the yearly cash flows and the yearly contribution to settle the loan

In finance and cost-benefit approaches, the discounted cash flow model operates as the basic framework for most analyses. The conventional view is that the net present value of a project is the measure of the value that it will add to the firm taking it. Thus, investing in a positive (negative) net present value project will increase (decrease) value. The net present value (NPV) of the yearly cash flows has been determined over the 35-year period by:

$$NPV \;\square\; \frac{CF_t}{1 \quad d^{\,n}} \qquad \text{(equation 2)}$$

where: d = discount rate (NCDs at 6.5%); CF = annual cash flow for year t; n = number of years

The yearly contribution necessary to settle the loan is determined with the following formula:

$$NPV = PMT \cdot \frac{1-(1+d)^{-n}}{d} \qquad \text{(equation 3)}$$

where: NPV = net present value; PMT = yearly payment; d = discount rate (NCDs at 6.5%); n = number of years

Annual cost-recovery rate may also be considered the required yearly net profit (RNP) that should be return out of initial investment, according to a given target, known as Return on Assets (RoA).

$$RoA = \frac{RNP}{NPV} * 100 \qquad \text{(equation 4)}$$

Where: RoA = 4% (as prescribed by South African Department of Water Affairs – National Water Resource Strategy); RNP: Required Net Profit; NPV: net present Value

Following the model, NPV, the total yearly payment (PMT), and the RNP per ha (to achieve targeted Return on Assets) have been calculated, under CPI inflation and NCD index scenario (for a 700-hectare scheme under actual irrigation), as indicated here below.

Discounting scenario: NCD (6.5%) Inflation scenario: CPI	NPV	Total PMT	PMT/ha	Target of 4% ROA	
				Required Net Profit	Required Net Profit / ha
C	ZAR -5 264 716	ZAR 384 652	ZAR 550	ZAR 210 589	ZAR 300.84

Since only costs were considered, NPV is negative. The intention was to ascertain what should be the yearly payment for recovering financial costs. Such annual payment amounts to ZAR 550 per ha (Exchange rate at that time: 1US$ = 10 ZAR) if all financial costs are to be covered. If a RoA of 4% is to be met (as of national policy requirements), then required net profit per ha should be about ZAR 300 per ha.

Field-based studies show that small-scale farmers grow mostly maize in this kind of schemes, with low crop density, low production and low productivity of factors, including water. There annual actual net profit is highly variable according to farming style and cropping systems (Yokwe, 2009; Speelman et al., 2009). In case of subsistence farmers and part-time farmers (the large majority), annual net profit is about ZAR 600-700 per ha.

This paper concludes that the cost evaluation model is applicable, albeit necessary adaptation and caution. Yet, it falls far short of providing a unique basis for establishing water fees, as it emphasizes capital cost recovery, which should be kept out of a sustainable cost recovery systems (Tardieu, 2005). Also, such approach ignores the reality of in-kind and labour contributions of small-holder farmers to O&M operations. Finally, it ignores some critical but hidden fiscal revenues by government, generated by the operation of irrigation systems, and which should be accounted for in cash flow analysis.

References

Perret, S.R. & Geyser, M. (2007) The full financial costs of irrigation services: a discussion on existing guidelines and implications for smallholder irrigation in South Africa. Water SA, 33(1): 67-78

Rieu, T. and Gleyses, G. (2003) Assessing the financial costs of water infrastructure and application to a raw water supply system in Guadeloupe Island (French West Indies). In: ICID Guidelines for assessing existing and future costs of irrigation services. ICID International Conference, 5th meeting of the Working Group on Socio-Economic Impacts and Policy Issues, September 15, 2003, Montpellier, France, 17p.

Speelman et al. (2009) Variability in smallholders' irrigation water values: study in North-West Province, South Africa. Irrigation & Drainage (2009, DOI: 10.1002:ird.539)

Tardieu, F.. (2005) Full cost or "sustainability" cost pricing in irrigated agriculture. Charging for water can be effective but is it sufficient? Irrigation & Drainage, 54 (3): 251-262

Yokwe, S. (2009) Water productivity in smallholder irrigation schemes in South Africa. Agricultural Water Management, 96 (2009): 1223-1228

❖❖❖❖❖

Part 3: Country Policies, Strategies and Case Studies of Water Use Charges

3.1 Policies and Strategies on Irrigation Charging Systems for Rice Paddies in Japan and the Asian Monsoon Region[1]

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 semiarid 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 costing and charging 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 charging 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 charging 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 charging that have not been adequately discussed.

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

(1) Immersion Cultivation under the Ample Water Conditions

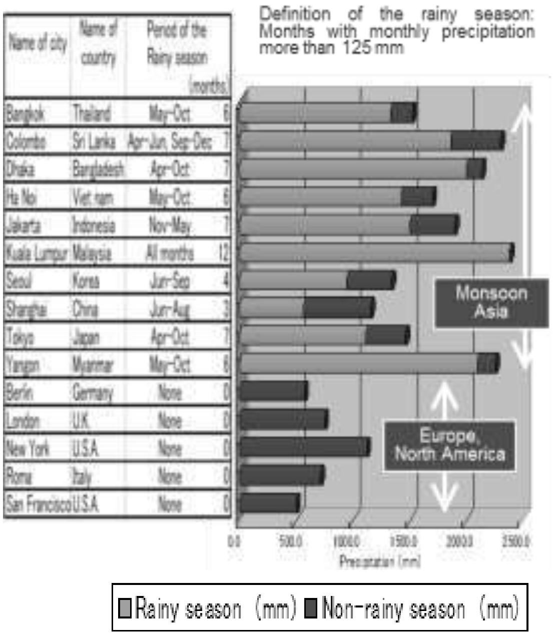
The Asian monsoon region embraces the Indian Ocean to the south, the expansive region of Tibet, the Himalayan mountain mass and continental China to the north, and the Pacific Ocean to the east. Most of it consists of high-precipitation warm regions that have annual rainfall in excess of about 1,500 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 125mm per month and may come up to 500mm 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 125mm throughout the year (Fig.1, Fig.2).

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

[1] Kazumi Yamaoka, Japan International Research Center for Agricultural Sciences

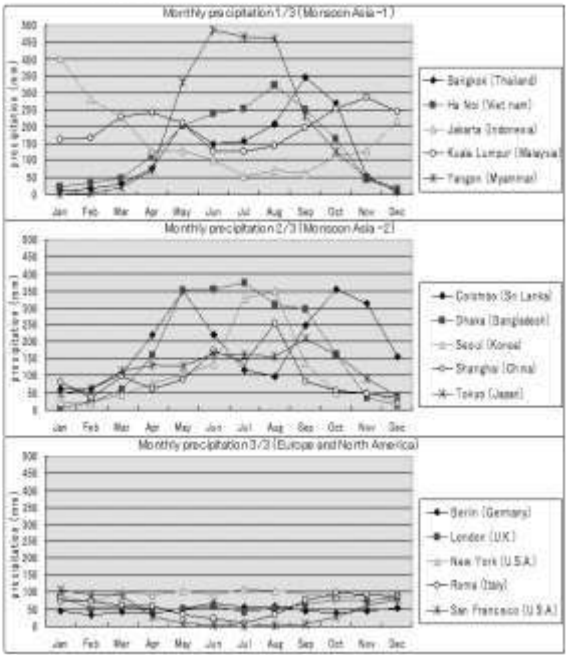
oxygen into its roots through the plant due to its distinctive body structure with paths for good air passage. Paddy rice allows cultivation known as "immersion cultivation", whereby the entire field is continuously covered with water. This method represents a fundamental difference from water management 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.

Fig.1. The rainy and dray season and annual precipitation in Cities in the Asian monsoon region and western countries



Name of city	Name of country	Period of the Rainy season	(months)
Bangkok	Thailand	May-Oct	6
Colombo	Sri Lanka	Apr-Jun, Sep-Dec	7
Dhaka	Bangladesh	Apr-Oct	7
Ha Noi	Viet nam	May-Oct	6
Jakarta	Indonesia	Nov-May	7
Kuala Lumpur	Malaysia	All months	12
Seoul	Korea	Jun-Sep	4
Shanghai	China	Jun-Aug	3
Tokyo	Japan	Apr-Oct	7
Yangon	Myanmar	May-Oct	6
Berlin	Germany	None	0
London	UK	None	0
New York	U.S.A	None	0
Rome	Italy	None	0
San Francisco	U.S.A	None	0

Fig.2. Monthly precipitation in cities in the Asian monsoon region and western countries



Note: Mean in 1971-2000 Source: WMO

(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 charging 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 using cheaper and ample water resources in the Asian monsoon region.

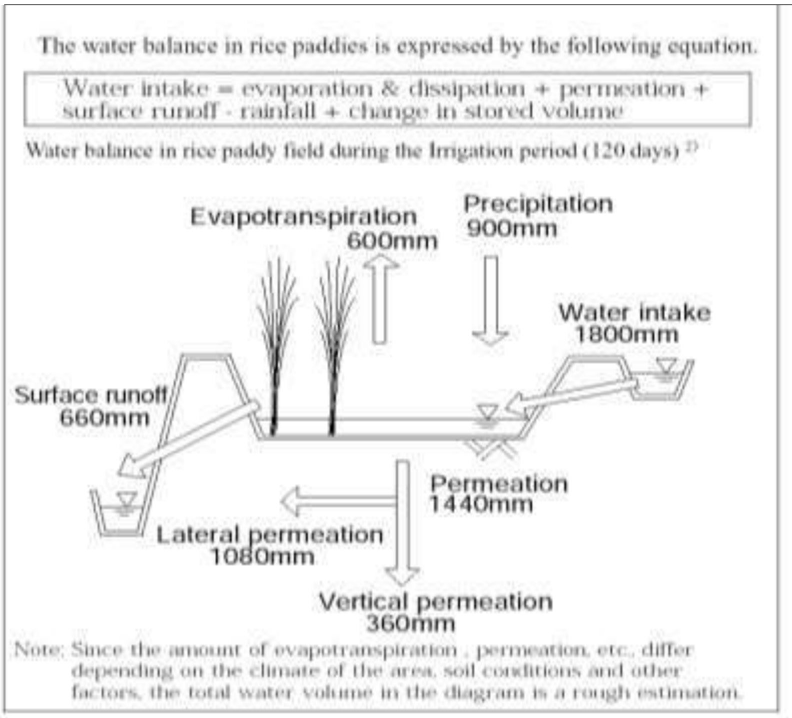


Figure 3. Water balance in paddy (Japan) [Source: Maruyama, T., R. Nakamura et al. (1998)]

Table 1. Advantageous effects of paddy rice agriculture with ample water use

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

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

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).

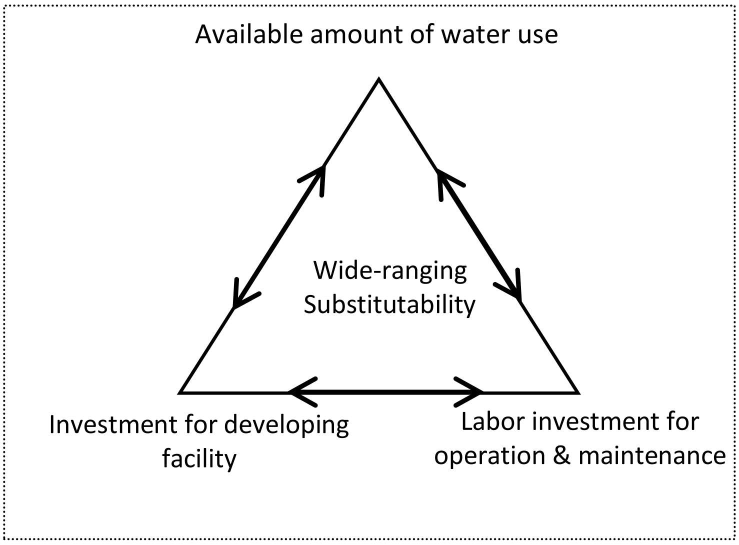


Figure 4. Substitutability among factors of production in irrigation management in paddy fields

(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.

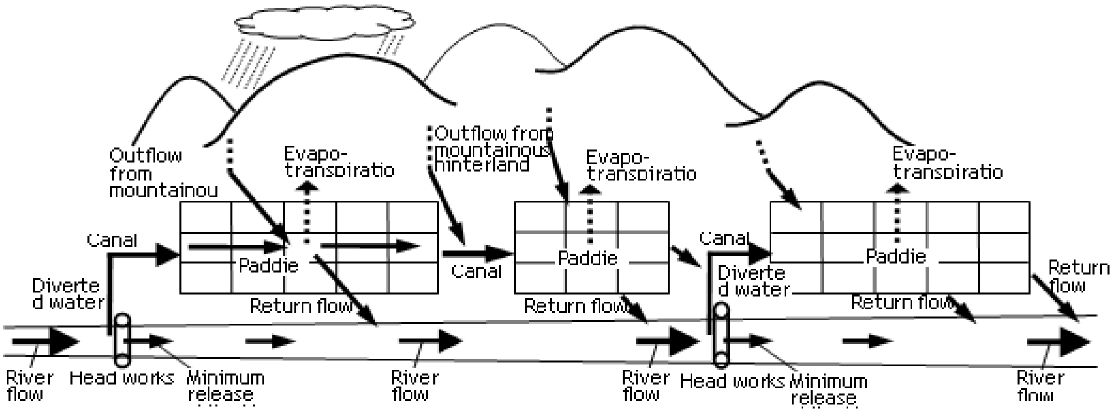


Figure.5. The role of paddy fields as a reservoir promoting a sound water cycle in a basin scale

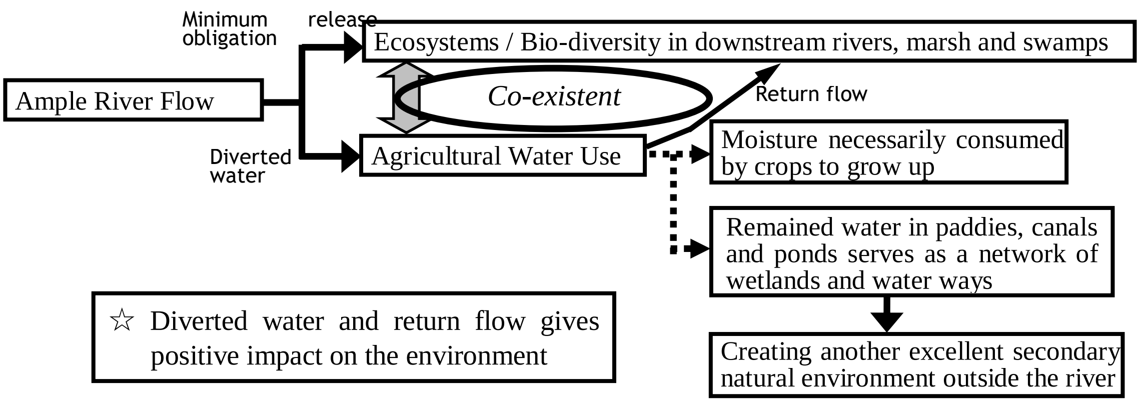


Figure 6. Contribution of paddy field irrigation to ecosystem services in humid regions

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.

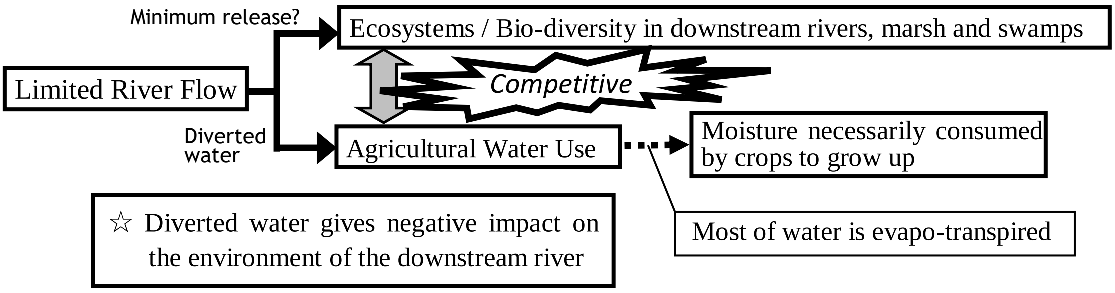


Figure 7. Competitive nature of water use in arid regions where water is constantly scarce

(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 temporally 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).

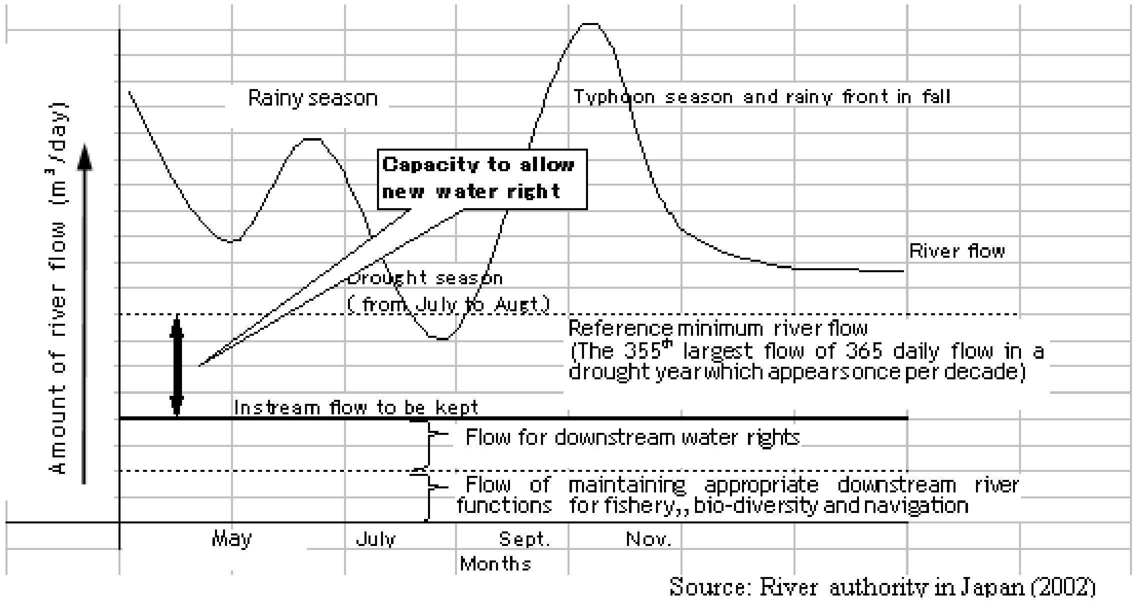


Figure 8. Conditionality for allocating a water right in rivers in Japan

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

Class	Lines	Authority	Length (km)	ratio	Minimum flow
Class 1 River	13,979	National Government	10,553	7%	Regulated
		Local Governments	77,008	54%	Regulated
		Total	87,560	61%	
Class 2 River	7,071	Local Governments	35,934	25%	Regulated
Quasi-class River	14,113	Municipalities	20,032	14%	Regulated
		Total	**143,528**	**100%**	

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.).

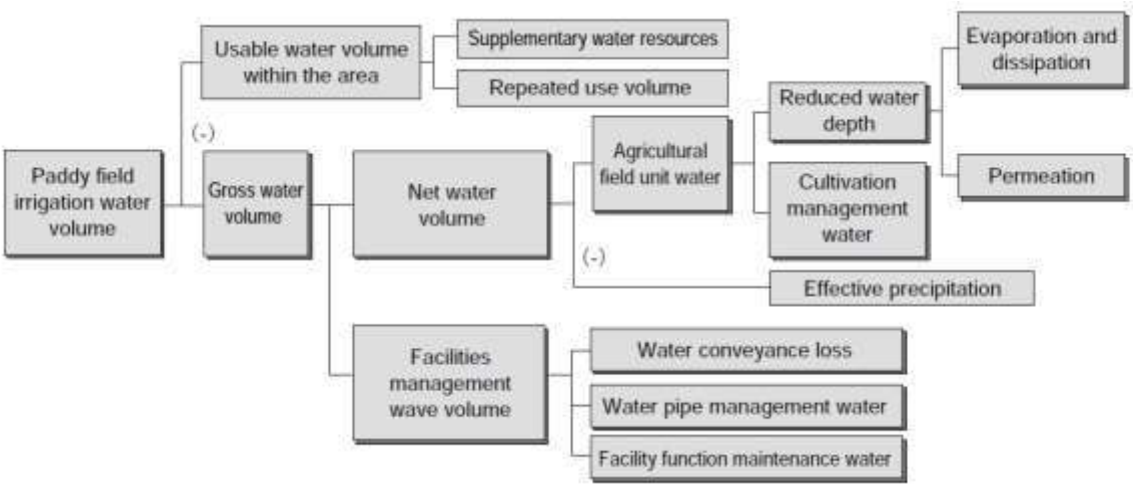


Figure 9. Structure for calculating the amount of water for paddy field irrigation in Japan

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

(1) Classified Water Charging Methods Adaptive to OECD Countries

The normal concept of water charging 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 charging 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.

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-charging". 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 charging 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 charging 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.

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

Water pricing method	Description
(1)Pricing method by land area	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.
(2)Metered pricing method	A method in which usage volume or time is calculated and fees are charged accordingly
(3)Dual pricing method	Pricing method in which usage fees are charged by annual fixed facilities expenses and unit water usage
(4)Pricing method by use	A different pricing method is applied for different uses. This is also known as block rate pricing.
(5)Improvement charged pricing method	Pricing method of fees levied against agricultural land based on the increase in land value due to the supply of irrigation water
(6)Incentive metered pricing method	Pricing method in which extra fees are charged for exceeding a given volume of water and incentives are provided for conserving a given volume
(7)Passive water intake method	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.
(8)Water market pricing method	Pricing method in which pricing is set by voluntary payments for marginal water volume units of farming families.

(OECD, Agricultural Water Pricing in OECD Countries – Working Party on Economics and Environmental Policy Integration –, 1999)

(2) Distinct Differences in Adaptability of Water Charging and Trades between Arid and Humid Regions

Water charging 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 charging practices work well from the viewpoint of the saving scare resources of water and efficient allotment of them.

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

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

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

Area charging 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 charging, 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 charging 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 charging 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 charging has actually been implemented in the Asian monsoon region.

(2) Volumetric Charging 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 charging 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 Charging in Surface Water Irrigation Areas

Volumetric charging 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 charging 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.

(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.

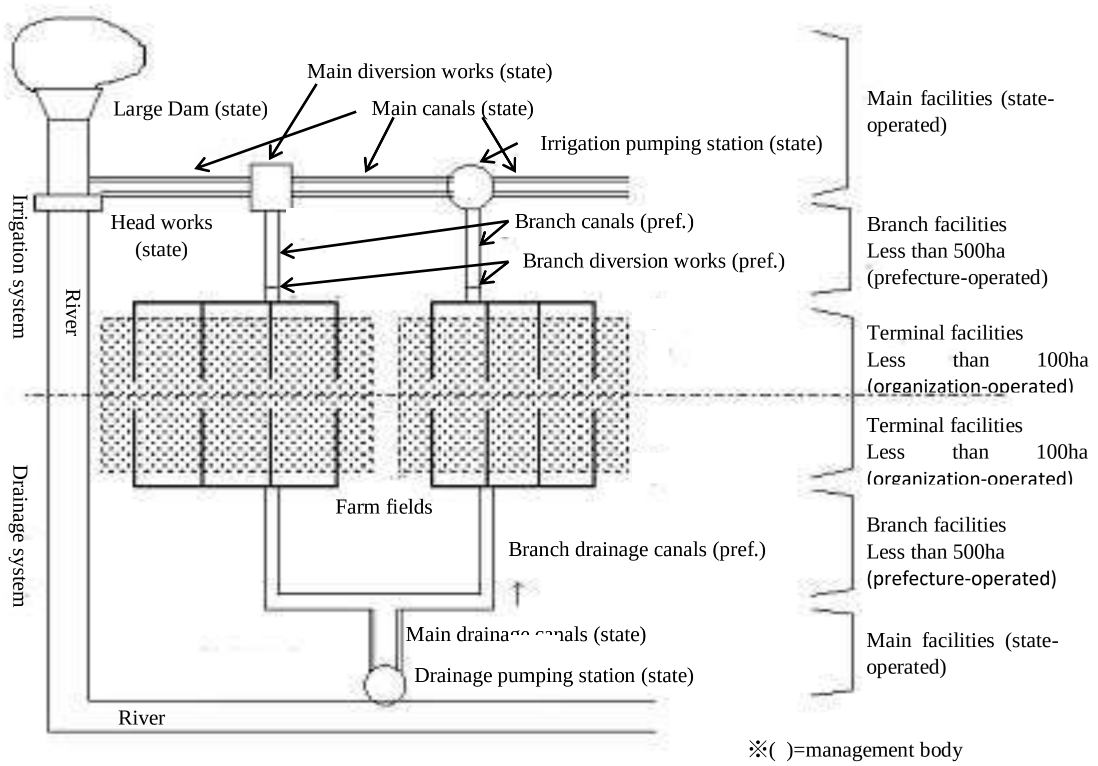


Figure 10. Facilities constructed by each project management body under the Land Improvement Law of Japan

(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.

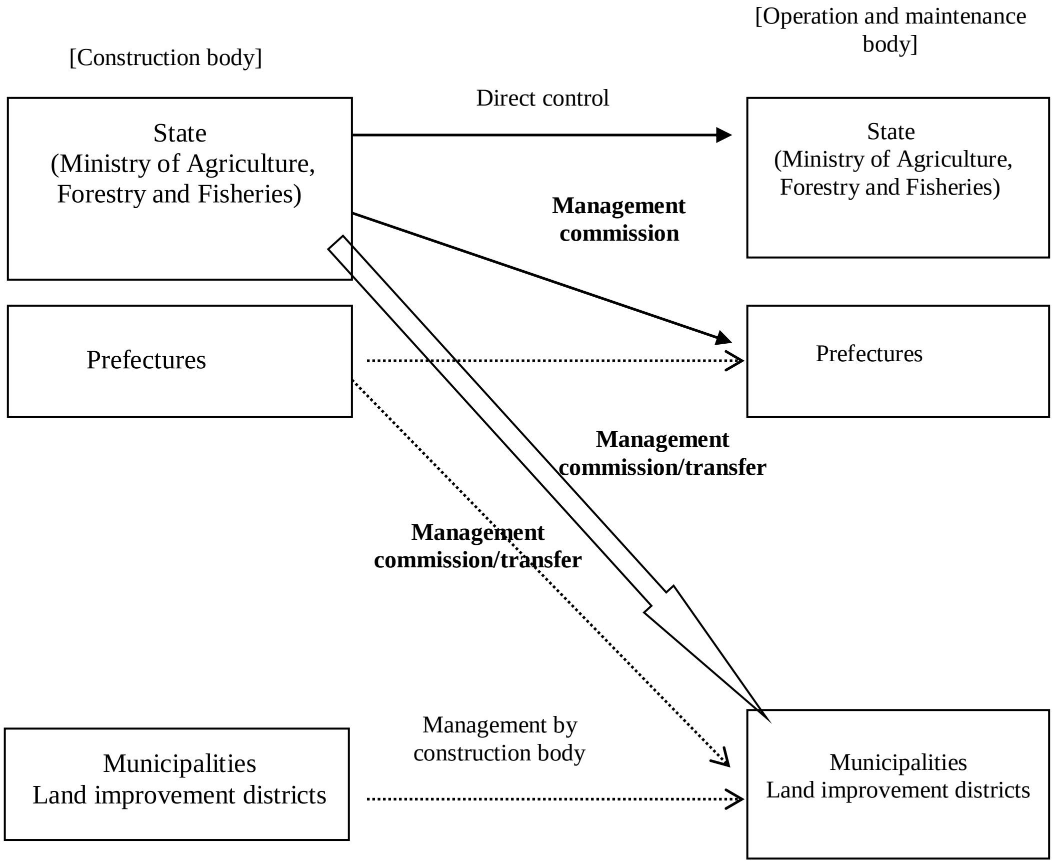


Figure 11. Relationship between construction bodies and operation and maintenance organizations for irrigation facilities under the Land Improvement Law of Japan

(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 charging 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 charging 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 charging 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 charging 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 charging 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 charging 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 (2000): Mizusigenn Saihaibun Syuhou tositeno Suikasettei(Water Pricing) nituite, Heisei12nenndoNougyoudoboku Gakkai Kantou Shibutaikai Kouyou, pp.44-46

FUJIMOTO Naoya (2001-1): Tounan Ajia niokeru Water Pricing no Igiduke-Mizusigenn no Yuukou Riyouni mukete, JSIDRE Dai 22kai Kokusai Mondai Sinpojiumu, pp.51-61

FUJIMOTO Naoya (2002-2): Nougyou Suiri no Tamentekiyakuwari nituiteno Ichi Kousatu, Nittyu Nougyou Suiri Kentoukai Ronbunnsyuu, pp.149-155

FUJIMOTO N. and TOMOSHO T. (2003): Water Trade in Shejinag Province, the People's Republic of China-A Literature and Field Survey,

FUJIMOTO Naoya et al. (2003): Heisei 14 nenndo Nougyousuiri Monndai Kenntoukai Siryou － Nougyouyousui Kannri niokeru Mizu no Puraisinngu no Itiduke

FUJITA Kouichi(1999): Kangaiyou Bijinesu, Sekai ha Ima, Nihon Nougyou Shinbun, 1997.7.5

JIID (2001): "Suido no Chi"wo Kataru,

JSIDRE, JIID and Shiga Prefecture Government (2002): Water for Food and Rural Development, -Multi-Functional Roles of Paddy Field Irrigation in Asia Monsoon Region-, Proceedings of the Pre-Symposium for WWF3, Otsu, Japan, p.296

KATAOKA Naoki (1995): Dai 3 syou Kasen to Suiri, Syakai to Hou -Hou Syakaigaku heno Sekkinn-, pp.97-108, Houritubunnkasya, Kyoto

MASE Tooru(2001): Suiden Kangai to Hatachi Kangai niokeru Seiirtu Haikei no Soui, JSIDRE dai 22 kai kokusai Mondai Sinpojiumu, pp.39-50

MITSUNO Tooru(2002): Yasugawa Ryuuiki niokeru Suidenn Yousui no Hanpukuriyou to Kasenn Ryuukyou, The Sixth Symposium on Water Resources, pp.19-24

OECD (1999-1): Agricultural Water Pricing in OECD Countries-Working Party on Economic and Environmental Policy Integration, pp.15-16

OECD (1992-2): The Price of Water-Trend in OECD Countries, OECD, Paris

MIZUTANI Masakazu et al. (1996): Sigenn Seiyakuka no Mizu Riyou Sisutemu - Indonesia "Subakku" no Keiken, pp.121-218, Mizusigenn no Kokatsu to Haibunn, Noubunnkyou, Tokyo

MUSHIAKE Katsumi (2002): Monnsu-nn・Ajia no Suimon to Mizusigenn, The Sixth Symposium on Water Resources, pp.17-26

National Institute for Rural Engineering (2002): Amerika Gassyuukoku Kariforunia-syuu niokeru Mizu no Kakaku tuke tou Tyousa Gaiyou

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

TANJI Hajime (2002): Nihonn no Nougyouyousui no kakaku to Sijyou Keisei ni Kannsuru Rekishiteki Kousatsu, Journal of Japan Society of Hydrology and Water Resources 15(5), pp.522-532

TOMOMASA Tatsumi et al. (2002): Suirihi no Jyuuryousei Kakinn Dounyuu no Kanousei - Suidennnougyou niokeru Tochiriyou karano Kousatsu-, Heisei 13 nenndo Nougyoudoboku Gakkai Kantoushibutaikai Kouyou, pp.25-27

TOMOMASA Tatsumi et al. (2002): Yousui Kanari no Genjyou to Kadai, Heisei 13 Nenndo Jyoukyuu Sisutemu Kensyuu Siryou, NIRE, pp.1-13

YAMAOKA Kazumi & OCHII Yasuhiro (2003): A Message from Japan and Asia to the World Water Discussions, The Japanese Institute of Irrigation and Drainage, pp.106-117

YAMAOKA Kazumi (2006): Paddy Field Characteristics in Water Use: Experience in Asia, AGRICULTURE AND WATER: SUSTAINABILITY, MARKETS AND POLICIES, Organization for Economic Co-operation and Development (OECD), Paris, ISBN 92-64-02256-2, pp.287-315

YAMAOKA Kazumi & YAMAMOTO Yusuke (2011): Policy Proposal on Water Management Systems in Terminal Canals for Paddy Fields in Indonesia – Lessons from Experiences in Asian monsoon region and Japan, GOI/ADB/OECD INTERNATIONAL WORKSHOP "Sustainable Water Management for Food Security: An international policy dialogue on progressing water policy reform in agriculture, with focus on Indonesia" 13 – 15 December 2011, Bogor, Indonesia

Water Resources Development Public Corporation (2002): Mizusigenn Kaihatsu Shisetutou Kanri Nenpou

Zennkokutochikairyoujigyoudanntai Renngoukai (1999): Totikairyouku Unnei Jittaityousa houkokusyo, pp.95-97

❖❖❖❖❖

3.2 A Perspective on Financing Irrigation in Australia[1]

A paper presented to the Financial Taskforce Group
61st Annual Conference of the International Council of Irrigation and Drainage, Yogyakarta, Indonesia. 12 October 2010

It should be noted that this is a Working Paper on work in progress. Please do not quote without corresponding with the author.

1. Introduction

The International Council of Irrigation and Drainage (ICID) established a Technical Taskforce dedicated to promoting the understanding and use of financial and economic principles in supplying and using irrigation water. The participants in that Taskforce have a particular interest in water user charging systems. The point was raised at a meeting of the Taskforce in New Delhi (in 2009) that any system of charging for irrigation would be dependent on the individual nature of an irrigation scheme itself. Thus, it was decided that in order to address the questions raised by the Taskforce would be necessary to document the nature and extent of irrigation schemes within individual countries. Such surveys should include not only the physical elements of the scheme, but more importantly, its financial operations and the strategies that the owners of schemes want to pursue. These issues, as they relate to the Australian situation, are addressed in this paper.

In this paper the policies and strategies used to finance irrigation in Australia are presented. In undertaking this task is first necessary to detail the physical extent of irrigation in Australia. This involves isolating where irrigation is undertaken in Australia, how old it is, how extensive it is, what is produced and who owns and operates the system? Then, the assets of the system are described, the revenues received from supplying water and expenditure to maintain those supplies are presented. Some attention is paid to the way charging for irrigation water in Australia is undertaken and the different way the provision of infrastructure is paid for. Finally, it is necessary to raise the current and future concerns of those stakeholders interested in irrigation in Australia. As the system is principally owned and controlled by the state, most of these concerns are of a political nature.

2. Physical Audit

Australia has, according to the ANCID (2007), 65 recognisable irrigation schemes located across the country (see Appendix Table A-1). Some water providers, such as Sunwater in Queensland and Goulburn Murray Water in Victoria, control multiple schemes, sometimes even across different catchments. The development of individual irrigation occurred through three fairly distinct phases. First, from the late 1880s river diversion schemes were developed, first in northern Victoria, along the Goulburn and Murray Rivers. These schemes collected water and distributed it through what could be termed formal irrigation networks, involving canals and the like. In the 1920s and 1930s irrigation from river diversions occurred, also mainly in the Murray- Darling Basin (MDB), but also in sub catchments further north. Farmers in this phase tended to be located along rivers. Finally, from the 1950s on, the development of large-scale reservoirs occurred and while some formal irrigation schemes were constructed, the needs of those who took water from a closely located river continued, particularly in Northern New South Wales.

According to the Australian Constitution irrigation is a State government responsibility. In 2005 – 06 approximately 2.8 million ha were available for irrigation, in a country that crops nearly 18 million ha and farms approximately 420 million of its 770 million ha ABS 2010). The vast majority of the land capable of being irrigated is in New South Wales and Victoria, where just over 2 million ha have the potential to be irrigated. It should also be noted that most of this is in the MDB (see Table 1). However, it should be noted that in the north of the country the water available (in the Ord and Burdikin systems) is very large, yet the area cropped is quite small. These schemes, above the Tropic of Capricorn in the tropics, are the most underutilized in the country. The economics of irrigation in

[1] Brian Davidson, Department of Resource Management, University of Melbourne, Parkville, Vic. Australia. 3010, b.davidson@unimelb.edu.au

northern Australia really needs to be questioned, as it is hard to see a case for a mature water economy where there is no scarcity of water.

Table 1. The Extent of Irrigation Activity in Australia

Area			Water Used			
State/ Region	**Scheme (ha)**	**Planted (ha)**	**Entitlement 2005-06 (ML/year)**	**Delivered 2005-06 (ML)**	**2005-06 Proportion (%)**	**2005-06 surface water pro-portion (%)**
NSW	1,080,940	285,938	7,001,231	4,966,529	71	92
Vic	976,149	486,436	2,658,104	2,810,066	106	92
Qld	399,947	163,552	2,125,283	1,472,817	69	93
WA	127,500	22,173	457,686	359,301	79	67
SA	104,098	102,160	942,004	130,560	14	45
Tas	35,975	1,977	15,222	2,631	17	90
Vic	976,149	486,436	2,658,104	2,810,066	106	92
Murray Darling Basin	2,073,554	767,949	9,701,088	7,678,873	79	87
Australia	2,778,364	1,062,236	13,293,258	9,792,889	74	86
Source ANCID (2007)						

The variety of crops produced is quite large and extensive (see table A-1). In the south pastures are grown mainly for dairy production and fodder, fruits and grapes predominated. In southern New South Wales rice and cereals are produced. In northern New South Wales and inland Queensland cotton is irrigated, along with cereals and sugarcane is irrigated in coastal Queensland. According to the ABS (2010), in 2008 – 09 Australian farmers applied on average 3.7 ML/ha of irrigation water to crops. In the MBD the figure was slightly higher at 3.8 ML/ha. The application rate can vary widely depending on the year (4.2, 4.0 and 3.4 in 2005-07, 2006-07 and 2007-08, respectively). In addition, it varies across crops with a maximum of 14 ML/ha applied to rice and as little as 2.2 ML/ha applied to some cereals (see Table A-2).

Variability plays a large role in Australian agriculture. While nearly 2.8 million ha have the potential to be irrigated, in 2005-06 only 1.06 million ha were planted, 767,949 ha in the MDB. The reasons for this low level of planting would appear to be due to an over allocation of the available water resources (resulting in the over development of irrigatable land) and the onset of a drought. Of the farmer's entitlements, approximately 13.3 million ML/year, only 9.8 million ML were delivered in 2005–06 (see Table 2). In some regions, such as Victoria, the allocation was 106% of the entitlement, whereas in New South Wales was only 71%. In the MDB the figure was only 79%.

Of all the water used in irrigation in Australia 74% is sourced from surface supplies, that figure is 79% in the MDB (ANCID 2007). It is only in South Australia were groundwater plays a significant role. The schemes' rely on 11,687 km of river to carry and distribute water (8297 km of which are in the MDB) and a further 16,000 km of canals and pipes (see Table 2). In addition, there are countless weirs, regulators, diversion points, pumps and metres employed to regulate water in Australia. In terms of meters, more than 95% of the volume of surface water supplied to farmers is measured. On average, the life expectancy of assets has been estimated to be 100 years and in Australia it has (on average) 43 years of life left. However, great variability surrounds these life expectancy numbers (ANCID 2007).

In Australia it is estimated that 41,000 farmers have some form of irrigation, 27,000 of them in the MDB (ANCID 2007, see Table A- 2 for more details). In 2005–06 there were an estimated 155,000 farm businesses in Australia, and yet the ABS (2010) estimates that 44,826 of them are irrigated. It should be remembered that this number varies greatly. By 2008-09, in the height of the drought, there were estimated to be nearly 136,000 farmers and just fewer than 40,000 were reliant on irrigation.

From these schemes 218 (mostly small) towns were supplied, 157 of them in the MDB. The largest of these is Adelaide, the population of over 1 million people. Just over 900 employees, 646 of them in the MDB, are employed in providing service (see Table 2). Like most efficient operations in Australia the irrigation sector is a highly capitalised one that relies on very little (expensive) labor.

Table 2. Australian Irrigation Schemes: Economic Dimensions

Physical Assets				People		
State/ Region	**Length of natural carriers (km)**	**Length of canal and pipes (km)**	**Average life left of assets (years)**	**Number of irrigators serviced (No.)**	**Towns supplied (No.)**	**Number of employees (No.)`**
NSW	7,227	4,407	50	9,197	78	308
Vic	595	7,276	52	16,523	77	303
Qld	3,773	2,435	29	7,787	54	177
WA	18	794	43	1,134	0	35
SA	0	575	17	4,545	6	48
Tas	74	214	na	314	2	7
NSW	7,227	4,407	50	9,197	78	308
Murray Darling Basin	8,297	11,774	48	27,030	157	646
Australia	11,687	15,971	43	41,102	218	908
Source ANCID (2007)						

As an aside, one might question whether it was ever in Australia's interests to develop irrigation schemes. Irrigation farming tends to work against the countries comparative advantage in producing goods which use vast quantities of land (the inexpensive factor), little labour (the expensive factor), have an export market (as the population is low) and produce a crop that is inexpensive to transport in as raw a form as possible. Since European settlement Governments have attempted to introduce industries, like irrigation, that violate if not all of these principles.

It can be concluded that irrigation means a lot to certain individuals and groups in Australia, particularly farmers and those who reside in small towns. However, in the larger scheme, irrigation farming is not the dominant land use or (with the exception of some notable crops like cotton, rice, fruit and vines) not a large contributor to overall agricultural output. That being said, the importance of irrigation needs more discussion than can be afforded here.

3. Financial Considerations

Any financial assessment of irrigation should be conducted at two separate levels: that from the perspective of the State or organisation that provides the infrastructure and that occurring on-farm and provided by farmers. While the analysis of each is different (encompassing different objectives and analysis), the same issues of assessing assets, costs, revenues and how to pay for them needs to be investigated. In this Section an overview of some of these issues is presented. The ANCID (2007) has surveyed a number of water providers (for the year 2005-06), while the ABS (2010) provides a reasonably comprehensive assessment of on-farm investment (for 2008-09).

The ABS (2010) estimates that in 2008-09 the value of farm irrigation equipment was $8.5 billion, with $5 billion of that in the MDB. In terms of farm expenditure on irrigation in 2008-09 the ABS estimates that of the nearly $1.4 billion spent on irrigation, only $110 million was spent by farmers on capital equipment. While far more was spent on licences ($147.1 million) and irrigation charges ($152.1 million), it should be noted that the life expectancy of some of these assets can be quite lengthy. Water purchases by farmers (admittedly in a drought year) amount of to approximately $254 million. The vast majority of expenditure on extra water was spent in the MBD, at almost $228 million. While water licences and charges amounted to more than $160 million, the amount spent on capital was just under $51 million (see Table 3). Check numbers please.

From a water provider's perspective, the current asset replacement value of the schemes has been estimated to be $6,407 million in 2005-06 (ANCID 2007). The assets in the MDB are estimated to be worth $3.5 billion, most of which are centred in Victoria. Expenditure on maintaining these assets in Australia was estimated to be $32.5 million in 2005-06 and in the MDB, $22.9 million. In terms of revenue ACID (2007) estimates that these assets earn approximately $193 million from water revenues alone. In the MDB water revenues were estimated to be $134.2 million (see Table 4). Check numbers please

Table 3. Irrigation Expenditure on Farm (2010)

State/ Region	Water licences	Irrigation charges	Purchases Temporary water	Purchases permanent water	Other irrigation expt.	Irrigation equip.	Capital	Total
	($,000)	**($,000)**	**($,000)**	**($,000)**	**($,000)**	**($,000)**	**($,000)**	**($,000)**
NSW	52,054	39,552	29,669	35,667	137,099	70,667	19,966	384,674
Vic	37,935	50,503	71,724	49,632	74,836	65,022	55,553	405,205
Qld	30,180	30,610	3,261	10,625	111,413	64,073	16,661	266,823
WA	20,749	24,820	41,012	4,736	68,993	43,248	5,460	209,018
SA	4,463	4,578	137	569	23,301	10,629	2,353	46,030
Tas	1,651	1,964	881	5,992	22,112	32,903	10,887	76,390
Murray Darling Basin	92,080	138,166	90,189	221,612	126,510	50,913	807,522	88,052
Australia	147,110	152,075	146,684	107,221	440,373	288,622	110,880	1,392,965
Source ABS (2010)								

Table 4. Assets, revenues and expenditure by water providers

Assets		**Revenue**	
State/Region	**Current replacement value ($A000)**	**Expenditure on maintain assets ($,000)**	**Revenue from irrigation ($A000)**
NSW	927,773	6,965	38,381
Vic	2,228,147	14,476	85,136
Qld	2,419,982	9,341	48,298
WA	386,000	967	7,890
SA	278,452	775	8,136
Tas	46,473	0	634
Murray Darling Basin	3,518,661	22,865	134,279
Australia	6,406,827	32,524	193,226
Source: ANCID (2007)			

4. Water Use and Charging for Water

Charging for water is directly related to both the issues raised above regarding the payment for assets and for goods (in this case water) provided by a water provider. There is a relationship between the charge levied by the water provider and the quantity of the good supplied. In Australia the quantity of good water supplied is to some extent not known. Farmers have an entitlement to a certain quantity of water each year, but received an allocation (or a proportion) of that, depending on the amount of water available. In other words, farmers' entitlements are a fixed share of a quantity of a good that varies sometimes quite greatly. In any one year, the result of calculating this share of the good is a farmer's allocation. Farmers pay for both the volume of water they receive and for the service of providing it. ANCID (2007) estimates that over nearly all of the surface water allocations, and most of the ground water extractions in Australia are metered. However, while efforts are in place to make farmers pay the full cost of water delivered, they do not repay the full capital costs of the service. This issue, while not discussed in this Section as the charge for repaying the capital outlays of the fixed assets is effectively zero, is important and will be raised in the following Section.

ANCID (2007) provides an interesting survey on the charging elements of the Australian irrigation system. It should be noted that every State does something different and within a State there is great variability amongst the individual schemes. In general, on average water users pay $73/ML, the highest being in Queensland at $105/ML and Victoria has the lowest charges at $41/ML in 2005-06. In the MBD the figure is closer to $53/ML in 2005-06. While all costs are not volumetrically based those that are generally low (they are included in other (see Table 5). Farmers pay a water entitlement charge (of $32/ML) regardless of the volume supplied, but the other charges are determined on a volume basis in many cases. It would appear that the costs of water a very low (see Table 5).

Table 5. Charges for water

State/ Region	Delivery charge	Water entitlement charge	Bulk water charge	Renewals charge	Environment charge	Other	Total
	($/ML)		($/ML)	($/ML)	($/ML)	($/ML)	($/ML)
NSW	16	32	3	11	0	11	73
Vic	7	9	3	2	1	20	41
Qld	12	46	7	31	0	9	105
WA	18	28	0	0	0	0	47
SA	13	0	0	35	0	32	80
Tas	40	0	0	0	4	6	50
Murray Darling Basin	15	22	6	0	0	10	53
Australia	16	32	3	11	0	11	73
Source: ANCIL (2007)							

Water pricing is only one side of the argument in a system that is as variable as it is in Australia. It should be asked are farmers getting what they pay for. ANCID (2007) suggests that across all schemes the entitlement is expected to be delivered in 93 years out of every 100 years (see Table 6). In the MDB is 97 years in 100, while in Victoria (the state with the most conservative allocation policy) it is also 97 years and 100. In New South Wales on the other hand, it is 53 years in 100. Taking an average over all years delivered, the reliability has been found to be 94 years 100, while in the MDB it is only 78 years in 100. In Victoria and New South Wales has been estimated to be approximately 93 and 67 years in 100, respectively. The system works reasonably well, with 97% of water delivered on time. It would appear that despite some delays in scheduling, farmers are getting water when they want it even if it is not in the quantities they might desire.

Finally, some reference must be made regarding water trading. While trading has played an important role in the Australian water market, in some way it is a measure of the discourse between what is supplied to producers and what they would really desire and need. The price water is also traded at most possibly more adequately reflects the value farmers place on the good. Australia has an active water market, one that was most active during the drought years when supplies were restricted. ANCID (2007) has estimated that approximately 116,000 ML of the 9.8 million ML of water delivered in 2005-06, was actually transferred on a permanent basis between users. In the MBD, 51,600 ML was traded on a permanent basis. It sold for an average of $911/ML, receiving a peak price of just over $1000/ML. In the MDB the price paid for permanent transfers were roughly $50/ML lower than the national average. Most water trading occurs on a temporary basis, where 435,655 ML was transferred temporarily in the MDB and just over 1 million ML Australia wide. Temporary water sold on average for $60/ML, but peaked at just under $130/ML in Australia (see Table 7). Most of the temporary water traded in Australia occurred internal, i.e. between users within a scheme. The external transfer of water (defined as being from one scheme to another) is a significant concern to the viability of many water providers. Maintaining canals and equipment is expensive and if significant water leaves the region, the ability to spread that cost evenly (at minimally) amongst users is lost, threatening the viability of the water providers.

Table 6. The Reliability of Service

State/Region	Stated water reliability (years/100)	Actual water delivery (years/100)	Entitlement delivered 2005-06 (%)	Difference in orders to delivery (days)	Proportion delivered on time (%)
NSW	53	67	69	3	98
Vic	97	93	93	3	94
Qld	99	71	68	2	100
WA	90	57	53	2	97
SA	99	73	69	0	100
Tas	na	na	na	na	na
Murray Darling Basin	97	94	96	3	97
Australia	93	78	76	3	97
Source: ANCIL (2007)					

Table 7. Water Trading 2005-06

State/ Region	Quantities transferred				Prices			
	Internal perm.	External perm.	Internal perm.	External perm.	Perm. average	Perm. Peak	Temp. average	Temporary Peak
	(ML)	(ML)	(ML)	(ML)	($/ML)	($/ML)	($/ML)	($/ML)
NSW	5,644	1,362	145,233	86,881	607	750	53	150
Vic	17,155	27,206	117,213	98,414	1,073	1,159	79	160
Qld	3,329	na	109,354	na	na	an	na	na
WA	674	1,800	2,559	-8,200	104	215	7	9
SA	526	302	3,220	-9,522	1,300	1,400	38	80
Tas	0	0	0	0	0	0	0	0
Murray Darling Basin	22,722	28,870	259,907	175,748	911	1,001	46	83
Australia	54,656	61,340	755,158	335,146	853	953	60	129
Source: ANCIL (2007)								

5. Water Charging Policies and Strategies

An overriding characteristic of the Australian irrigation system is that it is generally State owned (in one form or another). Of the 2.8 million ha that could potentially be irrigated, a reasonable amount (approximately 1.26 million ha) would appear to be supplied by private or autonomous authorities. However, these authorities only have an entitlement to 28% of the water supplied, or 2.9 million ML of the 13.3 million ML (ANCID 2007). An over reliance on state-based systems has two (among many) interesting elements to it. First, its origin can be placed very early on in the development of irrigation in Australia. Irrigation schemes were first established as a set of private trusts, which promptly were found to be unviable. The State took them over, assuming its debts in order to promote the objectives of regional development (Davidson 1969). In later years the State involvement continued for the same reasons: promoting regional development. Second, from a financial perspective the State has not tried to reclaim the fixed cost of capital in the schemes, something that continues today with the Northern Victorian Irrigation Modernisation Program, where $2 billion will be spent. Thus, the provision of irrigation infrastructure (in cases where little if any attempt is made to recover the capital costs) represents a transfer (or gift) from tax payers to those who directly benefit from its provision. While governments had the power and moral right to enact such transfers, they should be accompanied by an impact statement where the transparency of the transaction can be revealed. Ultimately, there is no such thing as 'a free lunch'.

Complicating this lack of transparency in funding infrastructure has been the fact that, until recently Governments in Australia had made no attempt to recoup the full cost of supplying water services. Maintenance and operating expenditures were not paid for by farmers. In Coleambally it was noted anecdotally at a stakeholders meeting that farmers favourite hobby after attempting to minimise their tax bill, is to rort their water bill. When Coleambally was privatised, the supply company went to great lengths to make sure farmers paid for their water. It should be noted, however, that this issue is being addressed with the development of the National Water Initiative Pricing Principles, which were agreed to by all State Governments in 2004 (Australian Government 2010). These principles include:

- The promotion of the sustainable economic use of all water resources, water infrastructure assets and government resources devoted to water management.
- Ensuring sufficient revenue streams to allow for the efficient delivery of water.
- Facilitating the efficient functioning of water markets.
- Applying the principles of user pays and transparency.

Most states have moved to implement these arrangements. For instance, in New South Wales the government has placed water pricing in the hands of an independent tribunal (IPART 2010). However, the one sticking point would appear to be in facilitating the operation of water trading.

The benefits of water trading, while well-known, have not been fully realised. While water can now move to its most productive uses, away from degraded regions and (during a drought) provide a measure of security to those producers who require it, at a cost. The problem with water trading lies in the fact that water providers have high fixed costs of maintenance that are not passed on when the water is trade outside the region. Hence, water providers, with the agreement of governments, have implemented extensive rules on the amounts that can be traded, with whom water can be traded and where water can be traded. So much so that the amounts traded, even in a drought, are pathetically low. Allowing water to cross a State border is virtually impossible and such restrictions are subject to a High Court challenge as they possibly violate Section 92 of the Constitution that trade between the States must remain free. These restrictive practices while the results of the inherent market failures of irrigation systems (see Davidson 2004) greatly impede the efficiency in the system.

The problems of financing and charging for irrigation services have been subsumed by the much greater problems regarding the drought and the supply of water to the environment. These concerns were most recently circulated in a report by the MDB Authority (2010). The intention is to reduce irrigator's entitlements by between 27% and 37% in the MDB. This task would seem from afar to not be that difficult, as many efficiency improvements have already been made and farmers have already adjusted to reduced allocations from the drought. However, this argument has been raging for the past 20 years. It is based on the relevant point that water is over allocated (especially in New South Wales) and that the environment, as a consequence, has suffered. To address these concerns the Coalition of Australian Governments first introduced a flexible CAP on water extractions, setting a flexible target of 11,000 GL of water in the MDB. They also allowed water trading to occur.

Measures such as the CAP and water trading have not satisfied the environmental lobby. They wish to see better river health outcomes, which at an extreme level could be broadly defined to mean over bank flooding. The problem with the environmental lobby's argument is it that little is known about both the price of environmental services and the environmental functions of rivers, especially over the large distances involved in Australia. Work by Davidson and Kennedy (forthcoming) would suggest that something is wrong with the data used to measure environmental river health and its relationship to the flows of rivers. Making policy prescriptions in such a situation is not an ideal way to proceed.

It is also surprising to find that the Chair of the MDB Authority (Dr. Mike Taylor, pers.com. 8 October 2010) admitted that the weak point with respect to the new plan for the MDB is the socio-economic modelling. This is surprising given that many of the developments that occurred were based on the need to develop regions. In addition, no expense has been spared on conducting numerous socio-economic surveys of the region (for instance The Living Murray program). The simple equation farmers are using to object to the plan, in which 'water to agriculture equals jobs', would seem to be entirely suspect. This is especially the case, given that the MDB is just experience its longest drought and water shortage on record. Surely the jobs in towns that once existed have already gone. Also, it could be argued that when the opposite was true, (when money was being invested at a loss in irrigation) the opposite claim of regional job losses in cities was not made. Such claims are usually made by quoting some Input Output analysis, where the benefits are double counted and the costs are ignored.

6. Concluding Remarks

In this paper two issues were presented, each possibly inadequately delivered given the nature of irrigation in Australia. The first was to provide an audit of irrigation, with some emphasis on the financial elements and charging methods that are applied. In many forums, such as the ICID Australia is held up as an ideal example of how the irrigation world should conduct its affairs. This status Australia enjoys is built on a number of unique attributes, such as the extent to which water quantities are accounted for and volumetric charging. These attributes have resulted in a data base that is extensive, comprehensive and in many cases up to date. However, such data is worthless if it is not used to address the concerns of stakeholders in the system. The second issue addressed was to reveal some of the issues currently facing policymakers. These issues ultimately go to the heart of charging for a service and to the economics of irrigation. The challenge facing irrigation stakeholders is to improve the transparency of charging from the already high levels that currently exist (with volumetric charging and allowances the fixed costs). In particular, the transparency of the government funded provisions of infrastructure needs to be improved. At another level, the economic evaluation of environmental functions of rivers also needs to be improved. In this case, not only is the price of environmental factors not known, the quantities are equally unknown. Finally, water markets need to be allowed the freedom to operate to their best ability. In doing so it should be noted that this will not only affect the recognised problems farmers face in adjusting to changing circumstances, but also to the hidden and most possibly substantial cost water providers also face. Australia's reputation as this ideal example which the world should follow, sounds hollow and undeserved if it does not attempt to investigate and resolve the considerable problems it faces. Underlying this investigation should be a detailed financial investigation of both the farming sector and the State's contribution to the irrigation sector. This latter point (the need for a transparent impact study on government expenditure on irrigation infrastructure) is something that is needed more today than at any time in the past. Until that investigation is undertaken, Australia's reputation in this business is built on a set of false premises.

7. References

ABS (2010). Water Use on Australian Farms: 2008-09. Canberra, Australian Bureau of Statistics: 52.

Australian Government (2010) National Water Inititive: Pricing principles. Environmnet Department. www.environmnet.gov.au/water/publications/action/nwi-pricing-principles.html, accessed 8 October 2010.

ANCID (2007). Benchmarking Data Report for 2005/2006: Key Irrigation Industry Statistics and Performance Indicators. Australian Irrigation Water Provider Industry Benchmarking Report. Torrens, ACT.

Davidson, B. R. (1969). Australia wet or dry?: The physical and economic limits to the expansion of irrigation. Carlton, Victoria, Melbourne University Press.

Davidson, B. (2004). The Problems of Analysing Markets for Irrigation Water. 46th Annual Conference of the Australian Agricultural Economics and Resource Society. Melbourne: 28.

Independent Pricing and Regulatory Tribunal (2010). Review of bulk water charges for State Water Corporation. Water-Final report Sydney, New South Wales Government, Sydney.

Kennedy, A. and Davidson, B. (forthcoming) The significance of the relationship between river flows and river health, in preparation.

Murray-Darling Basin Authority (2010) Guide to the proposed Basin Plan: Overview, Report no. 60, Canberra.

❖❖❖❖❖

Table A-1. Australian Irrigation Schemes: Location, Age and Physical Size

Name	State	In MDB	Area			Water Used			Major Crops Grown	
		(n=north, s=south	Year Est. (date)	Scheme (ha)	Planted 2005-06 (ha)	Entitlement (ML/year)	Delivered 2005-06 (ML)	2005-06 propn (%)		
Coleambally	NSW	S	1963	95,153	70,577	497,892	450,586	90	Rice	Annual Pasture
Murray Irrigation	NSW	S	1932	748,000	190,000	1,444,152	1,642,345	114	Rice	Annual Pasture
West Corurgan	NSW	S	1969	212,000	15,642	80,928	57,409	71	Winter Cereal	Summer Crop
Western Murray	NSW	S	1912	4,337	3,764	61,268	29,305	48	Vines	Citrus
Trangie Nevertire	NSW	N	1971	21,450	5,955	68,901			Cotton	Lucerne/Pastures
Diverters: Murrumbidgee	NSW	S	1912			1,829,108	1,596,863	87		
Diverters: Gwyder	NSW	N	1973			536,874	218,496	41	Cotton	
Diverters: Hunter	NSW		1958			200,305	157,052	78	Pastures	
Diverters: Lachlan	NSW	S	1935			689,416	112,436	16	Wheat	
Diverters: Macquarie	NSW	N	1966			619,892	180,590	29	Cotton	
Diverters: Namoi	NSW	N	1960			264,353	141,325	53	Cotton	
Diverters: Murray	NSW	S	1936			708,142	380,122	54		
SW Barker-Barambah	QLD		1988	8,590	8,590	33,721	19,510	58	Broad Acre Crops	Cotton/Viticulture
SW Bowen Broken	QLD		1983	400		5,736	522	9	Pasture	Lucerne
SW Boyne River	QLD		1982	3,255	3,255	14,190	2,792	20	Citrus	Dairy
SW Bundaberg	QLD		1970	59,200		187,575	128,506	69	Sugar cane	Macadamias
SW Burdekin-Haughton	QLD		1953	45,850		609,159	617,176	101	Sugar Cane	Small Crops
SW Callide Valley	QLD		1965	2,000	2,000	18,260	8,139	45		
SW Central Lockyer	QLD		1987	10,850		3,985	5,180	130	Vegetables	Lucerne
SW Chinchilla Weir	QLD	N	1974	700		2,868	1,693	59	Cereal Crop	
SW Cunnamulla	QLD	N	1991	420		2,476	2,053	83	Cotton	Small Crops/vineyards
SW Dawson Valley	QLD		1926	7,529	7,529	52,567	44,790	85	Cotton	Lucerne
SW Eton Water	QLD		1975	14,500	14,500	51,387	28,549	56	Sugar Cane	Lucerne

Name	State	In MDB	Area			Water Used			Major Crops Grown	
		(n=north, s=south	Year Est. (date)	Scheme (ha)	Planted 2005-06 (ha)	Entitlement (ML/year)	Delivered 2005-06 (ML)	2005-06 propn (%)		
SW Logan River	QLD		1995	3,996		13,598	2,415	18	Dairy	
SW Lower Fitzroy	QLD		1995	200	200	3,101				Dairy
SW Lower Lockyer	QLD		1970	4,500		11,200	43	0	Vegetables	
SW Macintyre Brook	QLD	N	1968	2,050		17,317	8,527	49	Mixed cropping	Small crops
SW Maranoa River	QLD	N	1984	20		798	41	5	Small Crops	Mangoes
SW Mareeba-Dimbulah	QLD		1953	30,000	18,000	152,113	118,364	78	Sugar Cane	Tree crops
SW Mary River	QLD		1964	19,110	6,190	41,146	22,112	54	Sugar cane	Cereal Crops
SW Nogoa Mackenzie	QLD		1968	26,000	26,000	165,333	183,978	111	Cotton	Various small crops
SW Pioneer River	QLD					46,526	12,875	28	Sugar cane	Various small crops
SW Proserpine	QLD		1990	7,800	7,800	39,965	24,127	60	Sugar cane	Grape Vines
SW St George	QLD	N	1953	16,119	12,000	71,703	109,038	152	Cotton	Forage crops
SW Three Moon Creek	QLD		1982	2,268	2,268	14,064	7,543	54	Lucerne	Dairy/Viticulture
SW Upper Burnett	QLD		1968	3,440	3,440	28,540	21,089	74	Citrus	Sorghum
SW Upper Condamine	QLD	N	1965	25,000		30,363	13,334	44	Cotton	Dairy
SW Warrill Valley	QLD		1961	8,170		20,463	796	4	Vegetables	
Pioneer Valley	QLD		1997	22,000	9,900	46,414	13,646	29	Sugar Cane	Vegetables
North Burdekin	QLD		1965	48,530	26,222	160,000			Sugar Cane	Vegetables
South Burdekin **	QLD		1966	27,450	15,658		75,979		Sugar Cane	Cotton
Diverters: Queensland	QLD	N	1975			280,715			Sugar	Potatoes
Angas Bremer	SA		1995	8,200	7,800	36,636	15,646	43	Grapes	Grapes
South East Region (SA)	SA		1998	80,000	80,000	743,536			Pasture / pasture seed	Citrus
Central Irrigation	SA	S	1910	15,000	13,564	152,869	107,635	70	Grapes	Vines
Sunlands	SA	S	1961	898	796	8,963	7,279	81	Citrus	Landscapes
Barossa Valley Area	SA			46,000		10,813			Grapes	Peas
Cressy-Longford	TAS		1972	14,667		8,299			Annual pasture	Orchards

Name	State	In MDB	Area			Water Used			Major Crops Grown	
		(n=north, s=south	Year Est. (date)	Scheme (ha)	Planted 2005-06 (ha)	Entitlement (ML/year)	Delivered 2005-06 (ML)	2005-06 propn (%)		
South East (TAS)	TAS		1986	15,077	1,977	3,553	2,631	74	Garden Salads	Potatoes
Winnaleah	TAS		1986	6,231		3,370			Annual pasture	Citrus
First Mildura	VIC	S	1887	7,755		82,915	50,985	61	Vines	Annual pasture
G-MW Murray Valley	VIC	S	1939	122,457	63,000	273,657	444,177	162	Perennial pasture	Annual pasture
G-MW Shepparton	VIC	S	1910	82,460	43,981	182,685	251,318	138	Perennial pasture	Annual pasture
G-MW Central Goulburn	VIC	S	1891	172,131	94,482	460,873	534,830	116	Perennial pasture	Annual pasture
G-MW Rochester	VIC	S	1912	117,066	70,240	245,972	305,355	124	Perennial pasture	Perennial pasture
G-MW Pyramid-Boort	VIC	S	1912	186,481	86,948	231,664	292,922	126	Annual pasture	Annual pasture
G-MW Torrumbarry	VIC	S	1905	173,366	83,510	357,885	696,355	195	Perennial pasture	Vines
G-MW Swan Hill Pumped	VIC	S	1920	8,518	4,900	37,561	24,344	65	Stone fruit	Permanent pasture
G-MW River Diverters	VIC	S	1890	53,583		705,872			Annual pasture	Orchard
SRW Bacchus Marsh	VIC		1914	1,812		3,661	4,173	114	Vegetables	Annual pasture
SRW Macalister	VIC		1926	55,000	36,100	145,274	244,896	169	Permanent pasture	Various
SRW Werribee	VIC		1914	3,275	3,275	13,000	11,696	90	Vegetables	Fruit
Gascoyne Irrigation	WA		1971	2,000	960	13,950	10,000	72	Vegetables	Trees
Ord Irrigation	WA		1963	13,500	13,500	335,000	250,000	75	Cane	Annual pasture
Harvey Water	WA		1915	112,000	7,713	108,736	99,301	91	Perennial pasture	Cotton

Table A-2. Crops irrigated in Australia 2008-09

Crop	No. of businesses		Area		Water	
	Total Australia	No. irrigating	Total Australia	Irrigated	Volume applied	Application rate
	(no.)	(no.)	(ha)	(ha)	(ML)	(ML/ha)
Pasture grazing	80949	12632	60429340	418750	1336980	3.19
Pasture Hay	25873	5042	739614	99490	362804	3.65
Pasture silage	8519	1325	296950	33802	101371	3.00
Pasture seed	1615	696	135835	39721	179515	4.52
Cereal hay	14739	838	810528	23240	57457	2.47
Cereal grain	36081	2305	20925049	292722	823556	2.81
Cereal other	12147	1009	1062644	24601	54254	2.21
Rice	161	161	7194	7194	101474	14.11
Sugar	4130	1984	417302	191865	761086	3.97
Cotton	498	446	158715	141923	880003	6.20
Other broadacre	15265	922	3385103	51800	144683	2.79
Fruit	9732	6627	172773	128046	597535	4.67
Vegetables	5832	4651	114982	99583	420181	4.22
Vegetable seed	930	425	9221	5027	12912	2.57
Nurseries	3253	2645	17250	12904	65425	5.07
Vines	8307	7615	179270	172344	543252	3.15

3.3 Policy and Strategies on Financing Water and Implementation of Water Use Charging Systems for Irrigation in South Africa [1]

1. Introduction

The consecutive phases of irrigation development in South Africa and changes in public policy coincided with different phases of economic development: Private irrigation schemes were dominant during the agricultural phase up to 1875. Co-operative schemes were implemented during the agricultural-mining phase thereafter. Government settlement schemes below public storage dams were promoted after 1920 during the agricultural-mining-industrial phase. Smallholder irrigation schemes in particular were established since the 1950s. Different political, social and economic objectives gave direction to irrigation development. These included the settlement of people in rural areas; providing alternative livelihood opportunities; supporting food production under irrigation; and improving economic welfare. The change in the area under irrigation over all these phases is shown in Table 1. Since about the 1980s the maturing phase of the water economy has been reached with amongst others increasing demand for water, intensive competition between all uses, pressing externalities caused by pollution and obsolete condition of dam and canal infrastructure. More recently, especially after 1997, the emphasis in water resource management has therefore shifted from supply to demand management (Backeberg and Groenewald, 1995; Backeberg, 1995; Backeberg, 1997).

Table 1. Change in the area under irrigation on Private Irrigation Schemes (PIS), Irrigation Board Schemes (IBS) and State Water Schemes (SWS) between 1910 and 1990

Year	1910		1924		1965		1990	
Scheme	Hectare	%	Hectare	%	Hectare	%	Hectare	%
PIS	207 369	89.6	171 380	53.8	308 483	41.9	781 586	63.5
IBS	18 852	8.2	128 535	40.3	216 795	29.4	240 015	19.5
SWS	5 141	2.2	18 852	5.9	211 654	28.7	209 243	17.0
TOTAL	231 362	100.0	318 767	100.0	736 932	100.0	1 230 844	100.0
Source: Backeberg, 1994; Backeberg, 2002								

2. Overview of Irrigation Agriculture

The total renewable water resources in 19 water management areas amount to 49 040 million m3 per year in 2000. Of this total 65% or 32 412 million m3 per year is stored in dams (see Table 2). The available yield is mainly sourced from surface water (78%) and less so from groundwater (8%), with return-flow (14%) from all uses contributing a substantial volume (see Table 3). The water requirements in 2000 were estimated to be spread as follows between the major uses at a standardized 98% assurance of supply: Irrigation 62%; domestic 27%; mining, industrial and power 8%; afforestation 3% (see Table 4).

With a total agricultural land area of 102.8 million ha, the arable land is 16.74 million ha (Nieuwoudt and Groenewald, 2003). Rain-fed farming is undertaken where rainfall is higher than 500mm per year. The total irrigated land is 1,676 million ha, based on registered water use (Backeberg and Reinders, 2009). The average water allocation is 7 700m3 per ha, which varies from 6 000 to 15 000 m3 per ha. The crops under irrigation are shown in Table 5, and it is clear that 90% of fruit and vegetables are produced under irrigation for local and export markets. The primary contribution of agriculture to the economy is relative low at 2-3% as is typical of an industrialised economy. When considering the backward and forward linkages, this contribution increases to 20-30% (Fényes and Meyer, 2003). Water use for irrigation must therefore be analysed from a perspective of value adding in the total food chain, as well as the business and employment opportunities which this creates.

[1] Gerhard R Backeberg, Water Research Commission, Pretoria; Worskhop on ICID Task Force, 12 October 2010, Yogyakarta, Indonesia

Table 2. Natural mean annual runoff and the ecological reserve (million m3/a) and storage in major dams (million m3)

Sl. No.	Water management area	Natural mean annual runoff	Ecological reserve	Storage in major dams
1.	Limpopo	986	156	319
2.	Luvuvhu/Letaba	1 185	224	531
3.	Crocodile West and Marico	855	164	854
4.	Olifants	2 040	460	1 078
5.	Inkomati	3 539	1 008	768
6.	Usutu to Mhlatuze	4 780	1 192	3 692
7.	Thukela	3 799	859	1 125
8.	Upper Vaal	2 423	299	5725
9.	Middel Vaal	888	109	467
10.	Lower Vaal	181	49	1 375
11.	Mvoti to Umzimkulu	4 798	1 160	827
12.	Mzimvubu to Keiskamma	7 241	1 122	1 115
13.	Upper Orange	6 981	1 349	11 711
14.	Lower Orange	502	69	298
15.	Fish to Tsitsikamma	2 154	243	739
16.	Gouritz	1 679	325	301
17.	Olifants/Doring	1 108	156	132
18.	Breede	2 472	384	1 060
TOTAL FOR SOUTH AFRICA		49 040	9 545	32 412
Source: National Water Resource Strategy, 2004				

Table 3. Available yield in year 2000 (million m3/a)

Sl. No.	Water management area	Natural Resource		Usable return flow			Total local yield
		Surface water	Ground water	Irrigation	Urban	Mining and bulk industrial	
1.	Limpopo	160	98	8	15	0	281
2.	Luvuvhu/Letaba	244	42	19	4	0	310
3.	Crocodile West and Marico	203	146	44	282	41	716
4.	Olifants	410	99	44	42	14	609
5.	Inkomati	816	9	53	8	11	897
6.	Usutu to Mhlatuze	1 019	39	42	9	1	1 110
7.	Thukela	666	15	23	24	9	737
8.	Upper Vaal	598	32	11	343	146	1 130
9.	Middel Vaal	(67)	54	16	29	18	50
10.	Lower Vaal	(54)	126	52	0	2	126
11.	Mvoti to Umzimkulu	433	6	21	57	6	523
12.	Mzimvubu to Keiskamma	777	21	17	39	0	854
13.	Upper Orange	4 311	65	34	37	0	4 447
14.	Lower Orange	(1 083)	24	96	1	0	(962)
15.	Fish to Tsitsikamma	260	36	103	19	0	418
16.	Gouritz	191	64	8	6	6	275
17.	Olifants/Doring	266	45	22	2	0	335
18.	Breede	687	109	54	16	0	866
19.	Berg	403	57	11	37	0	505
	TOTAL FOR COUNTRY	10 240	1 088	675	970	254	13 227

Table 4. Water requirements for the year 2000 (million m3/a)

Sl. No	Water management area	Irrigation	Urban	Rural	Mining and bulk industrial	Power generation	Afforestation	Total requirements
1.	Limpopo	238	34	28	14	7	1	322
2.	Luvuvhu/Letaba	248	10	31	1	0	43	333
3.	Crocodile West and Marico	445	547	37	127	28	0	1 184
4.	Olifants	557	88	44	94	181	3	967
5.	Inkomati	593	63	26	24	0	138	844
6.	Usutu to Mhlatuze	432	50	40	91	0	104	717
7.	Thukela	204	52	31	46	1	0	334
8.	Upper Vaal	114	635	43	173	80	0	1 045
9.	Middel Vaal	159	93	32	85	0	0	369
10.	Lower Vaal	525	68	44	6	0	0	643
11.	Mvoti to Umzimkulu	207	408	44	74	0	65	798
12.	Mzimvubu to Keiskamma	109	99	39	0	0	46	374
13.	Upper Orange	780	126	60	2	0	0	968
14.	Lower Orange	977	25	17	9	0	0	1 028
15.	Fish to Tsitsikamma	763	112	16	0	0	7	898
16.	Gouritz	254	52	11	6	0	14	337
17.	Olifants/Doring	356	7	6	3	0	1	373
18.	Breede	577	39	11	0	0	6	633
19.	Berg	301	389	14	0	0	0	702
TOTAL FOR COUNTRY		**7 920** **62%**	**2 897** **23%**	**574** **4%**	**755** **6%**	**297** **2%**	**428** **3%**	**12 871**

Source: National Water Resource Strategy, 2004

Table 5. Estimated contribution of irrigation to commercial crop production in South Africa

Crop	Area irrigated		Production	
	X 1 000 ha	% of total area planted to this crop	X 1 000 t	% of national production
Maize	110	3	660	10
Wheat	170	12	740	30
Other small grains	52	3	200	6
Potatoes	39	70	1 200	80
Vegetables	108	66	1 330	90
Grapes	103	90	1 300	90
Citrus	35	85	1 100	90
Other fruits	95	80	1 200	90
Oilseeds	54	10	108	15
Sugarcane	60	15	4 000	25
Cotton (lint)	18	17	17	42
Tobacco	12	85	20	90
Lucerne	203	70	1 600	80
Other pastures and forages	104	15	800	25

Source: Backeberg, et al., 1996

Medium to large-scale commercial farming takes place on irrigation schemes that vary in size from 500 to 30 000 ha (Backeberg, 1994). Small-scale and mainly subsistence farming for supplementary food production is found on irrigation schemes with a size of as small as 5 ha to 1 500 ha (Denison and Manona, 2007). These smallholder schemes are currently limited to 3% of the total irrigated land. The main irrigation technologies which are applied on all these schemes are sprinkler, flood, micro and drip irrigation (see Table 6).

Table 6. Changes in total area under irrigation and method of irrigation in South Africa between 1990 and 2007

Year	Area	Method of irrigation		
		Flood	Sprinkler	Micro/drip
	ha	%	%	%
1990	1 290 132	32.8	54.4	11.8
2007	1 675 882	14.4 (23.3)	54.9	21.8
Source: Backeberg and Reinders, 2009				

Irrigation farming is undertaken by two broad categories of farmers: Modern commercial operations by an estimated 40 000-45 000 farmers; and traditional, subsistence activities by an estimated 200 000-250 000 farmers (Backeberg, 2006). The farmer typologies vary from a diverse group of smallholder farmers, to medium sized family operated farms to large-scale company farms (Denison and Manona, 2007; Van Averbeke, 2008; Vink and Van Rooyen, 2009).

3. Water Policy and Strategies

Public policy, the legal framework and strategies for implementation of a range of measures for equitable, efficient and sustainable water management are guided by the National Water Policy (DWAF, 1997), National Water Act (RSA, 1998) and National Water Resources Strategy (DWAF, 2004). Major changes which have occurred and continue to receive attention are first registration of irrigation water use for the purpose of levying water use charges, second compulsory licensing and water allocation reform to achieve a re-apportionment of water use entitlements to the benefit of smallholder and emerging commercial farmers; and third establishment of Catchment Management Agencies (CMAs) and Water User Associations (WUAs) together with irrigation management transfer from government authorities to farmer level responsibility.

In the context of the discussion on financing water and implementation of water use charging systems, certain key aspects of water use and water demand management will be highlighted (DWAF, 2004): According to Section 21 of the National Water Act there are different types of water use. For the purpose of irrigation the most important are abstracting water, storing water and disposing of waste in water. Authorising water use is by means of a transitional arrangement of existing lawful water use, based on a two year period prior to promulgation of the Nation Water Act of 1998. Eventually all water use for irrigation will have to be licensed, either through individual application or in general through compulsory licensing and all applications are evaluated in terms of specific requirements as determined by Section 27 of the Nation Water Act (NWA).

The process of compulsory licensing was specifically designed to correct the current unequal allocation of water use entitlements. The criteria for assessing compulsory licensing are set out in Section 43(1) of the NWA and the process involves the following (DWAF, 2004):

- The lawfulness of existing use must first be verified;
- The responsible authority (i.e. the Department of Water Affairs) issues a call for licensing to registered users, but must identify other prospective users, especially from marginalized or disadvantaged groups, who have not previously had access to water resources because of racially discriminatory legislation, to ensure that water is allocated fairly.
- The existing users and prospective users must submit license applications which are evaluated by the responsible authority.

- The water requirements based on application and claims for licensing are reconciled with water availability and possible solutions are developed to find a balance between requirements of the reserve, water quality, application for and availability of water.
- The proposed allocation schedule is published for comment by all interested and affected persons.
- The objections and comments must be considered, where after a preliminary allocation schedule is prepared, with the right to appeal to the Water Tribunal by those whose application or claims were unsuccessful.
- The final allocation schedule is published in the Government Gazette.

As part of the implementation of the National Water Resource Strategy (NWRS) (DWAF, 2004) various interventions are considered to reconcile demand with supply. These include the following:

- Demand management – implementing cost recovery through consumer tariffs and user charges to influence the behaviour of water users and to install technologies which reduce waste and losses of water such as undetected leakages.
- Resource management – regulation of streamflow through storage; control of abstractions and releases; and assessment of the groundwater resource at specific localities.
- Re-use of water – recycling of return flows and treatment of water.
- Control of alien invasive vegetation – clearing of invading alien vegetation and controlling the spread of such vegetation to increase surface runoff.
- Re-allocation of water – enabling gradual transfers between use sectors with differential benefits through compulsory licensing, supported by water demand management and trading of water use authorizations.

It is specifically stated that the NWA (1998) does not make provision for water conservation and demand management (WC&DM) but that the definition of conservation makes these measures an essential component of water resource management (DWAF, 2004). WC&DM "relates to the efficient and effective use of water and the minimization of loss and wastage of water". However, water demand management is not only about reducing water use. Water users must understand the economic value of water as a scarce resource; and respond to incentives to save water which is then available for allocation to other uses. Sustained reduced consumption of water can lead to postponement of new capital infrastructure and delay increases in the cost of water supply. Finally, demand management can improve the financial independence of organizations such as water user associations (WUA) by balancing the budget through increased revenue collection and reduced unaccounted water and non-payment by users or consumers.

The WC&DM strategy for agriculture provides a framework for "regulatory support and incentives designed to improve irrigation efficiency …. in order to increase productivity and contribute to reducing income inequalities among people supported by farming activities". A plan of action is envisaged which must present the following strategic outputs:

- appropriate measures that reduce wastage of water
- progressive modernization of water conveyance, distribution and application infrastructure, equipment and methods
- preventative maintenance programmes
- water allocation processes that promote equitable and optimal utilisation of water
- generation of sufficient irrigation information which is accessible to all stakeholders
- implementation of water audits from the water source to the end user.

Regarding the above-mentioned water allocation processes it is necessary to refer to statements on transfer and trading of water use licences: According to the National Water Policy (DWAF, 1997) markets or trade in "water use allocations" can be considered as an option in future, but will be subject to varying degrees of control. Transfers of water use authorisation (DWAF, 2004) are dealt with in terms of Section 25 of the NWA (1998) under two circumstances: First, temporary transfers of water authorised for irrigation are either on the same property for a different use or to another property for the same or a similar use. In general these transfers are for one year only, with the option for extension of a further year, and applications for permission must be submitted to the water management organisation that has local jurisdiction. Second, permanent transfers involve one user offering to surrender all or part of an allocation to another prospective user. These types of transfers constitute a trade in water use authorisations which must be preceded by a licence application and are subject to all relevant requirements of the NWA. Permanent transfers must be approved by the responsible authority, may be attached with different conditions and the transfer only becomes effective when the new licence is granted. Both temporary and permanent transfers will only be permitted where the original and new water use are from the same water source. Adequate water and the required infrastructure must make it possible to physically deliver the water at different localities.

Under the part in the NWRS dealing with water pricing, water trading is discussed under the heading of achieving equitable and efficient allocation of water (DWAF, 2004). Three points must be highlighted: (a) trade in water use entitlements can promote the shift from lower to higher value uses but are always subject to a balancing of the public interest with the private interest of the water users participating in the trade; (b) the quantity, quality and assurance of supply of the authorised water use which is traded across water use sectors will be carefully considered before permission is granted; (c) regulations will be introduced which specify the conditions of trade, but over the interim period applications must be made in terms of provisions of the NWA (Backeberg, 2007).

4. Water Use Charging Systems

The National Water Act (1998) empowers the Ministry of Water Affairs in consultation with the Ministry of Finance to establish a "pricing" strategy in terms of Section 56 of the Act. Provision is made for amongst others the following types of water use charges (DWAF, 2004): "1. Funding water resource management: Activities such as information gathering, monitoring water resources and controlling their use, water resource protection (including waste discharge and the protection of the Reserve) and water conservation. 2. Funding water resource development and use of waterworks: The costs of the investigation, planning, design, construction, operation and maintenance of waterworks, pre-financing of development, a return on assets and the costs of water distribution. Resource management and resource development charges are financial charges, which are directly related to the costs of managing water resources and supplying water from schemes and systems."

The strategy on water use charges refers to all above-mentioned water use sectors. The water resource management charged is based on annual costs of catchment management. The water resource development charge is based on annual depreciation costs and a 4% rate of return on the depreciated replacement value. The water use charge is based on budgeted annual operation and maintenance (O&M) costs of waterworks. There are two broad applications of water charges in the irrigation sector: In the case of government water schemes the charges consist of depreciation and O&M costs. In the case of all other waterworks, the full financial costs including the servicing of loans are recovered. The charges to recover costs of water supply schemes are based on the volume of water used and fixed and/or variable charges may be applied.

Financial assistance is available for the emerging farmers for constructing or refurbishment of waterworks by providing subsidies on capital costs. O&M charges for water supplied to emerging farmers is also subsidised at a reducing scale over 5 years. The inclusion of depreciation in the charge will be phased in over a period appropriate to each case.

In summary the objectives of the water use charging system is cost recovery and in principle this is based on capital and O&M costs. The collection of charges is decentralised to CMAs and WUAs (Backeberg, 2006). Although the water use charges are calculated per m3 water, in practice the charges are levied on an area basis according to the authorised water use per ha. This practice largely defeats the purpose of promoting water use efficiency and crop productivity. Furthermore, effective water savings will only be achieved if levying of water use charges are accompanied by trading of water use entitlements. In practice this is also not taking place, since most applications for legal transfers to accomplish efficiency have not been approved recently because of equity considerations. Although the objective is full cost recovery, it is not linked to fiscal impact analyses and therefore involves some degree of double charging. Finally, it must be noted that reference is made to a “pricing” strategy which covers both charges for water use and trading of water use entitlements.

5. Case Study of the Vaalharts Irrigation Scheme

The Vaalharts irrigation scheme is located in the Northern Cape and North West Provinces and was constructed during the Great Depression of the 1930s. Water is abstracted by a weir on the Vaal river and gravity fed by concrete lined canals with a total length of 100km for the main canal and 180km for feeder canals to the irrigation scheme. The scheduled area of the Vaalharts scheme is 29 181 ha and the adjoining Taung scheme is 6 424 ha, with a water use authorisation of respectively 9 140 m3/ha and 8 470 m3/ha (Van Vuuren, 2009 & 2010). The main field crops are wheat, oats and peas grown in winter in rotation with cotton, groundnuts, maize and potato in summer. Lucerne for hay is also a major crop while the area under canola, pecan nut and citrus fruit orchards is gradually expanding. The typical farm size is 80 ha (three plots of 25.7 ha) and a total of 385 full-time commercial farmers are active in the scheme.

After transformation a WUA was established in 2003 with water control officers managing the scheme and reporting to a board representing farmers. Water is ordered on a weekly basis and water release is measured per farm. For the 2009/10 water year the total water use charges amount to R1 343 per ha. These consist of a water management charge of 0.87c/m3; a water development charge of 1.08 c/m3; a water use charge of 12.70098 c/m3; and a water research levy of R3.96 per ha (Benadé, 2010; Harbron, 2010). The main issue requiring attention in future is refurbishment of the canal system. Funds to the amount of R40 and R45 million for rehabilitation of the Vaalharts and Taung schemes respectively have been budgeted by the Department of Agriculture, Forestry and Fisheries (Morani, 2009). This involves upgrading and further developing the infrastructure on the schemes.

6. Conclusion

In order for implementation of water use charges to be successful, a number of changes are required. These are mainly effective water measurement and introducing some form of volumetric charging, preferably through a two-part charging system (Nieuwoudt and Backeberg, 2010). Regulations are currently being formulated which will govern water metering on irrigation schemes and farms. In addition the correct level of water use charges will only be determined if fiscal impact analyses are completed per irrigation scheme. A proposal in this regard has been made (Backeberg, 2010) and will hopefully be considered by officials in the Department of Water Affairs.

Future priorities which must receive attention are to ensure that clear incentives are provided for efficient water use and encouraging water savings per farm, irrigation scheme and agriculture as a whole. This will have to be accompanied by secure water use entitlements and water allocation reform to achieve a more equitable distribution of water use between commercial, emerging and subsistence farmers. Settlement of additional smallholder farmers will also have to be supported by access to markets and finance as well as training and extension services. The main focus should therefore be on both investments in human and physical capital to improve productivity of water use for food production together with a moderate expansion of the area under irrigation.

7. References

Backeberg, G.R. (1994). The Political Economy of Irrigation Policy in South Africa, PhD Thesis, University of Pretoria, (in Afrikaans).

Backeberg, G.R. (1995). Towards a market in water rights: A pragmatic institutional economic approach. Discussion paper submitted to the Department of Water Affairs and Forestry. Land and Agriculture Policy Centre: Johannesburg.

Backeberg, G.R. (1997). Water institutions, markets and decentralized resource management: prospects for innovative policy reforms in irrigated agriculture. Agrekon, 36(4).

Backeberg, G.R. (2002). Irrigation policy in South Africa. In Bate, R. and Tren, R. The cost of free water: The global problem of water misallocation and the case of South Africa. The Free Market Foundation, Johannesburg.

Backeberg, G.R. (2006). Reform of user charges, market pricing and management of water: problem or opportunity for irrigated agriculture? Irrigation and Drainage, Vol. 55, No1. John Wiley and Sons Ltd.

Backeberg, G.R. (2007). Allocation of Water Use Rights in Irrigated Agriculture: Experience with Designing Institutions and Facilitating Market Processes in South Africa. Paper presented at 4th USCID Conference, Sacramento, California.

Backeberg, G.R. (2010). Development and Financing of Irrigation Schemes: Towards a Consistent Approach. Case Study presented during a training session for DWA officials organised by the International Centre for Water Economics and Governance in Africa, September 2010, Pretoria.

Backeberg, G.R. & Groenewald, J.A. (1995). Lessons from the Economic History of Irrigation Development for Smallholder Settlement in South Africa. Agrekon 34(4).

Backeberg, G.R. et al. (1996). Policy Proposal for Irrigated Agriculture in South Africa. Discussion paper. WRC Report No KV 96/96, Pretoria.

Backeberg, G.R. & Reinders, F.B. (2009). Institutional Reform and Modernisation of Irrigation Systems in South Africa. Paper presented at the 5th Asian Regional Conference, New Delhi, India.

Benadé, N. (2010). E-mail communication on water management and water use charges for the Vaalharts Irrigation Scheme.

Department of Water Affairs and Forestry. (1997). White Paper on a National Water Policy for South Africa, Pretoria.

Department of Water Affairs and Forestry. (2004). National Water Resource Strategy (First Edition), Pretoria.

Denison, J. & Manona, S. (2007). Principles, approaches and guidelines for the participatory revitalisation of smallholder irrigation schemes. Volume 1 – A rough guide for irrigation development practitioners. Report No. TT 308/07, Volume 2 – Concepts and cases, Report No TT 309/07. Water Research Commission, Pretoria.

Fényes, T. & Meyer, N. (2003). Structure and production in South African agriculture. In Nieuwoudt, L. & Groenewald, J. (eds). The Challenge of Change: Agriculture, Land and the South African Economy. University of Natal Press, Pietermaritzburg.

Harbron, K. (2010). E-mail communication on water management and crop production on the Vaalharts irrigation scheme.

Morani, R. (2009). Rehabilitation of irrigation schemes. DAFF News No 9, September 2009.

Nieuwoudt, W.L. & Backeberg, G.R. (2010). Application of economic instruments, tradable licences and good governance for sustainable irrigation water conservation in South Africa. In Bjornlund, H. (ed) Incentives and Instruments for Sustainable Irrigation, WIT Press, Southampton, Boston.

Nieuwoudt, L. & Groenewald, J. (eds). (2003). The Challenge of Change: Agriculture, Land and the South African Economy. University of Natal Press, Pietermaritzburg.

Republic of South Africa. (1998). The National Water Act (Act No 36 of 1998), Government Gazette.

Van Averbeke, W. (2008). Best Management Practices for Small-Scale Subsistence Farming on Selected Irrigation Schemes and Surrounding Areas through Participatory Adaptive Research in Limpopo Province. Report No TT 344/08. Water Research Commission, Pretoria.

Vink, N. & Van Rooyen, J. (2009). The economic performance of agriculture in South Africa since 1994: Implications for food security. Development Planning Division Working Paper Series No 17, Development Bank of Southern Africa (DBSA), Midrand.

Van Vuuren, L. (2009). Water savings: Persistence pays off at Vaalharts. Water Wheel 8(6).

Van Vuuren, L. (2010). Vaalharts – A garden in the desert. Water Wheel 9(1).

❖❖❖❖❖

3.4 Policy and strategies for financing irrigation operation and development in Thailand: past and present [1]

“A water tax could be levied, in a manner similar to the paddy land tax, over the whole area at present cultivated and the future extension of this area, as far as the fields are benefited by the [irrigation] system… water rates could in general be assessed in some proportion to the quantity utilized, and would most probably be a suitable taxation for dry season crops and garden cultivation.” — Engineer H. Van der Heide (1903, cited by Molle, 2007)

Scope and goals of the paper

This paper aims at presenting the current situation of irrigation in Thailand, where rice has been long and far prevailing. It insists on the close physical, legal, political and financial connections that exist between the rice sector, irrigation and public policies. It establishes that irrigation development and operation has long been both supported and taxed by public authorities, and that ideas about irrigation water pricing and charging systems had emerged at times. Also, the paper investigates the fiscal system (rice premium) that made possible the massive development of irrigation during the 1970s. It finally tries to demystify certain ill-conceived yet established ideas about irrigation economics and policy in Thailand, and looks out for options in future.

1. Thailand’s rice-irrigation-policy nexus

Irrigation and irrigation policies in Thailand are entangled with rice production and policies. This section presents an overview of these intimate connections that form Thailand’s rice-irrigation-policy nexus.

Country profile and the agricultural sector

Thailand is a medium size country (513,115 sq km) situated in Southeast Asia and shares boarders with four other countries; Laos in the northeast, Cambodia in the east, Malaysia in the south and Burma (Myanmar) in the west to northwest. Thailand also borders towards two seas; the Gulf of Thailand and South China Sea in the east and the Andaman Sea and Indian Ocean in west. The climate is warm sub-humid tropics.

Thailand has a population of 67.8 million people of which 16.2 million, or 3.7 million households, are rice farmers. Thus, around 26 percent of the total population is involved in rice farming and the majority of the population lives in rural areas (66%). Thailand is classified as a transforming country characterized by declining importance of agriculture in GDP, very fast growing non-agricultural sectors, and high rural poverty. In Thailand there has been a large decrease in poverty in the past decades but most of it has occurred in urban areas. Between 1970 and 1999, poverty in urban areas declined 3.7 times faster than in the rural areas (World Bank, 2008).

Arable land covers about 30% of the country. Independent of income, rice is the main staple food for the whole population but consumption of rice tends to decrease as incomes increase. Agriculture, forestry and fishing constitute around 12 percent of total GDP with a decreasing share. Agricultural exports amount to about 15 percent of total exports and agriculture employs some 42 percent of the population (The Economist, 2012). Globally, Thailand ranks 6th, 5th, 10th and 2nd as producer of rice, sugar cane, tea and rubber respectively; it is the first exporter for rice, rubber, shrimp, cassava. The country exports also many other agricultural commodities and products.

The rice sector in Thailand

---

[1] Sylvain R. Perret, CIRAD, UMR G-Eau – 34398 Montpellier, France

Paper initially prepared for the ICID TF-FIN Workshop on “Country policies and strategies on financing and implementing water user charging systems in irrigation” in October 12, 2010 – Yogyakarta, Indonesia (updated in May 2012, towards a TF-FIN final report)

The total cultivated area in Thailand amounts to 21 million hectares of which around half is devoted to rice farming. Thailand is the 6th global rice producer and 1st exporter, under a wide range of challenges and changes.

From the end of the 1960s until the early 1980s, land devoted to rice farming expanded rapidly, along with intensification (achieved with the Green Revolution), irrigation expansion. As a result, production increased from 12.4 million tons to 21.2 million tons of paddy during the 1970s-1980s. Massive infrastructure development led to expand rice land in the country from 5.6 Mha to 9.5 Mha between 1960 and 1990 (about 10 Mha today). Rice production has tripled between 1961 and 2010, mainly due to increased production of rice in Northeastern region, with infrastructure development (roads, irrigation), intensification (mechanization and chemicals) and professionalization (wage labor). From the 1950s to 1970's rice land productivity increased by almost 50 percent, and still slowly improves by the year now.

From 2006 onwards, total production of (raw) paddy rice varies around 25-30 million tons, owing to climatic and socio-economic conditions. Production of milled rice is about 20 million tons, of which about 8-9 million tons are exported, making Thailand the largest exporter of rice in the world with a market share of around 30 percent. Around 50 percent of the Thai exports is high quality fragrant long grain rice, which receives the highest price on the market. Until recently, Thailand has been able to increase its exports almost yearly, as a result of a combination of increased production as well as a decrease in domestic per capita consumption. However, in 2011, massive floods and awkward pricing policies reduced exports to 6.5 Mt.

In recent years, with limited land availability for rice, Government policy tends to promote intensification to increase land productivity. Also concerning are the limited availability of water resources, high pollution, and increasing per-capita consumption. Rice production systems contribute 80-90% of freshwater abstractions in Thailand (yet with significant return flows), and pesticide–related toxicity is becoming a major concern. Authorities reckon an expansion potential for irrigation, estimated at 9.6 Mha, if the dry Northeastern region can be equipped and benefit from Mekong waters, its tributaries, and wetlands. Such scheme is deemed to incur massive infrastructures for water diversion, and potentially natural ecosystems destruction and environmental impacts. There is tremendous pressure on Thailand's water resources; the country ranks first in South-East Asia for annual per capita water availability, but it ranks 14th in the world in organic water pollution and eutrophication. One third of Thailand's surface water bodies are considered to be of poor quality; it is estimated that water pollution costs the country 1.6 to 2.6 percent of GDP per year.

Rice and irrigation

Thailand has an irrigable area of about 5 million ha, 4 being regularly cropped; 3 used for rice production (average cropping intensity of 130%). Agricultural land use ratio is 40%. Irrigated-to-agricultural land ratio is 24%.

The average yield is around 3 tons per hectare which is low compared to the world average of 4.1 and the Asian average of 4.2 tons per hectare (4.48 in Vietnam, 4.56 in Indonesia, 6.06 in China). A reason for this low yield is that Thailand mainly produces traditional low-yielding, high-quality types of rice (fragrant jasmine rice) with higher export market price than the modern high-yielding varieties. Another reason is the relatively low level of intensification: most paddy rice in Thailand is rainfed (uncontrolled ponding conditions in lowland paddy fields, depending on monsoon rainfall), mostly located in North East region; application of chemical inputs remains low compared to other rice-producing countries (N fertilizer: 86kg/ha, 285 in Vietnam; pesticides: 1.1kg/ha, 2.9 world average). The main rice growing season (wet season, monsoon), stretches from June to August with harvesting in October to January. The second season (dry season) stretches from February to April with harvesting taking place in April to June.

As said, low yields are also due to Thailand's low percentage of irrigated farming area; most of the farming area is rainfed lowland. Only around 20 percent of the total rice farming area is irrigated while 75 percent is rainfed lowland. Flood-prone areas (floating rice) and upland rice constitute only few percent of the total rice area.

Thailand is divided into four rice production regions; north, northeast, central and south. All the regions have different rice farming environments (see figure 1 where rice areas feature in yellow).

The largest rice producing area is the northeast region in which the most famous rice variety, jasmine rice, is grown. One third of Thailand's total area and around fifty percent of the total rice farming area are located in this region. It is also the most densely populated region. Farms in this region are predominantly family farms with small land holdings, producing mostly for their own needs. In cases of production surplus, rice is sold to the domestic market or to rice exporters. Rice is grown on the less favorable and more risky rainfed lowlands, with only one crop per year due to lack of irrigation. Only 20 percent of Thailand's irrigated areas are located in this region, and less than ten percent of the land is planted with rice in the dry season.

In the central and northern regions, farms are commercialized to a much larger extent. Farm holdings are on average three times larger than in the northeast and production surpluses are larger. Rice is grown in more favorable environments with irrigated areas in the central plains and along the large Chao Phraya River, yielding two crops per year. One fifth of the wet season rice and almost 75 percent of the dry season rice is grown in the central region. Farms in the central region use high technology, irrigation and mechanization to a large extent. In addition to the large rice production, the central region is also home to a large share of the industry in Thailand which causes labor shortages in the rice peak seasons.

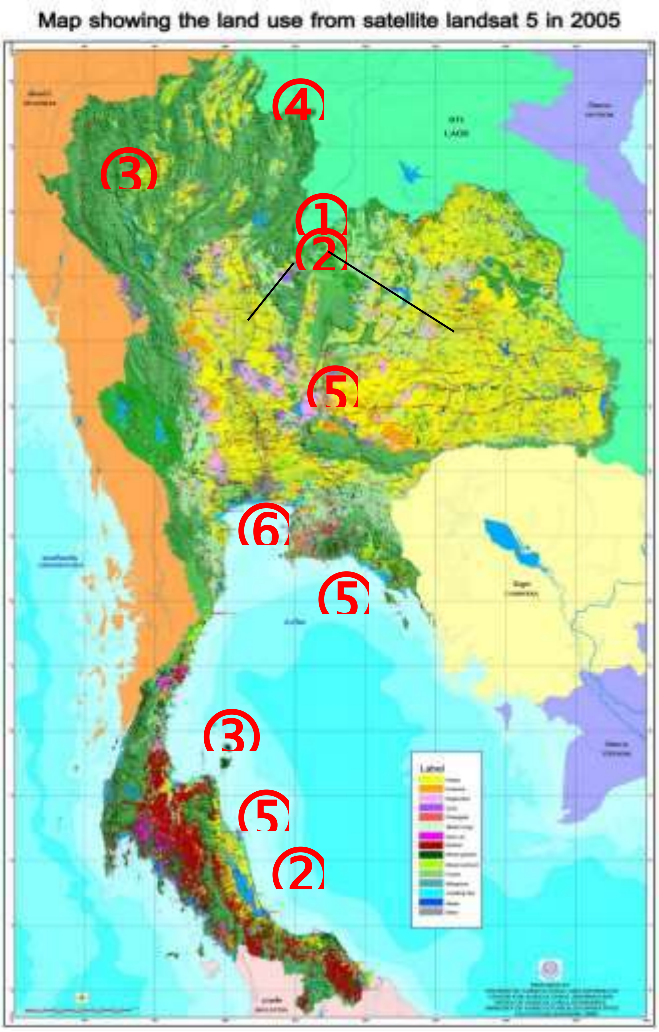


Figure 1. Map of Thailand, featuring land use (yellow for paddy fields) and rough location of the different types of irrigation systems

In the northern region, rice is grown in upland areas or on terraces and lowland valleys where there is abundant water. This region has almost one third of Thailand's total land area and around 20 percent of the total rice farming area. Farms in this region are also mechanized to a much larger extent compared to the northeast region.

The southern region has only a small rice production. The environment is less suited for rice farming and in total only 14 percent of the total land area and six percent of the total rice area are located in the southern region.

Rice is not anymore the backbone of Thailand's export-oriented economy, and yet, it still contributes a significant portion of GDP (about 9%) and employment (about 35%). Rice is grown on some 10 million ha of land during wet season (or 20% of the country) or more than 13 if both seasons are considered (overall 130% cropping intensity); it shapes most landscapes, and still deeply influences all policies, and life styles of Thai people. Different rice cropping systems co-exist in Thailand, from low input, uncontrolled irrigation (wet season, rainfed) paddy fields in Northeastern region, to intensive, double-crop systems under canal irrigation in Central Plains.

While recent advances helped improve overall production of rice, many peasants in North East cannot afford all the new chemicals, rice strains, and mechanization, and turn from land-owning rice producers to manual laborers, or migrants to Bangkok or abroad. Further, rice farmers are aging, younger generation is uninterested in farming, and labor scarcity is becoming an issue. While rice farmers form a large, poor class in Thailand, the sector shows high production costs and low land productivity compared to Vietnam, which is deemed to become world first exporter soon.

Water resources and irrigation systems

Main water resources for irrigation is raw surface water supplied by RID[2] of MoAC[3], mostly through dam or reservoir storage / control. Irrigation water use represents 70% of all water storage capacity or 63% of allocation plan by RID ; in practice 80-90% of all extractions go to irrigation (with significant return flow). Irrigation water demand has grown annually by 4.9% during the 80s, but only by 0.1% per year since 2000. Most large basins got closed, with fierce competition for water in dry season. With regards to irrigation water use, opportunity costs and environmental issues are raising.

As shown in figure 2, only about 20% of the total rice area is irrigated while 75% is rainfed lowland (paddy fields where water is only supplied by rainfall / runoff). Although most rice fields are not under "controlled irrigation", irrigated rice still mobilizes most of water resources. Box 1 proposes a typology of irrigation systems in Thailand, most being dedicated to paddy rice.

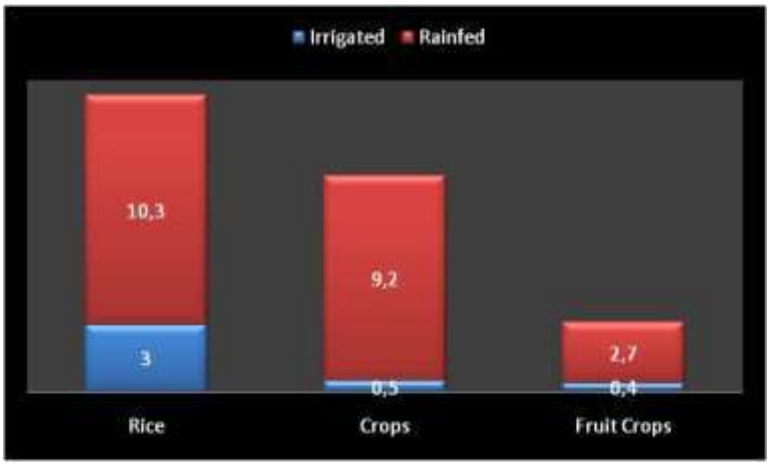


Figure 2. Irrigated and rainfed areas (in MHa) as per crop types in Thailand (2004)

---

[2] *Royal Irrigation Department, in charge of water allocation to all sectors*
[3] *Ministry of Agriculture and Cooperatives*

Box 1. A typology of irrigation systems in Thailand

Thailand has about 15,000 irrigation schemes, with an average size of 330ha. The average irrigation farm size is 4.7ha. The following list is a rough typology of irrigation systems (type numbers are located in figure 3):

1. Medium to large-scale public paddy rice irrigation systems (RID), N=788, 4800ha av. (Central Plains and North East; more than 75% of all irrigated areas)
2. Medium public irrigation systems (DoEDP, Royal initiative), N=4380, 200ha av. (Centralm Plains and North East; about 18% of all irrigated areas)
3. Small diversified public irrigation systems (RID), N=11600, less than 10ha on av. (North and Peninsula; less than 2% of all irrigated areas)
4. Small, diversified community-managed irrigation systems in remote hilly regions (muang fai) (ethnic communities in the North)
5. Medium commercial privately managed irrigation systems for local and export markets (e.g. fuelcrops, rubber, coffee) (South East, Central Plains and Peninsula)
6. Farm-scale, periurban individually managed irrigation systems for local markets (e.g. fresh vegetables) (around Bangkok mostly)

All activities in RID-managed schemes (type 1) are carried out by RID of MoAC (design, implementation, distribution, operation, maintenance, extension and technical advising, training)

Water availability ratio (cm/cap/year)

Australia	25,700
Indonesia	13,400
Thailand	**6,500**
Japan	3,400
South Africa	1,150

Figure 3. Water availability ratio (m3/capita/year) in Thailand and other countries

Tables 1a and 1b show that paddy rice requires about 1100mm (750mm from irrigation) in dry season cropping, or about 3 liters of water per kg of dry rice produced. In wet season, paddy rice requires about 800mm (230mm from irrigation), or 1.8 liter per kg produced (case study in Rayong area, South East; Rahatwal, 2010).

	Rice WF, m^3/ha	
Season	Blue Water Footprint	Green Water Footprint
Dry Season	7475.71	3765.76
Wet Season	2323.02	4514.19

	Rice WF, m^3/ton	
Season	Blue Water Footprint	Green Water Footprint
Dry Season	1993.52	1004.20
Wet Season	619.472	1203.784

Tables 1a and 1b. Water use in paddy rice cropping: case study estimation from Rahatwal (2010) (blue water = Irrigation Water Requirements; Green Water = Total Crop Water Requirements – IWR)

2. Water policies in Thailand: white elephant and paper tigers

This section presents the broad policy and institutional framework of the water sector in Thailand, with special emphasis to public rice policies aiming at supporting the sector and/or deriving revenue from it.

Overall setting

Weak rural development, along with rapid economic growth in Bangkok area, has widened the economic gap between urban and rural areas. Successive Thai governments strive to reduce these regional income differentials, often targeting the irrigation sector. Typical and recurrent, yet contradicting approaches consist in supporting rice price at farm gate, provide irrigation service free-of-charge to farmers, and to tax export rice. Public policies have always supported rice production through irrigation development schemes, subsidized water supply, allocation of idling State land to rice production (e.g. during the global food crisis in 2008), various multi-billion non-budgetary stimulus packages to offset weak external demand and to shore up confidence, and rice price premium to farmers (e.g. 50% price subsidy set up in 2011). Yet, past policies have also often taxed export rice, to the expense of farmers, to whom the tax burden was readily transferred by downstream agents along the export chain.

As shown in figure 3, Thailand is well-endowed with water, and has plethoric water resources in wet season; it also has (too) many stakeholders in the water sector; yet the Royal Irrigation Department is the one big player, decision-maker and manager of most resources and infrastructures, beyond irrigation use, including the several large multipurpose dams. Also, policies and management are still much resource-development oriented, well over resource and demand management, or allocation stance.

Although many drafts have been developed and circulated over recent years (first draft in 1993), Thailand has no National Water Act so far (hence the “white elephant” image), due to political power games, multiple stakeholders with diverging agendas, fast political turn-over, overall lack of consensus and vision on integrative water resource management policy. One advanced draft of National Water Act was sunk in 2003 because of issues around irrigation water fees. There are currently about 30 water-related laws, implemented and administered by about 30 departments under 6 different ministries in Thailand (hence the “paper tigers” image).

Under the still-standing Royal Irrigation Act of 1942, Royal Irrigation Department makes allocation decisions at basin level, manages multipurpose-reservoirs and raw surface water delivery to all sectors, irrigation. It is also in charge of flood mitigation measures, including at farm level (e.g. ‘[RID]… has the right to move water across or to store water on private land without hindrance from landowner’).

Beyond a “free irrigation water” policy: costs and tariffs

‘Chonlaprathan’ means irrigation in Thai language, literally meaning ‘royal gift’; water resources are de-facto widely considered free, open-access resources by individuals. However, Thailand allocates the equivalent of 5% of its agricultural GDP to irrigation O&M costs; in certain recent years, up to about 10% of national budget was dedicated to irrigation investments and O&M expenditures. Overall, in recent years, about one billion US$ has been spent annually for running RID, all costs and investments included.

Thailand keeps investing significantly in irrigation (on its own funds): e.g. about 780 million US$ annually invested on irrigation systems and irrigation water supply systems by RID between 2000-2004; a plan of 5 billion US$ for “irrigation water grid” for North East region in 2003; another megaproject of 15 billion US$ in 2008; 334 million US$ to be spent on irrigation infrastructures in 2008-2015, etc. Faced with such costs, Thailand authorities contemplate the attractive option of pricing and charging irrigation water.

The idea of irrigation water costing and charging system dates back to 1903 (see suggestion by Eng. Van Der Heide in introduction), implemented in 1942, lost soon after, revived in 2001-03 under ADB[4] and World Bank auspices and pressure, leading to much opposition and protests. Section 8 of the RIA of 1942 establishes water fees (5 THB per rai per year for irrigation, 0.5 THB per cm for other sectors; current value: about 1US$ per year per ha under irrigation). After the so-called Asian crisis of 1997-1998, global neoliberal policies promoted irrigation fees and charging system. In 2001, ADB

[4] *Asian Development Bank*

consultants suggested an average water fee of 120THB per rai (or about 5-7% of a farmer's net income per area cropped), which was never implemented.

The official irrigation water fee established in 1942 is theoretically still standing today, fixed at 50THB per rai (or about 10 US$ per ha per year) by RID, yet abandoned and widely forgotten. No collection was ever organized.

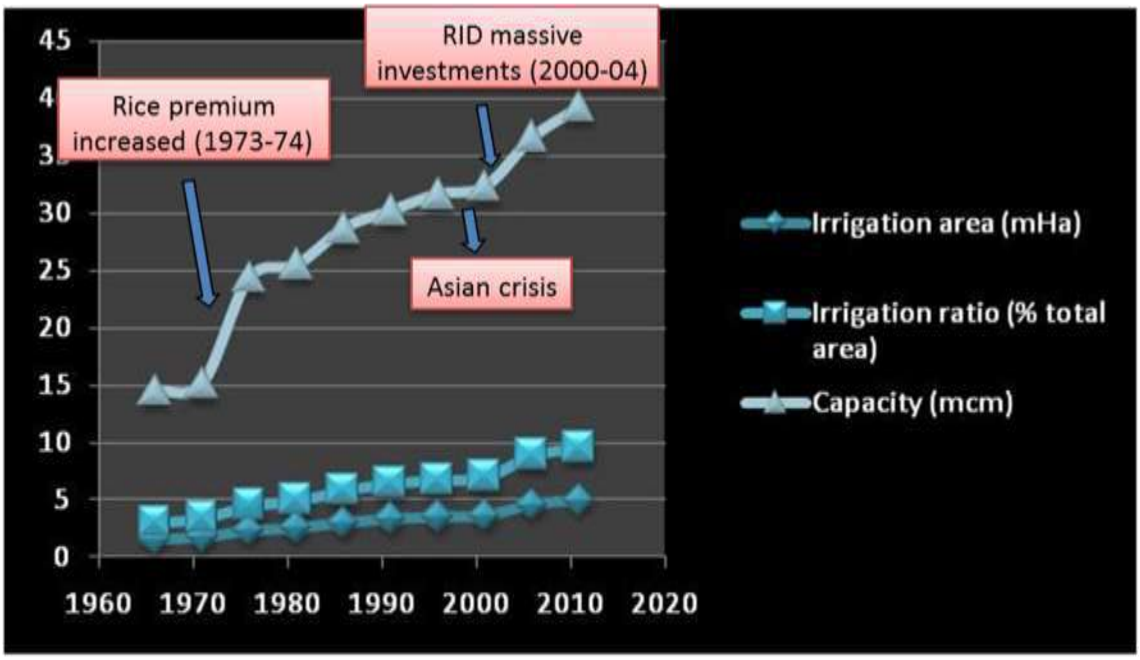


Figure 3. Comparative evolutions of irrigation capacity, ratio and area in Thailand (1965-2011)

Financing irrigation in Thailand: the past

A common viewpoint is that rice farmers in Thailand have long benefited irrigation water, infrastructure and water supply services for free. In fact Thailand governments have managed, throughout the 1950s to 1970s, to generate revenue by taxing the rice export, first at the expense of the farmers (as exporters transferred the tax burden to farm-gate price), then with indirect support to irrigation development. Box 2 sums up the storyline of the so-called rice premium scheme.

The rice premium was a specific export duty based upon global rice price and volumes exported, a fiscal instrument, taxing all rice exports at 20 to 60% between 1956 and 1986; naturally export chain operators kept their share by putting the burden on farmers who were paid lower prices at farm gate.

Certain years, rice premium incurred about 25% loss in farmers' income. Small et al. (1989) estimated that rice premium amounted to 3 times the O&M costs, i.e. about 16 US$ per 1000cm. So, even though irrigation farmers benefited from capital investments, operation and maintenance, as returns from the rice premium (tax), they have paid a heavy tribute to its implementation for more than 40 years.

Box 2. The Rice Premium system in Thailand (adapted from Forssell, 2009)

Origins

The government interventions in the rice sector started after the Second World War when a rice export monopoly was created. In 1954 the government abandoned the monopoly and private exports were allowed, but subject to several taxes and regulations. The long history of export orientation of the agricultural sector made it possible for the Thai government to implement effective and straightforward rice policies. The aim was to stabilize prices, keep them low for consumers and to extract revenues. During the period 1950-1986, four instruments for intervention and taxation of exports were used. They all had different foundations and were controlled by different departments but all the revenues accrued to the government. Together these instruments resulted in an export taxation rate around 40 percent from the end of the 1950s until the beginning of the 1970s (Warr and Khopaiboon 2007).

1950s-1970s: Phasing-in the rice premium

From the 1950s until the 1970s, the Thai government used the high export taxes to extract revenues that could be used to industrialize the country and subsidize the urban citizens. The subsidy was made possible by introducing a “rice reserve requirement” which forced all exporters to grant the Ministry of Commerce rice at prices under the market price (Siamwalla and Setboonsarng 1991). Since agriculture was not seen as a dynamic sector, it was thought that agriculture would not lead to growth of the economy. The price elasticity of agricultural products was low, at least in the short run, and this made it possible to tax the agricultural production. Farmers in general and rice farmers in particular were poor, uneducated and lacked organization, which also made taxing agriculture attractive from a political point of view (Warr and Khopaiboon, 2007). The effects of the tax called the “rice premium”, together with other interventions resulted in more stable, lower domestic prices which at the time was the goal of the rice price policies. However, another effect of the rice premium was that farmers had to carry most of the burden of the tax; they received much lower prices than would have been the case without the tax (Wiboonpongse and Chaovanapoonphol, 2001). The interventions also resulted in lower exports and since Thailand was a large country on the rice market, a higher world market price. This was achieved by the government by restricting the quantity of rice that was allowed to be exported (Siamwalla and Setboonsarng, 1991). The extra profits from these limited exports mostly benefited the exporters themselves. Prices were profoundly affected in the domestic market. However, consumer prices and the farm gate prices were only slightly affected. Instead it was the retail shops that received most of the profits from the cheap rice program, and the millers who acquired the profits from the producer price support program. From a political point of view the interventions were very important.

1970s-1986: Phasing-out the rice premium

The period that followed the 1970s is characterized as a phase out period in which there was a sharp break with earlier rice tax policies and rice taxes were lowered. Even though the rate of export taxation increased to around 60 percent during the commodity price boom 1972-1974, then 40 percent during the second oil price shock of 1979-1980, it declined afterwards to around 20 percent (Warr and Khopaiboon, 2007). While Thailand governments were realizing that farming, and rice production in particular, was instrumental to the country’s development, the Farmers’ Aid Fund Act was created in 1974. The Act stated that the revenue from the rice premium should accrue to an aid fund for the farmers. In this way, the government taxed the farmers and used the revenues to help the same farmers. Most of the revenue generated was de-facto invested in irrigation infrastructure development and operation, and contributed to the expansion of rice irrigation in the 1970s. Since the revenues no longer accrued to the Ministry of Commerce, the rice premium was no longer as attractive and instead the rice reserve requirement became the preferred intervention.

Another important change in the 1970s was that policies shifted from being pro-consumer towards benefiting producers. The cheap rice program was slowly reduced in both amount and quality and was abandoned at the beginning of the 1980s. At the same time the support prices for farmers were gradually increased. The main purpose of the support program was to redirect profits from the export tax to the millers. The rice millers had substantial influence over politics since they were financiers of political campaigns and also in control over key votes. Since millers often worked as agents for the government in rice procurements, they were able to acquire a rather large share of the benefits of the program (Siamwalla and Setboonsarng, 1991).

At the beginning of the 1980s the Thai government changed its rice policy to be more free-trade oriented. In 1982, Thailand signed the GATT agreement which played a role in liberalizing the rice policies (Kajisa and Akiyama, 2003). Overall, the 1980s was a decade devoted to liberalizing the rice policy; the Thai government more or less withdrew from the domestic market and let the world market determine the domestic rice prices. However, some interventions and support were still provided in the form of indirect measures which the farmers themselves could choose whether to use or not (Kajisa and Akiyama, 2003). Until the mid-1990s, the result of all interventions and policies concerning rice was still a net taxation of rice production (Warr and Khopiaboon, 2007). The post-1980s liberalization of rice policies in Thailand was largely due to political considerations. Thailand had experienced rapid urbanization and urban incomes were increasing much faster than the rural incomes. The poverty disparities between rural and urban areas were increasing. The political climate in Thailand was also changing with more democratic institutions evolving (Warr and Khopaiboon, 2007).

After 1986, sharp increase of rice price made the rice premium system unbearable. Voices started to denounce the inequity and absurdity of it: rice premium applied to all export rice while only between rural and urban areas (Choeun et al. 2006).

Choeun et al. (2006) irrigation farmers would benefit from returns through re-investments in irrigation development and management. Even rainfed rice farmers would indirectly pay for irrigation under such system. The tax was by essence a varying tax, subject to volatile global rice prices and export volumes. However, rice premium was instrumental for funding irrigation development in the late 1960s and 1970s. But it also helped maintain rural poverty and meagre peasant livelihoods overall. In 1986 the rice premium was abolished and export subsidies were introduced as a result of the downward trend in world food prices and the increasing income disparities modelled and analyzed the rice premium system and showed that Thai government initially over-taxed rice exports during the farmers’ low income stage (hence favouring urban rice consumers and chain operators) and gradually reduced it to a more optimum level corresponding to increases in per-capita income. In the latest stages of rice premium, system moved to under-taxation in terms of social welfare maximization for the nation.

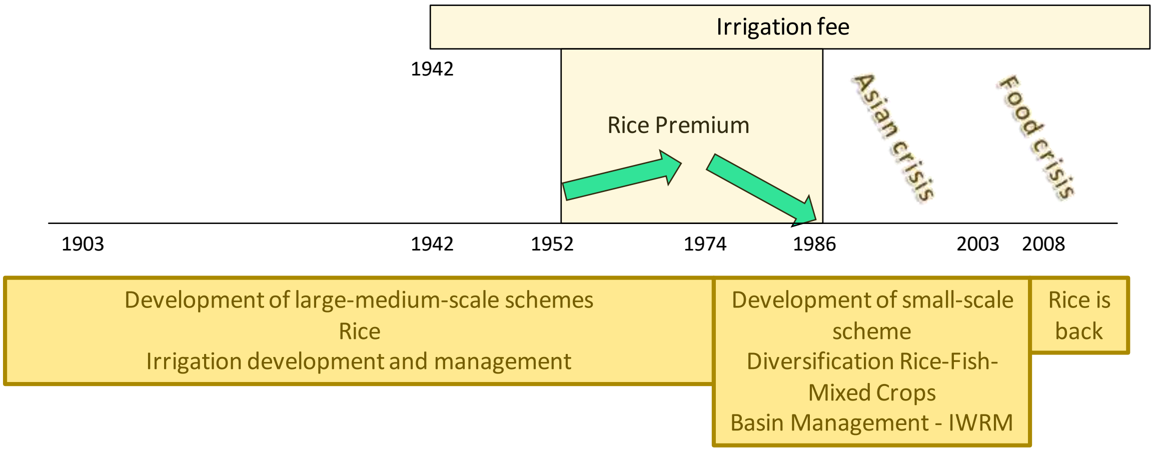


Figure 4. Chronological synopsis of a century of irrigation development and financing in Thailand

3. Current situation and the future

Demystification and the reality

With regards to the so-called "free irrigation water" situation in Thailand, which supposedly benefits the farmers at the expense of government coffers and the tax payer, a number of contextual facts ought to be kept in mind:

- Implementation of irrigation water costs and charging system based on actual individual consumption in Thailand is made very difficult since gravity supply prevails and does not allow for easy measuring of water use; collective allocation and charging is also hindered by the poor organization of farmers, the lack of local institutions and of clear collective property rights;
- While there is no actual fee system, farmers do pay for water supply since private pumps are commonly used for over-the-bunds water transfers and water-lifting operations; 80% of farmers in the Central Plains have at least one pump set (Molle, 2007);
- The notion of farmers wasting water with excessive use is a myth; during the wet season, excess water that returns to natural flows and underground is actually not wasted in economic terms since its opportunity cost is nil; during the dry season, farmers are well-aware of the scarcity hence the value of water, and permanently adapt (conjonctive use, dug well ponds, drilled wells, closed small drains, as listed by Molle, 2007); reuse of water along the Central Plains towards Bangkok is such that, in the dry season, only about 12% of the water released by the dams upstream is lost to non-beneficial evaporation or outflow (Molle, 2007);
- Farmers do know the value of water, and their willingness to pay for it is much higher than usually assumed (around the O&M costs, as demonstrated by Tiwari in a case study in Thailand's Central Plains; 1998);

What the future holds

Rice has a future, and a key role to play in global food security since more than 3 billion people have rice as staple food. After 2008 and years of instability, rice price has stabilized around 500-600 US$ per ton since 2008 (Thai long grain white rice sold at 200US$ per ton in 2003; 376 in 2007; 963 in May 2008). Cropping systems evolve and intensify in all producing countries.

However, some challenges remain in Thailand, alongside with the recurring issue of cost recovery and financing in irrigation systems:

- Fuelcrops and plantations (rubber) development, urbanization demand more land, often at the expense of rice land, calling for further intensification;

- Labour scarcity and farmers' aging are becoming a serious issue in Thailand' agricultural sector, requesting labour, land and immigration policies;
- Soaring production costs, including labour costs, make it increasingly difficult to compete with neighbouring developing countries with lower prices (Vietnam, Myanmar notably, which are emerging as competitors to Thailand, including on high quality high value fragrant varieties);
- Pushed by quality and health issues, and the need for product differentiation, quality requirements and labeling support the development of certification and standards on sustainable production (organic rice, Good Agricultural Practices); also, Thailand tries to protect its advantage on high quality fragrant rice (Vietnam and Myanmar have recently been denied the right to brand their fragrant varieties "Jasmine Thai Rice");
- Recent heavy floods in Thailand's Central Plains (2011) re-initiated discussions on Payment for Environmental Services to paddy rice farmers, whose fields serve as buffer areas to store flooding waters, therefore protecting downstream urban, commercial and industrial areas.

Still thinking about charging for irrigation water?

The main global rice producers happen to be the main consumers, as merely 5% of global production is traded (half of it by Thailand and Vietnam). Most of these countries are transition countries, which benefit from industrial transition, a healthy import-export balance, low debt. This means that for Thailand, and also Vietnam, China, it is financially feasible, socially accepted, to subsidize irrigation water supply and services. It is also politically crucial to support production in order to achieve self food security, and Thailand also has long supported price at farm gate (various mortgage and price support systems since the 1990s). Charging farmers for water would look contradictory to such support.

If water fees and charging system are to be implemented, it should be for the right reasons: as demonstrated by Molle (2007), charging for irrigation water is not likely to make farmers use less water, at least not when there a need for it (i.e. in dry season); it is not likely to promote diversification and higher value crops either since poor farmers are risk-averse, lack the necessary skills and capital, and the paddy landscape and soils are not favorable to easy crop change; market access is also an issue. Further, international experience shows that any charging system deemed to succeed should be harnessed to a reform on property rights, local institutional developments, and the transfer of management for many irrigation services to farmers themselves. Such conditions are not met in Thailand where most farmers are basically workers on their own land, with no involvement in collective action or decision. RID still prevails, provides, advises and trains, yet at a very high cost (about 1 billion US$ per year overall), and with low land and water productivity.

Cost recovery mechanisms are probably to be designed together with a new irrigation management paradigm in Thailand, and possibly with the involvement / contribution of the many private economic agents which benefit from the export bounty.

This working paper is followed by a case study on the economics of irrigation rice in Thailand, investigating the values of irrigation water, the costs incurred, and innovative ways to cover for irrigation costs.

4. References

Choeun, H., Godo, Y., Hayami, Y. (2006) The economics and politics of rice export taxation in Thailand: a historical simulation analysis, 1950-1985. Journal of Asian Economics, 17 (2006): 103-125.

Forssell, S. (2009) Rice price policy in Thailand: policy making and recent developments. University of Lind, Department of Economics, Minor Field Study Series no.189, ISSN 0283-1589, 45p.

Kajisa, K. and Akiyama, K. (2003). The Evolution of Rice Price Policies over Four Decades: Thailand, Indonesia and the Philippines. Foundation for Advanced Studies on International Development, Tokyo, Japan.

Molle, F. (2007) Thailand's 'free water': Rationale for water charge and policy shifts. In: Irrigation water pricing; F. Molle & J. Berkoff, editors, CAB International, pp126-142

Rahatwal, S.D. (2010) Application of LCA and virtual water approaches to access environmental impacts of rice production. Unpublished M.Eng thesis, AIT, Water Engineering & Management, Bangkok, Thailand

Siamwalla, A. and Setboonsarng, S. (1991). Thailand. In: A.O. Krueger, M. Schiff, A. Valdés (eds.) The Political Economy of Agricultural Pricing Policy. The International Bank for Reconstruction and Development/ The World Bank. The John Hopkins University Press

Warr, P. and Kohpaiboon, A. (2007). Distortions to Agricultural Incentives in a Food Exporting Country: Thailand. Australian National University, Canberra, Australia and Thammasat University, Bangkok, Thailand

Wiboonpongse, A. and Chaovanapoonphol, Y. (2001). Rice Marketing System in Thailand. International Symposium, Agribusiness Management towards Strengthening Agricultural Development and Trade: III Agribusiness Research on Marketing and Trade.

❖❖❖❖❖

***Ezzatollah Farhadi [1]**

1. Preface

With over 1,648,000 km^2 area and 70M population, Iran is situated in an arid and semi-arid region of the world. Taking about 1.1% of the whole land area, Iran has only 0.34% of available water. Mean precipitation in Iran amounts to about 250mm or 411 billion cubic meters (BCM). Total available water is about 130 BCM, 97.4 BCM of which is used for potable, agricultural and industrial demands. Exploitation of the remaining capacity is finite. The following table shows water resources and uses in the country.

Water Resources and Uses in Iran (Billion Cubic Meters)

User Sectors	Agricultural					Industrial			Potable			All Users
Details	Surface water			Ground water	Sub Total	Surface water	Ground water	Sub Total	Surface	Ground	Sub Total	Total
	Modern system	Semi – modern system	Traditional system									
Volumes	13	12.3	5.4	57.4	88.1	0.8	1	1.8	2.5	5	7.5	97.4
Percentage	13.3	12.6	5.5	58.9	90.5	0.8	1	1.8	2.5	5	7.7	100

51M ha of total lands area of the country is cultivable, but 18M ha (11.5% of the country's area) are the existing farmlands.

Shortage of precipitation and available water is the most significant reason of the difference between existing and potential farmlands. High rate of evaporation is another reason for the shortage of water availability; also the precipitations are unseasonable with regard to the time of water consumption by the crops. Ancient Iranians began in very early ages to build hydraulic structures such as storage & flood control dams, diversion dams, traditional canals and kanats, to exploit surface and ground water for agricultural and domestic purposes.

The Kurit gravity arch dam near Tabas in Khorasan Province was constructed in 1350 BC, having a 60m height; it has been the highest dam in the world until the early years of the 20th century.

The Abbasi flood retarding dam is an illustrating example of water wisdom of the builders; the dam has protected the city of Tabas from the floods of the Nahrian River for 600 years. The dam is an ancient and valuable engineering structure whose construction technique and flood control operation had been neglected for years; this construction technique was reconsidered by the engineers throughout the world in modern times. Another invention of Iranians for groundwater exploitation is kanat, The Qasbeh Kanat in the city of Gonabad is known as the oldest, deepest and longest kanat in the world the construction of which is believed by historians to date back to 2500 years ago, id EST,

---

[1] **Ezzatollah Farhadi, Iran**
Member of High Council of Iranian National Committee (IRNCID) & WG (AC-IPRLD) and (R&D) of ICID; Member of Management Council of Iranian Society of Consulting Engineers; Managing Director of Pooyab Consulting Engineers
(June 2012, Adelaide, Australia)

the Achaemenian. The kanat has 500 wells, 32 km length with a 300m deep main well. Its total excavation is estimated to be 73 MCM. Now, experiencing many earthquakes and droughts, it yields 150 LPS.

2. General Information on Irrigated Land in Country

Out of 18M ha farm lands of country, 9.8 ha are rain fed agriculture, 8.2M ha irrigated lands, out of which 2.6 ha are irrigated by modern networks system and 5.6 ha by ground water and traditional canals system.

Wheat and barley are the main irrigated crops taking high percentage of the crop pattern. This is for two reasons, one for being strategic crops in food security terms and the other for the simultaneity of their growth period with affluent surface water in spring.

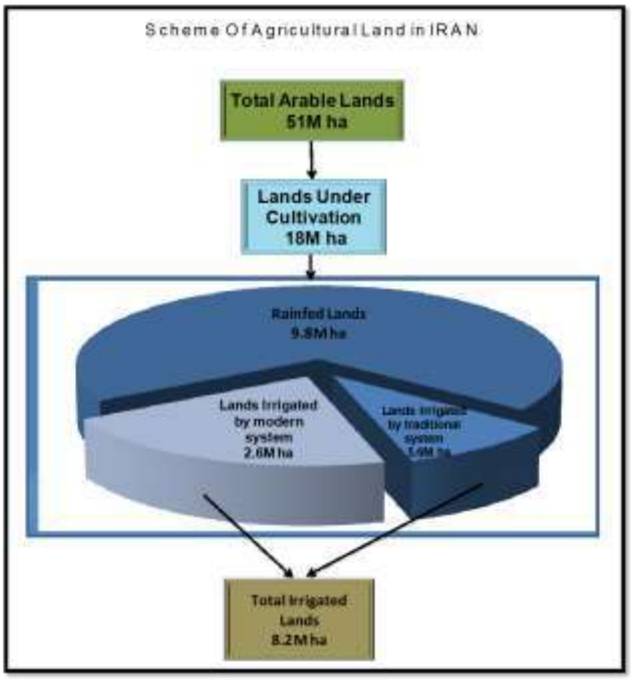
Having 22% of the total country employment, only 14% of the gross domestic product is assigned to the agricultural sector.

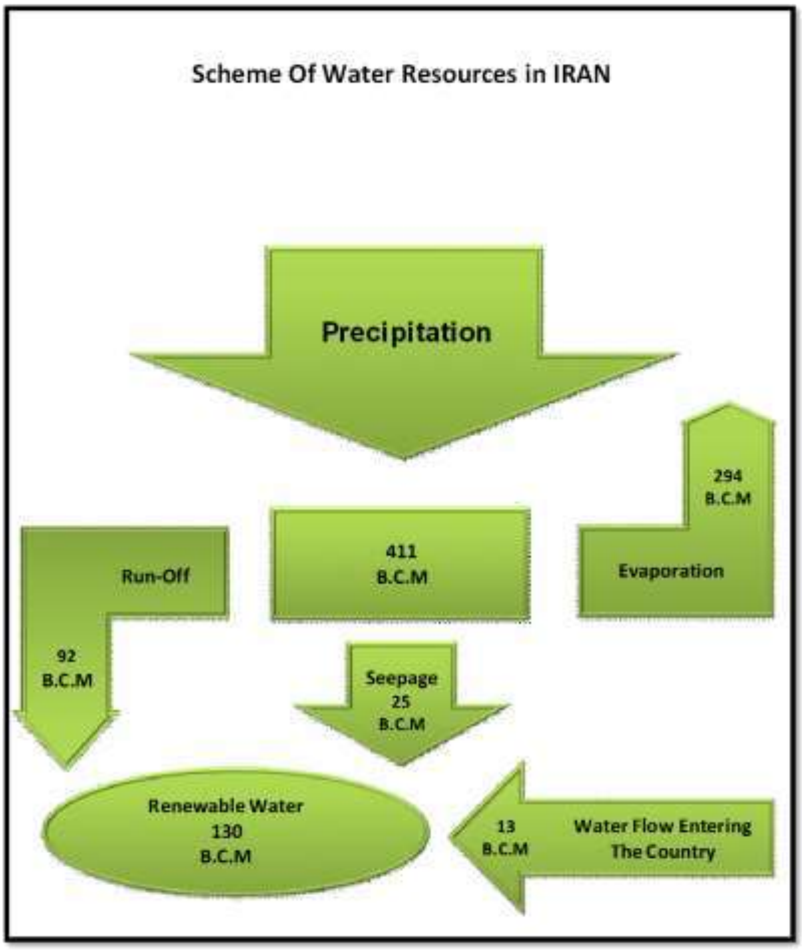
In terms of soil & water balance for Irrigated agricultural development, irrigable lands far outweigh available water.

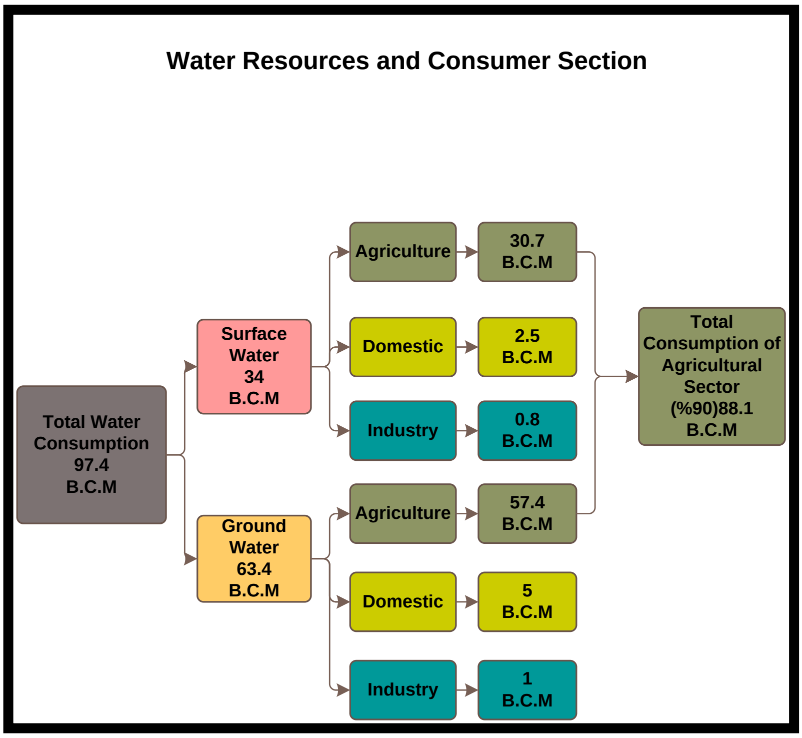
Agricultural water consumption comprises about 90% of total surface and ground water resources. These resources mainly depend on permanent or seasonal rivers flow, stored water in dams and local reservoirs (AB- BANDAN) and groundwater resources in the form of wells, springs and kanats.

The dimension of irrigation systems changes according to the size of lands, operation systems and amount of available water. Smallholders' farm area ranges from 0.5 to 20 ha or more, while traditional and modern networks irrigate a substantial amount of these lands in regions where there is sufficient water. One of the country's largest irrigation projects under construction which is located in Khuzistan Province (Karkhe Irrigation & Drainage Network) has an area of about 300,000 ha.

The main irrigation method in existing modern and traditional systems are mostly surface irrigation, but irrigation has been applied through pressurized methods (sprinkler, drip irrigation and low pressure methods) in the recent decade.




Scheme Of Water Resources in IRAN
Precipitation
411
B.C.M
294
B.C.M
Evaporation
Run-Off
92
B.C.M
Seepage
25
B.C.M
Renewable Water
130
B.C.M
13
B.C.M
Water Flow Entering
The Country


Water Resources and Consumer Section
Total Water Consumption 97.4 B.C.M
Surface Water 34 B.C.M
Ground Water 63.4 B.C.M
Agriculture
30.7 B.C.M
Domestic
2.5 B.C.M
Industry
0.8 B.C.M
Agriculture
57.4 B.C.M
Domestic
5 B.C.M
Industry
1 B.C.M
Total Consumption of Agricultural Sector (%90)88.1 B.C.M

3. Water Charging; Principles & Policies

3.1 Global Orientation

The most significant subjects on global orientation related to water are:
Effect on weather & climate, relying on virtual assets and added value, increase of water productivity, decrease of overhead costs (storage, transportation, conveyance) and balanced management of quadric sources from clients viewpoints, capacity building in private sector and change of the government's role, empowering water users and water user associations (non-governmental). Special attention should be paid to water rights and newly merged judiciary, interactions & transactions on water, knowledge sharing and uptake of innovation, water charge and water economy.

3.2 Importance of Water Charging

The necessity of limited water resources management, favorable water allocation and distribution management, water consumption and water economy equity and equality, helping to all social classes, affect and add to the importance of water charging for water use.

3.3 Characteristics of Charging in Water Sector

The excessive nature of water, complexity, implication of different objectives on efficiency, equity, equality and sustainability, requisite response to increasing demands and upgrading the level and quality of services, supply and reimbursement of heavy costs of investment and operation & maintenance, improvement and development of projects, uncertainty in sustainable water supply during droughts, different users with different usages and sensitivities are the main characteristics of water sector.

4. Objectives of Optimum Charging for Water Use

Objectives of the optimum charging of water are focusing on:

Economic efficiency; Means encouragement of differently motivated people to efficient activities and prevention of inefficient activities, financial sustainability; Means provision of the possibility for fulfillment of the firms obligations, based on the services at agreed level, equality & justice; Means receiving relative costs from customers with regard to affordability and welfare necessities, sustainability of environment and water resources; Means encouragement for environmental cost mitigation, or accepting compensation activities costs, charging simplicity; Means simplicity of calculation , low cost application execution by the operator and ease of collection and payment.

5. Some Global Attitudes toward Water

5.1 World Food Summit Plan of Action:

Considering water resources as a social and economical good, enforcement of decisions related to water resources allocation and demand management application, using water charging and other motivating mechanisms, application of methods to receive actual water price considering the affordability of water user.

5.2 F.A.O

Elimination of subsidies on irrigation water respecting its effects on impoverished farmers, pricing based on water use efficiency and sustainability, application of volumetric water pricing system.

5.3 World Water Forum

Total cost compensation as an applicable method in water pricing, water supply cost estimation, including environmental, economical, external fixed and variable costs, prevision of complementary plans to compensate for case allocated subsidies effects on increase of water use and its negative external effects on environment (including land salinity and water logging).

6. A Glance at Water Charging in Different Countries

In developed countries cases, water charging covers all financial costs as well as opportunity costs and external effects.

General recommendation for irrigation water is first to cover all operation & maintenance costs and then to cover parts of investments. Some countries whose farmers are responsible for operation & maintenance of tertiary canals impose no charges on farmers. In some countries, water charging is received as operation & maintenance costs or as investment costs, that is; water charging is conducted based on water volume and land area. In some other countries, parts of operation and maintenance costs are received through costing on the basis of land area. In some other countries parts of operation and maintenance costs and investment costs are received through volumetric charging of water.

7. Water Charging For Agriculture in Iran

Iran has basically a non-volumetric system based on the type of network and crop production. Based on fixing of irrigation water cost law, average water charge partly compensates official costs. Volumetric control of irrigation water is possible based on the enforceable rule on the optimized irrigation water use pattern. On this basis a draft of the law was submitted to the government council of ministers in 2006.

8. Basic Policies for Water Charging in Iran

8.1 Long Term Development Strategies for Water Resources Passed by the Council of Ministers in 2003.

Water charging in different uses should be conducted in such a way that basic demands of drinking and sanitation usages be met according to the rural and urban consumption patterns. Further consumptions should be supplied with respect to financial supply and diversity, first, all operation and maintenance costs should be covered and then the investment costs.

8.2 Comprehensive Document on Water Resources Management Passed by the Council of Ministers in 2005.

It is on the allocation of water to other users based on water economic mechanisms, water charging so that the average water cost is inclined to compensate the total cost harmonious with the country's economic structural reform. (Paragraph "C" of Article 39 of the 4^{th} development plan to promote governmental firms efficiency and financial balancing). Charging is limited to public and private goods and services and essential goods. In case at any reason, the government enforces to sell goods or services lower than the determined charge, it must compensate the cost by exchanging from its credits or revenues in that year or from the debts of the firm.

8.3 Some Requisite Infrastructure

It contains the structural reform of the customer affairs, agreeing on the level of services and structural reform of service providing firms, provision of a possibility for volumetric water intake and effective volumetric water pricing for irrigation water, defining some mechanisms to balance different water pricing system objectives with the requisite infrastructures at the country's managerial and political level, stage planning to move from the existing condition to achieve favorite condition.

9. Laws of Water Charge in Iran

9.1 Law of Fixing Water Charge for Irrigation Water

This article is approved by the Parliament of Islamic Republic of Iran in July, 1990.

"Single article: Since the approval of this law, the water charge for irrigated agriculture with priority to discount for strategic cultivated crops is as follows:

1- Average of water charge for regulated water and modern irrigation network equal to 3 percent of cultivated crops production.
2- Average of water charge for regulated water and semi modern (combination of modern and traditional system), equal to 2 percent of cultivated crops production.
3- Average water charge for regulated water and traditional irrigation system, equal to 1 percent of cultivated crops production. "

9.2 Law of Prohibition to Receive Water Charge on Farmers Water Rights Before Construction of Any Dam on River.

This article is approved by the Parliament in June 2006.
"Article No. 58- Receiving water charge on farmer water rights beneficiary from the rivers flowing to the sea during the years before storage of the flow by construction of the dam on the river is prohibited."

9.3 Law of Prohibition to Receive Water Charge for Right of Ground Water Monitoring From Agricultural And Animal Husbandry Sectors.

This article was approved by the parliament in October 2004.

"Article No. 3- from the beginning of 1384 (March 20, 2005).

Receiving any water charge related to the right of ground water monitoring from the activities on agricultural and animal husbandry is prohibited. "

9.4 Law of Receiving Water Charge in Zabol Counties (Sistan Area).

This article was approved by the parliament in January, 1987.

"Single article: from the approval of this law, the Sistan and Bloochestan Regional Water Authority is allowed to receive water charge in Zabol counties at most 150 Rls per each 4 ha of cultivated lands in the years that they could deliver water to these lands."

10. Some information of water price is shown on tables as follows

10.1 Water Cost

(Rials per cubic meter)

Methods	Details	Depreciation		Cost of Maintenance & Operation	Water Cost Charge**
		Dams	Systems		
1	Book value with O & M real cost, and 12% capital investment interest rate***	569	624	252	1445
2	Projects executed in the first 4 years of the 4th development plan (with 12% interest rate of capital investment)	2093		252	2345
3	Estimation of projects in phase 2 (with 12% interest rate of capital investment)	1589	2495	252	4336
Water supply from wells					839****

* Based on costs approved in 2009

** Weighted mean of 3 methods is 1665 Rials per cubic meter.

*** Electric power price: 430 Rials per Kw/h.

**** Calculated by Shiraz University Professors for several fields in FARS province.

10.2 Average Existing Tariffs of Agricultural Water:

(Rials per cubic meter)

Water Resource	Tariff *
Modern System	46.4
Semi-Modern System	26
Traditional System	2.7
Ground-water (Monitoring Fee)	0

10.3 The Role of Water Cost on Production Costs of Several Agricultural Products Based on Insured Price of Ministry of Jihad-e- Agriculture (2009):

Details		Production Costs (Rial)	Water Charge (Rial)	Water Charge Share on Production Cost (%)	Water Volume Used Per Hectare	Water Charge Per m^3 (Rial)
Wheat	With average water cost*	12998000	1025000	7.8	6410	160
	With average water cost (semi-modern system) **	12140000	167000	1.3	6410	26

Details		Production Costs (Rial)	Water Charge (Rial)	Water Charge Share on Production Cost (%)	Water Volume Used Per Hectare	Water Charge Per m³ (Rial)
Sugar Beet	With average water cost *	27774000	2160000	7.7	12000	180
	With average water cost (semi-modern system) **	25926000	312000	1.2	12000	26

* Based on costs approved in 2009

** Based on costs approved in 2009 with present value of water

The major work done until now has been on the construction of dams and main irrigation and drainage networks, paying less attention to on farm irrigation systems.

On the one hand, construction of new irrigation systems in rain fed lands has been recently taken into consideration to increase irrigated farming and crop yield, and on the other hand renovation of traditional irrigation networks has been considered for irrigation efficiency and water productivity increase. In this direction it has been tried to employ water user's financial capability in addition to national funds for the construction of modern irrigation systems. Hence, passing new laws, the parliament let the executive organizations provide requisite credits from public funds and farmer's financial participation based on the ratios clarified within the law for the construction of irrigation systems. Samples of these laws are shown as follows:

Article 76 the 2nd Development plan law (year 1994)

"In order to facilitate and attract more investment to construct the projects on agricultural soil & water issues, on farm irrigation & drainage networks, birds and cattle breeding and fisheries, irrigation & drainage systems and watershed management, the government is bound to give at most 30% of the approved credits of the above projects in the annual budget to the Keshavarzi (Agriculture) Bank based on the declaration of responsible ministers through corresponding Ministries. The Keshavarzi Bank has to bestow loan conveniences based on its laws from a combination of the mentioned credits, its banking system credits and the revenue derived from farmer's financial participation in order to invest in these projects. If necessary, parts of the mentioned projects required credits secured by public fund can be considered as gratuitous contribution."

Article 5 of 2011 Budget law

"In order to facilitate the construction of weirs , and construction , equipment and fulfillment of on farm irrigation & drainage networks, encouragement of legal and natural investors of the private section and firms, water users and farming corporation , national and provincial executive organizations are allowed to secure the requisite credits for the mentioned projects from their corresponding investment assets acquisitions up to 85% as a gratuitous governmental aid and 15% as the users ration .

Waver: Deprives regions and water users who have participated in the construction of irrigation and drainage networks are exempt from all charges paid as the participation share.

References

Ministry of Energy; Water Resource Managements Co. of Iran, Principals and Policies of Water Price (2008).

Ministry of Jihad - e - Keshararzi (Agriculture), Bureau of Statics and Information Technology.

Water Recourse Management Co. of Iran Office of the Irrigation and Drainage Network Development and Public Participation.

❖❖❖❖❖

3.6 Pakistan Policies and Strategies on Financing and Implementation of Current Water User Charging Systems in Irrigation[1]

1. General Information of Pakistan

1.1 Indus Basin Irrigation System (IBIS)

Pakistan, a country of enchanting landscapes offers a combination of beaches, mountains, beautiful deserts and valleys. Its vast farm lands are sustained by the Indus Basin Irrigation System (IBIS), the largest contiguous irrigation system in the world. The IBIS irrigates 16.70 Mha (million hectares) of farm land which produces wheat, rice, fruits, vegetables, sugarcane, maize and cotton in abundance for local use as well as for export. Individual farms receive water from the gravity flow of a massive network of canals, distributaries and watercourses fed by the Indus River and its tributaries. In recent years public tubewells have become an additional, though somewhat limited, source of irrigation water.

The Indus Basin Irrigation System comprises of three major reservoirs, 85 small dams, 19 barrages and head-works, 2 siphons across major rivers, 12 inter-river link canals, 45 canal systems, 1.0 million private and public tubewells and more than 144,000 watercourses. The aggregate length of the canals is about 64,500 km. In addition, watercourses, farm channels and field ditches cover another 1.6 million km. Typical watercourse command ranges between 80 and 325 ha. Salient features of Irrigation System are given in Table 1.1, while Schematic Layout is shown in Fig. 1.1.

Pakistan is administratively governed by four provinces namely; Punjab, Sindh, Khyber Pakhtunkhwa and Balochistan. Provincial Irrigation Departments (PIDs) have been responsible for water sector planning, development and operation & maintenance of irrigation, drainage, reclamation and flood control works which are of provincial nature. Water & Power Development Authority (WAPDA) a federal agency created in 1958 is responsible for water sector planning and execution on federal level. The projects which are not of inter-provincial nature are handed over to PIDs after construction for operation and maintenance. PIDs are also responsible for distribution of irrigation water, assessment of water rates and settlement of water disputes at farm level. Maintenance of irrigation distribution system up to the distributary and minor is the responsibility of the PIDs. Province wise, infrastructure of Indus Basin system is as follows:

The public irrigation infrastructure in the Punjab consists of 13 barrages, 2 siphons across major rivers, 12 link canals and 24 major canal systems having an aggregate length of 34,500 km. The whole irrigation infrastructure lies within the Indus Basin Irrigation System and serves an area of 9.964 Mha.

Sindh has 13 publicly owned irrigation systems, which receive water from three barrages across the River Indus. These systems, with an aggregate length of 18,000 km of canals, serve an area of about 5.736 Mha.

Khyber Pakhtunkhwa has 6 publicly owned irrigation systems in the Indus Basin, which serve a total area of 0.587 Mha. These systems receive water from two headworks across Swat River, Tarbela Dam and Warsak Dam. In addition, there are six other canal systems which serve a total of 0.13 Mha of land. Khyber Pakhtunkhwa has over 200 canals called `civil canals`, which are community or privately owned.

Balochistan has two canal systems within IBIS, which receive water from the Indus through Guddu Barrage and Sukkur Barrage, located in Sindh. These canal systems serve a total area of 0.399 Mha. One of these, the Pat Feeder Canal System, has been improved recently. In addition, there are 431 independent publicly owned small irrigation schemes, which serve 0.14 Mha. There are a few privately owned small irrigation schemes as well.

[1] Mr. Bashir Ahmed Sial, Member TF-FIN (Pakistan)

Table 1.1. Salient Features of Indus Basin Irrigation System

Sr. No.	Headworks/ Barrages/ Reservoirs	River	Designed Capacity of Barrage (m^3/s)	Off-taking Canals			Area (1000 ha)	
				Canals	Length* (Km)	Discharge at Head (m^3/s)	GCA	CCA
1.	Amandara	Swat	96	Upper Swat Canal	575	51	129	112
2.	Munda	Swat	55	Lower Swat Canal	276	23	59	54
3.	Warsak	Kabul	15,290	Warsak Left Bank Canal	160	1.3	5	4
				Warsak Right Bank Canal		13	51	44
				Kabul River Canal	138	13	37	31
4.	Tarbela	Indus	39,930	Pehur Canal	26	30	40	-
5.	Jinnah	Indus	26,900	Thal Canal	3233	212	941	651
6.	Chashma	Indus	28,317	Chashma Jhelum Link	1227	614	-	-
				CRBC	260	198	231	-
7.	Taunsa	Indus	21,238	Taunsa Punjnad Link	61	340	-	-
				Muzaffargarh Canal	1606	252	324	289
				D.G.Khan Canal	1706	235	318	283
8.	Guddu	Indus	25,485	Ghotki Canal	1373	241	388	338
				Desert Feeder (Pat)	688	365	168	155
				Begari Feeder	1392	439	438	389
9.	Sukkur	Indus	42,475	Eastern Nara Canal	2554	379	977	928
				Khairpur East Canal	701	76	231	153
				Rohri Canal	3440	317	1154	1053
				Khairpur West Canal	1550	54	172	130
				North West Canal	1475	144	511	391
				Rice Canal	947	289	240	210
				Dadu Canal	964	91	255	223
10.	Kotri	Indus	25,485	Lined Channel	713	116	236	197
				Fuleli Canal	1114	391	409	376
				Pinyari Canal	1232	408	385	318
				Kalri Beghar Canal	1028	255	279	244
11.	Rasul	Jhelum	24,069	Rasul Qadirabad Link	47	150	-	-
				Lower Jhelum Canal	2389	54	701	607
12.	Mangla	Jhelum		Upper Jhelum Canal	-	623	28	219
13.	Marala	Chenab	31,149	Marala Ravi Link	101	623	72	43
				Upper Chenab Canal	2045	331	856	674
14.	Khanki	Chenab	29,733	Lower Chenab Canal	4551	331	856	674

Sr. No.	Headworks/ Barrages/ Reservoirs	River	Designed Capacity of Barrage (m^3/s)	Off-taking Canals			Area (1000 ha)	
				Canals	Length* (Km)	Discharge at Head (m^3/s)	GCA	CCA
				BRBD Link				
15.	Qadirabad	Chenab	25,485	Qadirabad Balloki Link	137	623	-	-
16.	Trimmu	Chenab	18,406	Trimmu Sidhnai Link	71	31	-	-
				Havelian Link	67	147	66	64
				Rangpur Canal	798	77	151	140
17.	Balloki	Ravi	63,713	Balloki Sulemanki Link	-	62	-	-
				Lower Bari Doab Canal	2321	255	769	1617
18.	Sidhnai	Ravi	4,729	Sidhnai Mailsi Link	100	286	424	397
				Mailsi Bahawal Link	16	110	-	-
				Sidhnai Canal	47	127	358	322
19.	Sulemanki	Sutlej	9,910	Eastern Sadiqia Canal	1377	164	46	381
				Fordwah Canal	772	96	191	173
				Upper Pakpattan Canal	1743	147	465	430
20.	Islam	Sutlej	10,987	U&L Bhalwal Canal	1031	153	294	231
				Qaim Canal	11	14	-	-
21.	Punjnad	Punjnad	19,822	Punjnad Canal	2502	294	626	540
				Abbasia Canal	257	37	53	44

* Given lengths are combined lengths of the canal system including main canal, branches distributaries and minors.
Source: Main Report of Revised Action Programme for Irrigated Agriculture (1979), Master Planning and Review Division, WAPDA, Lahore.

1.2 Water Apportionment Accord 1991

Sharing of waters of the Indus river system among the four provinces remained a contentious issue for a long time. Water Apportionment Accord of 1991 finally resolved the old dispute. To ensure implementation of agreement reached between the four provinces Indus River System Authority Act 1992 was enacted defining the powers and duties of the Authority. Prior to Water Apportionment Accord 1991, water allocations to provinces were made by the Federal Government on ad-hoc basis according to historical uses of Indus river system water. Under the Accord, historical uses were mutually recognized and provinces agreed to meet their irrigation, domestic and industrial needs from their agreed shares as given in Table 1.2.

Table 1.2. Water Apportionment Accord, 1991

Province	Apportionment					
	Kharif (May-October)		Rabi (November-April)		Total	
	MAF	BCM	MAF	BCM	MAF	BCM
Punjab	37.07	45.73	18.87	23.27	55.94	69.00
Sindh	33.94	41.86	14.82	18.28	48.76	60.15
Khyber Pakhtunkhwa	3.48	4.29	2.30	2.84	5.78	7.13

Province	Apportionment					
	Kharif (May-October)		Rabi (November-April)		Total	
	MAF	BCM	MAF	BCM	MAF	BCM
Balochistan	2.85	3.52	1.02	1.26	3.87	4.77
Sub-Total	77.34	95.40	37.01	45.65	114.35	141.05
Khyber Pakhtunkhwa Civil Canals	1.80	2.22	1.20	1.48	3.00	3.70
Grand Total	79.14	97.62	38.21	47.13	117.35	144.75

Source: 1. Pakistan's Water Resources Development and Management, Javed Saleem Qamar, 2007; 2. Water Apportionment Accord, 1991.

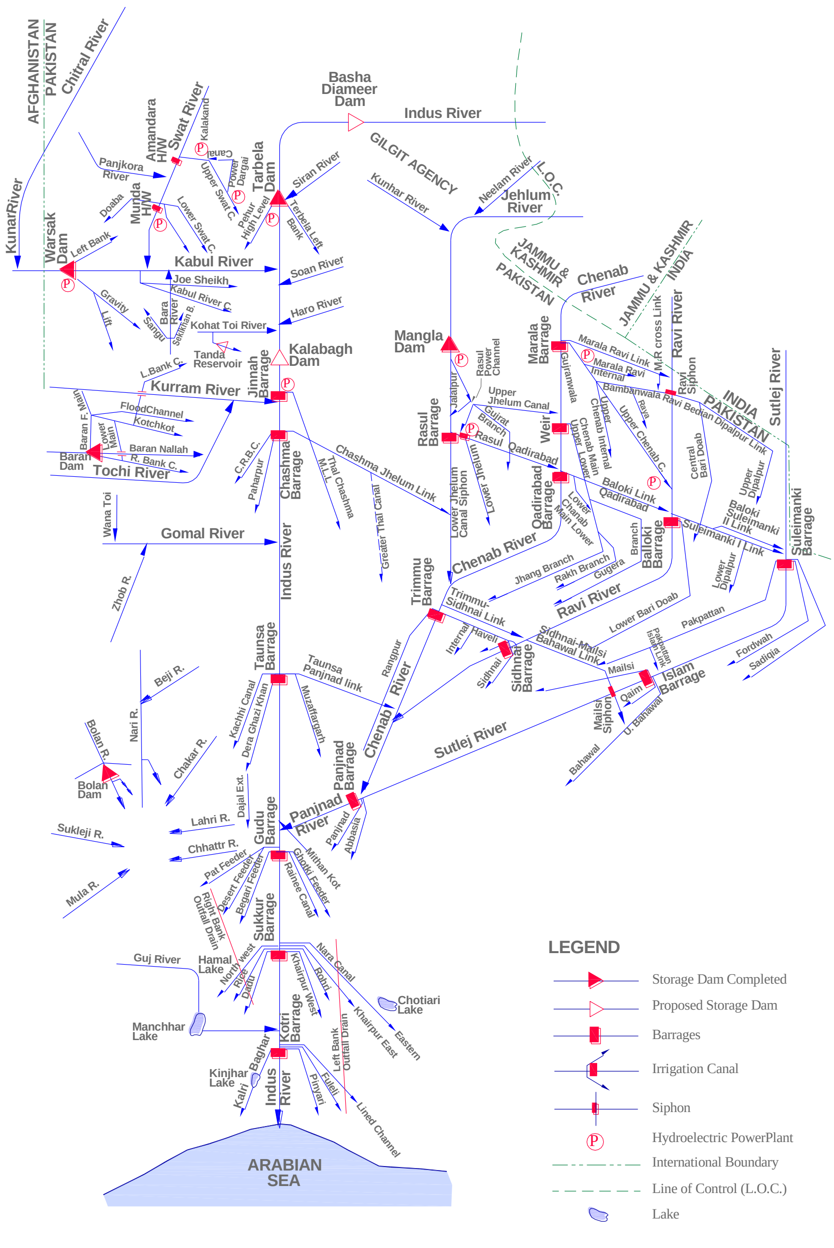


Figure 1.1. Indus Basin Irrigation System (Schematic Diagram)

Shares of balance water supplies including flood water and future storages were agreed as 37% for Punjab, 37% for Sindh, 14% for Khyber Pakhtunkhwa and 12% for Balochistan. The system-wise allocation worked out on ten daily basis form part of the agreement. The need for certain minimum escapages to sea below Kotri to check sea water intrusion has also been recognized in the Accord. The provinces agreed to undertake new projects within the apportioned shares.

1.3 Water Availability, River Diversions and Irrigated Area

The average annual inflow of Indus River and its tributaries at rim stations is about 185.63 BCM for the post-Tarbela period (1976-2000). The average annual diversion during the ten years period (1991-2000) was 130.08 BCM.

The corresponding seasonal diversions were 83.96 BCM and 46.12 BCM for Kharif and Rabi seasons respectively. The province-wise statistics for 10 years (1991-2000) are as follows:

Average Annual Canal Diversions in BCM (1991-2000)

Province	Kharif	Rabi	Total
Punjab	42.31	24.51	66.82
Sindh/Balochistan	38.73	19.81	58.54
Khyber Pakhtunkhwa	2.92	1.80	4.72
Total	**83.96**	**46.12**	**130.08**

A further 62.00 BCM is pumped annually from the groundwater reservoirs, of which more than 90% is used for irrigation. The status of water availability, province wise river diversions and irrigated area is given in Table 1.3.

Table 1.3. Water Availability, Diversions for Irrigation & Irrigated Area of Indus Basin

Description	Unit	Punjab	Sindh/ Balochistan	Khyber Pakhtunkhwa	Total
Long term river water availability at Rim Stations (1976-2000)	BCM	-	-	-	185.63
Diversions for irrigation (1991-2000)	BCM	66.82	58.54	4.72	130.08
	% total flow	51.4	45.0	3.6	100
Command area	Mha	9.964	6.135	0.587	16.70
	% of total area	59.7	36.7	3.6	100
Groundwater abstraction (2001)	BCM	49.30	10.20	2.50	62.00
	% of total abstraction	79.5	16.5	4.0	100
Irrigated area (2006-07)	Mha	14.57	4.02	1.00	19.59
	% of total area	74.4	20.5	5.1	100

During 2006-2007, the total irrigated area from all sources, including private canals, irrigation schemes, wells and tubewells and publicly owned infrastructure was of the order of 19.59 Mha. About 74% of the total irrigated area of Pakistan falls in the Punjab province, while 5% area falls in Khyber Pakhtunkhwa, 21% in Sindh and Balochistan. Distribution of irrigated area with respect to source of irrigation is given in Table 1.4 and is depicted graphically in Fig. 1.2.

Table 1.4. Distribution of Irrigated Area by Source of Irrigation (2006-07)

Sr. No.	Province	Total Area (Mha)	Govt. Canals %	Canals Tube-wells %	Private Canals %	Tube-wells %	Canal Wells %	Wells %	Others %	Total (Mha) %
1	2	3	4	5	6	7	8	9	10	11
1	Punjab	14.57	24.57	52.92	-	19.77	1.51	0.96	0.27	100
2	Sindh	2.74	63.25	-	-	17.15	-	14.60	-	100
3	Khyber Pakhtunkhwa	1.00	40.00	7.00	34.00	7.00	-	5.00	7.00	100
4	Balochistan	1.28	39.84	-	6.25	36.72	-	6.25	10.94	100
5	National	19.59	32.47	39.71	2.14	19.86	1.12	3.42	1.28	100

Source: Agricultural Statistics of Pakistan, 2006-07.

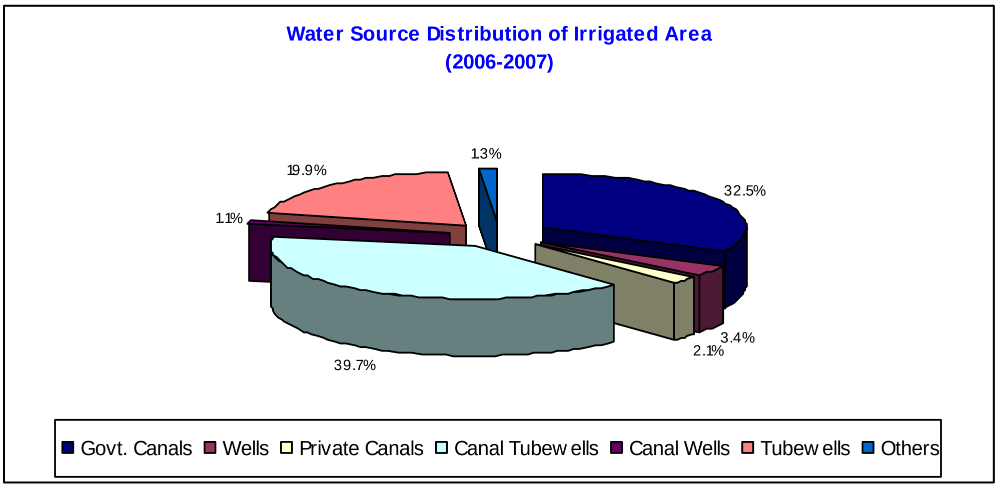


Figure 1.2. Distribution of Irrigated Area Based on Water Source

1.4 Groundwater Usage for Irrigation

The use of groundwater for irrigated agriculture has a long history in Pakistan. Existence of 'Karezes' in Balochistan was documented by Greek travelers as long ago as 2,500 years. Open wells were the earliest mode of tapping groundwater while the use of tubewells for irrigation started in the last decade of the nineteenth century.

In the Indus plain, alluvial deposits form a huge aquifer. The use of groundwater for irrigation increased with the passage of time due to increase in cropping intensity as the surface water supplies became deficient. Groundwater is being used for irrigation as well as for domestic, municipal and industrial use.

The province-wise ground water development for irrigation purposes is described in the following:

Punjab

In Punjab, the main source of groundwater is within the Indus alluvial plains, where groundwater occurs predominantly under water table conditions. General groundwater movement is from northeast to southwest with gradients ranging from 3.3×10^{-3} to 4.0×10^{-3}. Depth to water table below the land surface in the province ranges from less than a meter (m) in the areas near major rivers, to more than

20 m in some parts of the Doabs. In about 67% of the area, water table is located within 6.0m from the ground surface and can be conveniently exploited by centrifugal pumps.

The mineralization of groundwater generally increases as one move away from the rivers. In 70% of the Gross Area, the groundwater quality is fresh and useable (<1500 ppm) for irrigation, while in 14% of the area, the groundwater quality is marginal (1500-3000 ppm) which can be used for irrigation after mixing it with canal water. In the central parts of the Doabs in the Punjab, pockets of highly mineralized groundwater are present which contain 4,000 to 20,000 PPM of dissolved salts and cannot be used for irrigation purpose.

Presently, there are about 848,666 private tubewells (PTWs) in the Punjab Province. Discharge of the PTWs varies from less than 50 m^3/h to more than 150 m^3/h with an average of 80 m^3 /h and operation factor ranges from 3% to more than 30% with an average of 10%. In addition, some tubewells in fresh water zone have been installed as part of Salinity Control & Reclamation Projects (SCARPs) for lowering water table and utilizing the pumped water for irrigation purpose. Groundwater abstraction in the Punjab Province has been estimated as 49.3 BCM.

Sindh

In Sindh Province useable groundwater is mainly found in the Indus Plain, which is recharged by the meandering river and by the irrigation network and fields. Depth to water table is shallow due to which groundwater can be extracted by centrifugal pumps.

Fresh groundwater in the region occurs in pockets and lenses overlying denser, older, heavily mineralized, saline water. By far the largest of these fresh water bodies occurs as seepage along the Indus, but minor fresh water lenses exist along major canals. The Indus River in Sindh Province flows on a ridge. The movement of groundwater in the lower Indus aquifer is very slow and generally in the direction away from the river and down the valley. Sub-surface drainage follows the direction of the river quite closely. Some of the flow drains towards the desert in the east and towards the Kirthar Hills in the west. Groundwater abstraction in the province has been estimated as 9.2 BCM. As per Agricultural Statistics of Pakistan 2006-07, there are 94,530 tubewells in Sindh.

Khyber Pakhtunkhwa

In Khyber Pakhtunkhwa groundwater is being used for irrigation, domestic, municipal and industrial purposes. Tubewells, dug wells fitted with lifting devices and Persian Wheels are used to extract groundwater. Groundwater is also obtained from springs and through karezes. Khyber Pakhtunkhwa is a mountainous area and groundwater is found in soft rocks, sand and clay bed in sufficient quantities. The aquifer in such terrain with low porosity is related to weathered intrusions of igneous rocks. Groundwater from hard rocks discharges through springs. The main groundwater reservoirs in Khyber Pakhtunkhwa are the alluvial plains and many valleys.

As per agricultural statistics (2007), there are over 14,382 tubewells in Khyber Pakhtunkhwa. Nearly all of the shallow tubewells supply water for irrigation or for domestic use. The quality of shallow groundwater in the valleys, which is largely derived from infiltration of rainfall and seepage from canal and fields, is generally good. However, in Bannu Basin, the chemical content of the upper horizon ranges from 350 to 3,000 PPM.

According to the Planning Division of WAPDA, some 491 tubewells have been installed by WAPDA in various SCARPs in Khyber Pakhtunkhwa. There are 946 government tubewells other than SCARP tubewells in Khyber Pakhtunkhwa as well. Most of these tubewells have been installed by Irrigation and Public Health Engineering Department. Total groundwater abstraction in the province has been estimated to be of the order of 2.50 BCM per year.

Balochistan

In Balochistan Province, groundwater occurs in substantial quantity in unconsolidated aquifers in almost all basins and sub-basins and generally flows from catchment boundaries to the axis of the valleys and then follows the general trend of surface drainage. Depth of water table varies from less than 1 meter to over 100 meters but typically ranges from 5 to 50 meters.

Groundwater is the principal source of water supply in the province for meeting domestic needs and irrigation of deciduous horticulture, vegetables and some of the traditional grain crops. Groundwater is generally found trapped in the alluvial plains and piedmont plains. Under the traditional system, water is brought to the surface for use through karezes and dug wells.

Under a study sponsored by United Nations Development Programme (UNDP), WAPDA Hydrogeology Directorate evaluated the groundwater resources of Balochistan during the period 1973-83. The UNDP is the central coordination organization for United Nations development activities worldwide. The amount of groundwater abstracted has been difficult to quantify from the United Nations Development Program (UNDP) studies to the present day. The reasons are numerous but the more important ones include lack of monitoring of pumping times and discharge rates, complex water rights that exist in Balochistan and a natural reluctance amongst the farmers and tubewell owners to pass on the necessary information. Total groundwater abstraction in the province has been estimated to be of the order of 1.0 BCM per year. As per Agricultural Statistics of Pakistan 2006-07, there are 25,734 tubewells in Balochistan.

1.5 Irrigation Efficiencies

Despite being an agrarian country, Pakistan has demonstrated extremely low irrigation efficiencies, creating problems related to water conservation, water logging and salinity. As a result, the crop yields in Pakistan are quite low. With the present irrigation efficiency in Pakistan, only 39% of the water that reaches the fields is actually used by the crops. Irrigation efficiency is a compound of three efficiencies i.e., canal-head efficiency, watercourse efficiency and farm efficiency.

1.6 Small Dams

The northern part of Punjab Province has a broken terrain with numerous small streams, which carry only seasonal flow during rains. The scanty agriculture is mainly rainfed and uncertain. Drinking water supply is also extremely scarce.

It is estimated that nearly 3.95 MCM of water, equivalent to one-third of the useful capacity of Tarbela reservoir, flows down the Potowar Plateau into the Indus river during the short rainy period, carrying with it a huge quantity of fertile soil and thus creating a serious problem of land erosion. In order to collect this runoff and to provide assured irrigation supplies to the rainfed cultivated land, a comprehensive scheme for constructing small dams was formulated and 28 of such dams had been constructed up to 1994, while some more dams were planned. These dam projects led to multipurpose development at local level. The emphasis in these projects was more on social consideration rather than purely financial (PANCID, 1987 and 2003).

1.7 Economic Impact of Indus Basin Irrigation System

The agricultural produce, in addition to providing food security constitutes:

(a). 23 percent of GDP
(b). 70 percent of total export earnings
(c). 54 percent employment of labor force

The overwhelming majority of its produce comes from the areas irrigated in the Indus Basin. The IBIS is therefore essential in sustaining the agriculture and consequently economic well-being of Pakistan. The Indus Basin now serves as the bread basket of Pakistan.

1.8 Five Years Development Plans and Vision 2025 Programme

Water and land are the two promised gifts of God to mankind and nothing can survive on land without water. As such water resources planning has always occupied prime attention of the planners and the engineers. After independence in 1947, the year 1955 initiated a new era of formal economic plans –

the Five-Year Plans; the first in the series covered the period 1955-60. This cycle was briefly broken during the period 1975-78, when annual plans were framed. The Sixth Five-Year Plan therefore covered the period 1978-1983 and so on.

The first plan was based on the data and statistics collected in traditional manner. The data were not enough nor capable to support planning hypotheses or future project trends. Sound strategies to implement the plan could be successfully adopted only on the basis of sound technical information. Technical studies were required to support development planning. This was duly recognized by the people at the helm of affairs. Foreign assistance was sought and reputed foreign consultants were engaged. Over the years, planning in the water sector, as in other sectors of the economy, was duly supported with technical studies.

A cursory view of the strategies enunciated in five year plan portfolios indicates partial continuity in approach and a weak conception of the issues. Up-to-date performance in irrigation and drainage indicates more experimentation than comprehended solutions. As a result, even after implementing eight 5-year development plans in the water sector, the objectives of fully utilizing the water resources and achieving agriculture potential remained unrealized. In fact Pakistan's irrigated agriculture base is so wide and irrigation system so extensive and complex, that it baffles any planner. The human and financial resources required to tackle the situation are astronomical that a developing country like Pakistan found difficult to acquire.

Ninth 5-year plan was conceived for the period 1998-2003 but could not be launched due to changing political conditions. Instead WAPDA's Vision 2001-2025 plan hurriedly completed on the basis of prepared in-house feasibility studies, was launched in year 2001.

2. Policy, Legislation, Strategy and Regulation on Irrigation Water user Charging System

2.1 General

During the last decade, the concept of water demand management has received increasing attention from both development agencies and banks. In the face of rising costs for supply augmentation and concerns over the apparently inefficient use of water in agriculture, managing demand appears a priority means of mitigating water scarcity problems. Economists, in particular, have used theoretical frameworks to argue for the use of "economic instruments" to provide incentives that may lead to water saving or enhancing economic efficiency.

The objectives of cost recovery and demand management must be understood and addressed separately as their realization requires the use of different charging mechanisms. In most situations farmers could pay the levels of charge required to meet ongoing operation and maintenance and future replacement costs. The widespread failure of farmers to pay is often due to dissatisfaction with the level of service provided, lack of confidence in the legitimacy of the charging process and the lack of resources invested in establishing effective and transparent charging mechanisms.

To bring about any significant change in water use requires that users be charged volumetrically at prices greater than those required to cover costs. These issues present important technical and political challenges that must be recognized.

The canal system, which has been in operation for more than 100 years, is believed to have become too obsolete to cater for the needs of modern agriculture and is, therefore, in desperate need for rehabilitation. But resource-poor Pakistan cannot undertake the rehabilitation work on its own, and must depend on foreign loans or at least ensure full recovery of annual operation and maintenance (O and M) expenditures. Apart from generating investment funds, the cost recovery, with higher water charges, would also lead to greater water-use efficiency and an equitable income distribution at the farm level. The irrigation system supplies irrigation water through a fixed roster of turns agreed upon by the farmers concerned. The duration of irrigation for each farm is determined strictly by the proportion of that farm's commanded area to the total commanded area of the watercourse concerned regardless of the farm's cultivated, uncultivated, cropped or uncropped area.

2.2 Legal Framework

Various laws related to Irrigation system of Pakistan are as follows:

1. The Canal and Drainage Act 1873.
2. The Punjab Minor Canals Act 1905.
3. The Soil Reclamation Act 1952.
4. The NWFP Irrigation (Amendment) Act 1948.
5. The Sindh Irrigation Act 1879.
6. The Balochistan Water Supply Regulation 1941.
7. Land Revenue Act, 1967
8. Balochistan Pat Feeder Canal Regulation 1972.
9. Balochistan Development Authority (BDA) Act, Quetta 1974.
10. The Balochistan Groundwater Rights Administration Ordinance 1978.
11. The Balochistan Canal and Drainage Ordinance 1980.
12. Balochistan Coastal Development Authority Act 1998.
13. Balochistan Conservation Strategy.
14. The Sindh Water Users' Associations Ordinance 1982.
15. The Punjab Water Users' Associations Ordinance 1981.
16. The NWFP Water Users' Associations Ordinance 1982.
17. The Balochistan Water Users' Associations Ordinance 1982.
18. Water Apportionment Accord, 1991.
19. Indus River System Authority Act, 1992.
20. The Punjab Irrigation and drainage Authority Act 1997.
21. The Sindh Irrigation and Drainage Authority Act 1997.
22. The NWFP Irrigation and Drainage Authority Act 1997.
23. The Balochistan Irrigation and Drainage Authority Act 1997.
24. Pilot Farmers Organizations (Elections), Regulations, 1999 and (Amendments) Regulations 2003, (Amendments) Regulations 2004 and (Amendments) Regulations,
25. Punjab Irrigation and Drainage Authority, Pilot Farmers Organizations (Financial Regulations), 2000.
26. Punjab Local Government Ordinance 2001.
27. Balochistan Irrigation and Drainage Authority (amendment) Ordinance, 2001
28. The Sindh Water Management Ordinance, 2002
29. Punjab Irrigation and Drainage Authority (Pilot Area Water Board) Rules, 2005.
30. Punjab Irrigation and Drainage Authority (Pilot Farmers Organizations) Rules, 2005
31. The North-West Frontier Province Irrigation and Drainage Authority (Amendment) Bill, 2005
32. Punjab Area Water Board (Conduct of Business), Regulations 2007.
33. Punjab Irrigation and Drainage Authority, Farmers Organizations (Conduct of Business) Regulations, 2007.

Brief summary of legal framework laws are as follows:

In the 1990s, on the advice of the World Bank, Pakistan's government embarked on major institutional reforms in irrigation management. The original reform proposal by the World Bank, devised through a detailed analysis of the situation (World Bank, 1994) was too revolutionary. It proposed:

(a) to treat water as a tradable commodity rather than a public good;
(b) to create private water markets by giving farmers water property rights disconnected from land;

(c) to divide the four Provincial Irrigation Departments into 43 autonomous Public Utilities (PUs, one each for 43 canal commands) and to create Farmers Organizations (one for each distributary); and

(d) PUs should have company style management and be registered with the Corporate Law Authority under the Companies Act.

The Pakistani government sought comments from provincial governments on the proposal, who dismissed the analysis, and provided highly critical comments. All the provincial governments reacted that the Banks' proposals were too much divorced from reality, and the ideas did not match the prevalent socio-economic conditions. The federal government initiated discussions with the Bank for improving the reform model. The discussions and debates continued for another three years, when finally the World Bank and the federal government agreed on a revised reform model. The Bank rigorously pursued the reform through an 800 Million Dollar loan to the government under its National Drainage Program (NDP). The federal government pushed the provincial governments to accept the reform through attaching the further disbursement of NDP funds with the progress with the passage of legislation. Consequently, all the four Provincial Assemblies passed Provincial Irrigation and Drainage Authority (PIDA) Acts in 1997.

The revised model envisaged a three-tier irrigation and drainage management structure. The Farmer Organization (FO), established through the representation of watercourse level water users, was to supply water to irrigators, be responsible for operation and maintenance (O&M) of secondary irrigation canals, to levy and collect water charges, and to make payments to the canal level Area Water Board (AWB) for cost of supplying bulk water to the FO. The operating public utility would be the AWB, with an average command area of a million hectares (ha) who would manage and distribute irrigation water, through formal volume-based contracts with FOs, and trade water with other utilities. The Provincial Irrigation and Drainage Authorities (PIDAs) would be responsible for such functions as province-wide water delivery, system maintenance, and development, and sales of water beyond amounts contracted with AWBs.

However, Punjab's reform legislation overlooked the essence of accountability. The preamble of PIDA Acts of 1997 (Government of Punjab, 1997) conceived four key objectives of reform:

(a) to implement the strategy of the Government for streamlining the irrigation and drainage system;

(b) to replace the existing administrative setup and procedures with more responsive, efficient and transparent arrangements;

(c) to achieve economical and effective operation and maintenance of the irrigation, drainage and flood control system in the Province; and

(d) to make the irrigation and drainage network sustainable on a long-term basis and introduce participation of beneficiaries in the operation and management".

Punjab

The Canal and Drainage Act (1873), which is the principal legislation for irrigation in the Punjab province, has no scope for the water users' organizations

The Punjab Water Users' Associations Ordinance (1981) provides for such associations only at the watercourse level. The Ordinance does not provide for any Water Users' Association at the higher (i.e. distributary, canal, etc.) levels.

The Punjab Irrigation and Drainage Authority Act (1997) provides for establishing Farmers Organizations (FOs) at distributary and minor levels with functions as assigned to them by the Provincial Government. The Act will, therefore, govern the FOs at distributary and minor levels while the associations at the watercourse level will be covered under the Punjab Water Users' Associations Ordinance (1981).

Sindh

The Sindh Irrigation Act (1879) also does not have any scope for water users' associations.

The Sindh Water Users' Associations Ordinance (1982) makes provision for the Water Users' Associations at the watercourse distributary and canal levels.

The Sindh irrigation and Drainage Authority Act (1972) provides for establishing Farmer Organizations at the distributary and minor levels. The function as may be prescribed by regulation (to be framed by SIDA) leaves the Sindh Water Users' Associations Ordinance (1982) to govern the associations at the watercourse level.

Khyber Pakhtunkhwa

The Canal and Drainage Act (1873), which is the principal legislation in the province has no scope of the water users.

The N.W.F.P Irrigation and Drainage Authority Act (1997) provides that Farmers Organizations are formed at the minor/distributary level.

Balochistan

Balochistan Irrigation and Drainage Authority (BIDA) Act (1997) makes provision of Farmer's Organizations.

2.3 Existing Water Rights

Traditional irrigation water rights are defined by a "*warabandi*" system, where water supply is determined by rotation and an individual's water allocation is measured by the time of water intake proportional to the size of farmland irrigated. Therefore, the traditional water rights are based on a time-equitable system. Water users are called "shareholders" in Pakistan since they hold time-share for the rotation system. In this way the water rights are linked with the farmland and cannot be separated from its land holding. The *warabandi* system has been operated for 100 years by farmers, with official recognition of the government.

Farmers used to observe traditional *warabandi* by themselves without interference of the government. The government (Irrigation Department) interferes when farmers have a dispute and cannot solve it by themselves. In such a case, the farmers go to the Irrigation Department for help in deciding rules of water distribution. With the government interference, "*Kaccha Warabandi*" is a rule of trial basis, and it becomes "*Pucca* (final) *Warabandi*" after the trial yields satisfactory results. Traditional *Warabandi* controls about 50% of water users, and government-enforced *Warabandi* about 50%.

2.4 Water Charging System

Water rates, known as *abiana* are charged by the Provincial Government for canal water supplied to irrigators. This is not a tax, but a service charge recovered from the farmers. The history of the modern water rates structure dates back to 1873, when the Canal and Drainage Act was enacted. Section 36 of this Act prescribed that "The rates to be charged for canal water supplied for the purposes of irrigation to the occupiers of land shall be determined by the rules to be made by the Provincial Government and such occupiers as accept the water shall pay for it accordingly". The first schedule for irrigation water charges was prepared for the Upper Bari Doab Canal (UBDC) in 1891. Similar schedules were prepared for other projects upon their completion (Akhtar, 1989).

Farmers pay "*abiana*," a water charge for the irrigation, to the government. The Irrigation Department makes crop assessments four times a year: two major assessments for winter and summer crops and two assessments for short-term crops like vegetables. During each crop season, assessment is made three times: at the time of first irrigation, in the middle of maturation, and at the final stage of crop maturity. The assessment results are sent to the Revenue Department, having offices in Districts and *Tehsils* (Subdivisions), for water charge collection. Finally, a headman of the village collects the water charge.

A study was organised by PIDA to explore the views of farmers about the benefits and the shortcomings of the crop based abiana system of assessments and collections. 183 farmers were interviewed in 17 Districts of Punjab. 75% of farmers were not satisfied with the prevailing abiana system and favoured the imposition of flat rate system. 73% of the farmers interviewed complained about non receipt of demand slips and pilferages in assessments. The farmers also pointed out inefficiency and malpractice in correct booking of crop sown.

In a cabinet meeting of June 10, 2003 – Introduction of flat rate on the basis of Culturable Command Area (CCA) was presented so as to facilitate small landowners, achieving higher revenue collection and to do away with the discretionary powers of Patwaries. Various options for recovery of abiana on flat rate per hectare (ha) were also presented. The Cabinet approved the system of flat rates as under:

- Flat rate of abiana at Rs. 210/- per ha included in culturable command area for Kharif crop, Rs. 125/- per ha included in culturable command area for Rabi crop was approved. Further rate of Rs 620/- per ha for sanctioned orchards was approved.
- The new system of flat rate of abiana came into effect from 1st of July 2003.
- The collection of abiana will continue to be made through revenue administration.

The flat rate of abiana has been perceived to help the farmers community escape from the high-handedness of revenue staff and to bring the large scale landowners into recovery net without compromising the total recovery from abiana in the province of Punjab. The flat rate system also makes the leakages from the system of collection difficult and thus contributes to a higher sense of efficient utilization and equitable distribution amongst small landholders.

The existing flat rate assessment of Abiana in Punjab is shown below:

(i)	Perennial hectares forming basis for the sanction of the discharge of an outlet (CCA) a) During Kharif b) During Rabi	 Rs. 210/ per ha Rs. 125/ per ha
(ii)	Non perennial hectares forming basis for the sanction of the discharge of an outlet (CCA) during Kharif only	Rs. 210/ per ha for Kharif only
(iii)	Sanctioned Gardens in perennial areas	Rs. 620/ per ha per crop season
(iv)	Sanctioned Gardens in Non-perennial areas	Rs. 620/ per ha for Kharif only
(v)	Sugarcane for which extra canal water is sanctioned in perennial areas	Rs. 620/ per ha per crop season
(vi)	Paddocks in perennial areas	Rs.420/ per ha per crop season
(vii)	Paddocks in Non-perennial areas	Rs.420/ per ha per crop season
(viii)	Fish Farms of 0.4 cusec supply in Perennial areas	Rs. 21,000/- per ha per crop season
(ix)	Fish Farms of 0.04 cusec supply in Perennial areas	Rs.2,100/ per ha per crop season
(x)	Fish Farms of 0.4 cusec supply in Perennial areas	Rs. 21,000/ per ha for Kharif only
(xi)	Fish Farms of 0.04 cusec supply in Non-Perennial areas	Rs. 2,100/ per ha for Kharif only.
Source: Irrigation & Power Deptt. Govt. of Punjab, 2003.		

The existing water rates for some major crops are shown below:

Water Rates for Major Crops in all Provinces

(Rs per ha)

Crops	Balochistan		Khyber Pakhtunkhwa		Sindh		Punjab	
	P. Canals	NP. Canals	P. Canals	NP. Canals	P. Canals	NP. Canals	P. Canals	NP. Canals
Sugarcane	155.8	126.6	162.1	132.4	158.1	119.8	158.1	152.2
Orchards	123.6	58.4	124.5	104.8	123.6	123.6	102.8	102.8
Cotton	81.1	68.1	73.1	43.5	80.9	69.8	83.0	83.0
Maize	34.7	38.9	47.4	33.6	34.6	34.6	47.4	47.4
Wheat	46.3	38.9	47.4	43.5	46.3	38.3	53.4	53.4
Kharif Oilseeds	65.6	48.7	59.3	47.4	65.5	65.5	57.3	57.3
Rabi Oilseeds	46.3	29.2	55.4	43.5	46.3	35.8	27.7	27.7

Where P&NP represent "Perennial and Non Perennial Canals" respectively.

Source: PCR Engineering/Checchi, Irrigation System Management Project, 1985.

2.5 Pakistan Water Policy

The latest water policy was drafted in 2004 (GOP, 2004), but still awaits its implementation in full. The policy draws heavily on the mainstream principles of Integrated Water Resources Management (IWRM), the contemporary and perhaps the most influential water resource management paradigm. The International Financial Institutions (IFIs) aggressively advocate the IWRM paradigm in water development cooperation. Pakistan's new water policy refers to it as the main source of inspiration. Some elements of the new water policy, such as statements on full cost pricing of water, increasing the storage potential, and devolving the management of irrigation systems to farmer's organizations and private sector have potential to trigger further controversies amongst various segments of society, and can be seen as the "sticking points" of the policy.

The IWRM inspired guiding principles of Pakistan's water policy can be summarized as:

(a) holistic development, planning and management of water resources;
(b) decentralization of development, management, planning and service provision;
(c) separation of regulatory and service provision functions;
(d) autonomy of service providers organizations and ability to recover full cost of the service from consumers; e) use of incentives for inducing efficiency, conservation and environmental protection; and
(e) inclusiveness, accountability, and transparency amongst the service delivery organizations.

Irrigation sub-sector is by far the largest water user, and the current water policy document confirms to expand and further deepen the on-going reform in irrigation-drainage sub-sector. This paper therefore examines the emergence and implementation of water policy related to Irrigation Management Transfer (IMT), which had been a bone of contention amongst various actors in water policy arena. The paper restricts itself in large parts to the IMT experience in the most populous Punjab province, which forms the major part of Pakistan's irrigated area, and remains the biggest user of water diverted for agricultural use.

2.6 Policy for Assessment & Collection of Water Rates

A three tier system of the water management system consists of PIDA, Area Water Boards and Farmer's Organizations.

A. Under Area Water Board (Conduct of Business) Regulations - 2007, water rates will be reviewed, assessed and collected. The regulation para 10 is as follows:

(1) Assessment of normal water rates

The Chief Executive through the Recovery Cell of the Area Water Board shall closely monitor the monthly progress reports received from Farmers Organizations regarding assessment of water rates. It shall be responsibility of the Chief Executive that without cogent reasons, the Culturable Command Area (CCA) under assessment of the Distributary is not allowed to alter. The Review Committee shall review the assessment made by the Farmers Organizations on quarterly basis and submit its report before Area Water Board in its Ordinary Meeting for its consideration.

(2) Assessment & Collection of Special Charges.

The Special Charges should be collected within due date and shall not be allowed to fall in arrears. It is the responsibility of FO to report each case of unauthorized irrigation and theft of water to Police and to levy Special Charges under Canal and Drainage Act, and Area Water Board shall pay full attention to it and, through Recovery Cell and Chief Executive, shall monitor it on monthly basis. The Review Committee shall review the progress on this account on quarterly basis and shall place its report before Area Water Board in Ordinary Meeting for is consideration.

(3) Assessment of Miscellaneous use of water

The Chief Executive of the Area Water Board shall, in consultation with concerned Superintending Engineer of the Canal Circle, keep a close watch on its assessment and collection. In case of failure by any agency, he shall proceed under the provisions of the Agreement for cancellation of the water supply. The Chief Executive of Area Water Board shall place a report in the Ordinary Meeting of Area Water Board annually.

(4) Collection of water charges (Abiana)

(a) The progress of Abiana Collection by the Farmers Organizations shall be reviewed by Chief Executive, through Recovery Cell of Area Water Board on monthly basis. He shall take suitable measures, to improve the Abiana collection as deemed necessary.

(b) The Chief Executive shall ensure that each FO is adhering to the schedule of collection of Abiana and takes action against defaulters as per Regulations and Instructions of Punjab Irrigation and Drainage Authority. He shall also ensure that Tehsildar Recovery follows up and proceeds for the recovery of arrears from the defaulters under the concerned law.

(c) The performance of the Farmers Organization and that of Recovery Cell must be reviewed by Review Committee on bi-monthly basis. It must also be reviewed and discussed in Ordinary Meeting of the Area Water Board on quarterly basis. The Farmers Organizations, having collection of water charges below the minimum level, as per IMT Agreement, be cautioned about the consequential actions under concerned Rules/Regulations and the Agreement.

(d) The Farmers Organizations which repeatedly fail to improve the collection of water charges should be dealt with by the Chief Executive under the provisions of Rules / Regulations and IMT Agreement. The quarterly report on such occasions shall be placed by Chief Executive before Area Water Board in its Ordinary Meeting for its consideration and inform Punjab Irrigation & Drainage Authority accordingly.

B. Under Pilot Farmers Organizations (Financial Regulations), 2000, para 8. Revenue Assessment and Collection will be as per Attachment 'A' described below:

Water Rate Assessment and Collection

1. Introduction

1.1. Flat Rate Assessment of Abiana will form the basis of assessment of water rates (Abiana) for Kharif & Rabi seasons. Assessment of water rate (Abiana) is leviable per ha of CCA (Culturable Commanded Area). As such the procedure of entries of field data and assessment of occupiers rates and formats have been provided for information and guidance of the Farmers Organizations. This procedure is required to be implemented by the FOs in assessment and collection of water rates, with the assistance of Nehri Punchayats (where formed) and Khal Punchayats.

2. Assessment

2.1 The record of Culturable Command Area i.e. CCA of the occupiers within the Chakbandi of an outlet shall be prepared on Form No. 1 in the office of the FO. These forms will be bound in shape of a register in respect of each outlet. The register shall be updated regularly to incorporate the changes. The authenticity of the record of occupiers will depend upon the certified record of Revenue department or by certified authority letters (Mukhtar Nama) of the owner along with his ownership deed (Ferd Malkiyat) of the land within the Chankbandi of an outlet. Any subsequent changes on ground may also be reported by the FO members i.e. Chairmen KPs, or Members of KPs. Thereafter it shall be checked and verified by the Treasurer of the Farmers Organization under his dated signatures. Aggregate of the land of the occupiers within the chakbandi of an outlet shall always be in agreement with the Gross Area (GA)/Culturable Commanded Area (CCA) of the outlet.

2.2 The concerned official of the FO or a nominee of the FO shall carryout survey of the Culturable Commanded Area of the outlet, complete Form No.1 and assign to each occupier a folio No. (Khata No.), for each Kharif and Rabi Crop Season. Instructions for preparation of the said record for assessment and billing thereof at Annex-A should invariably be complied with by all concerned.

2.3 The FO shall arrange preparation of assessment and check the accuracy of the area assessed and rates applied. It shall be ensured that the area assessed agrees with the CCA of the outlet, and the remissions/additions are incorporated after it has been allowed under the rules on the subject.

2.4 The FO shall prepare assessment summary of each outlet of the distributary, minor and sub minor on Form No.4. It shall be physically checked with concerned record by the Treasurer. The President and the Treasurer of FO shall sign it. The FO shall submit this summary in respect of Kharif crop on 15th of December and Rabi crop on 15th of May to the offices of the concerned Canal Division and the AWB/ Canal Circle. A copy of this summary shall also be sent to PIDA office.

2.5 Sanction of extra supply in all cases will be subject to policy of the Govt. in the I&P Department and the procedure for sanctioning and maintaining the extra supply of canal water for Gardens will be in accordance with the procedure and instructions at Annex- “B”.

Annex A. Record of CCA, Assessment and Recovery of Water Charges

Responsibilities of Farmers Organization

(1) The Farmers Organization (FO) shall obtain attested copies of watercourse plan and Outlet Register of the distributary / minor or any part thereof within its jurisdiction from the concerned Canal Division.

(2) Form No.1 is for record of CCA. The Farmers Organization shall prepare outlet-wise, village-wise record of CCA of occupiers, whereas FO members and members of Khal Panchyats shall assist the Farmers Organization in performance of this task. The entries recorded shall be signed by the concerned official of FO whereas Revenue Assistant of FO shall check and sign it.

(3) Form No.2 is for Assessment of Water Rate. The area recorded in Form No. I shall be assessed as per schedule of water rates and shall be completed by the concerned official after making assessment of the area of current crop and other dues / arrears relating to the concerned occupier in Part - I.

(4) Total amount of water charges payable by the occupier shall be abstracted in Part – I of Form No. 2. After making assessment of abiana, other recoverable dues such as addition, arrears, amount of special charges and remission will be incorporated to determine the total payable amount. The concerned official preparing the abstract of assessment of the occupiers on this Form shall sign it, whereas the Treasurer of FO shall check and sign it. The accuracy of the assessment shall be the responsibility of the FO.

(5) The FO shall prepare a list of Assesses (Occupiers) on Form No.5 for each Kharif and Rabi crops seasons from Form No.2 of each outlet and will arrange handing over of bills to the concerned occupiers after taking acknowledgement on the said Form. A copy of this list shall be handed over to the concerned Khal Panchayat to check the delivery of bills in time. The Khal Panchayat and Nehri Panchayat (wherever it exists) shall assist the Farmers Organization in recovery of abiana from the occupiers.

(6) The FO shall prepare and submit assessment summary of each outlet on Form No.4 for Kharif Crop on 15th of December and for Rabi crop on 15th of May to the office of concerned Canal Division/Area Water Board/Canal Circle office and a copy to PIDA office.

(7) It is the responsibility of each occupier to pay the bill in time. The bill may be deposited in FO office or with its authorized representative or bank in the manner as approved by the FO.

(8) In case the bill is deposited in the office of FO, the Recipient shall sign the bill with stamp and the receipt shall be appended with Form No.2 Part-I. Receipt of Recovery of water charges shall be entered in this part.

(9) In case the bill is deposited in the FO Account of its nominated bank, the bank shall send list of occupiers along with the receipt of each bill to the office of the concerned FO within 24 hours. The concerned official of the FO shall append such receipt of recovery of water charges with Form No.2 Part-I and shall enter particulars of Receipt of Recovery of water charges therein.

(10) The FO shall prepare the bill of miscellaneous use of canal water on Form No.3, which shall be signed by the official concerned and checked by the Revenue Assistant of FO. The accuracy of the bill is responsibility of the FO. The concerned person/Organization or Department shall deposit the amount of the said bill in the office of the FO or in its nominated bank in the FO Account. The said bank shall send a list of depositors (occupiers) with receipts of the paid bills within 24 hours to the FO office. Such receipts of bills shall be appended with Form No.3 for record. The concerned official of FO shall append such receipt with Form No.3 of the concerned depositors for record.

(11) The FO shall prepare weekly, fortnightly and monthly account of the amount of recoveries of abiana and that of miscellaneous use of canal water. The FO shall prepare the list of defaulters of abiana and water charges for miscellaneous use of canal water for Kharif and Rabi crops respectively and shall take timely necessary action according to the regulations and instructions of PIDA Authority.

2.7 Water User Charging Principles of Pakistan

The variety of problems now in full bloom in the Pakistan water sector have been evolving for some time and have been the subject of considerable reflection by the Government and others. Consider, for example, the conclusions which have emerged from discussions of the irrigation sector, summarized by two of the principal actors in these reforms. “In the 1990s, after consultations with international agencies, the Pakistan government embarked on major institutional reforms. At the provincial level, the three tiered system of PIDA, AWB and FO was established, through the PIDA Acts, 1997. The PIDA would be responsible for such functions as province-wide water delivery, system maintenance and development, and sales of water beyond amounts contracted with AWBs. The FO was to supply water to irrigators, be responsible for levying and collection of water charges, and make payments to the AWB. The operating public utility would be the AWB, with an average command area of 600,000 hectares. It would be established at the level of one or more canal commands, of which there are 43 in the Indus basin irrigation system. The AWB would manage and distribute irrigation water, through formal volume-based contracts with FOs, and trade water with other utilities.

2.8 Water Charges Collection Ratings

The Farmers Organization shall be entitled of retention of the share to the extent of the collected water charges provided in the "Annex-III of IMT Agreement with FOs".

Water Charges Collection	FO Share	PIDA Share	Rating	Remarks
Below 60%	40%	60%	Unsatisfactory	Liable to action by the Authority
Upto 80%	40%	60%	Conditional	Under watch by the Authority requires improvement
80% and above	40%	60%	Satisfactory	Requires further improvement
Above 90%	43%	57%	Good	FO share enhanced

2.9 Irrigation Management Transfer (IMT) in Pakistan

In Pakistan, users have managed the tertiary level irrigation infrastructure since the first development of irrigation. However, owing to concerns about sustainability of the secondary and main system, reforms were introduced in 1997 through the promulgation of Provincial Irrigation and Drainage Authority (PIDA) Acts. The reform acts were largely pushed by the World Bank with a sector loan to the Government of Pakistan at a time when it had enormous balance of payment problems, without cultivate large tracts of land. While the absentee landlords residing in urban areas remain uninformed, their lessees have no stake in long-term institutional development, as they keep on changing their operational areas with different landlords at different canals.

The mobilization of communities for participation in O&M and governance through electing the leadership has been one of the major challenges. In some parts, like in Sindh Province of Pakistan, NGOs had been deployed to carry out social mobilization and capacity building, while in the biggest province of the Punjab, the task was carried out by the ID staffs, which were directly threatened by the reforms. Though social mobilizers were also recruited by the PIDAs, but in very small numbers, they could not counterbalance the rumors spread by the ID staff. Therefore, the PIDA in Punjab had to reduce the number of O&M responsibilities initially vested with FOs to only 'reporting offenders'. This role, however, is perceived to be very bad socially. The Balochistan Province was still looking for consultants to implement the reform till 2004, even after seven years of passage of the enabling legislation. In the Khyber Pakhtunkhwa, the initial actions only started in 2003, when the consultants were commissioned through the agricultural department as well as directly by a World Bank project in 2004, where the DHV International Inc. undertook community mobilization, but with little content and coverage. For example, the International Water Management Institute (IWMI) tried to use the FOs as a basis for training and extension on Crop Based Irrigation Operations, but in the end ran a separate program directly at village level, covering all the villages in Maira Branch Canal (Upper Swat/Pehur High-Level Canal system), where no FOs had been formed, and only existed on paper (Turral pers. comm. 10 December 2006). At whatever limited scale these reforms have been implemented, it is clear that these have been successful in areas wherever NGOs have mobilized and trained FOs, and have almost failed or drifted from the original intent in areas where ID staff alone or with government recruited mobilizers have mobilized communities. There is documented evidence that returns to mobilization efforts are high in terms of improving participation and governance by the users (Ul-Hassan et al. 1999; Wahid and Ul-Hassan 2000). While FOs have to maintain more than 20 sets of registers for state inspection of their performance, the state is not obliged to be answerable to the FOs for anything. Lessons from Pakistan's reform in relation to water resource governance are summarized as follows:

(a) There is a strong need to translate policy statements presented in media and press to actions on the ground to show that the commitments are serious;

(b) While the legal frameworks are in place, the enforcement mechanisms are weak, and the reform efforts have been largely impeded by the inadequate support by the implementing agencies;

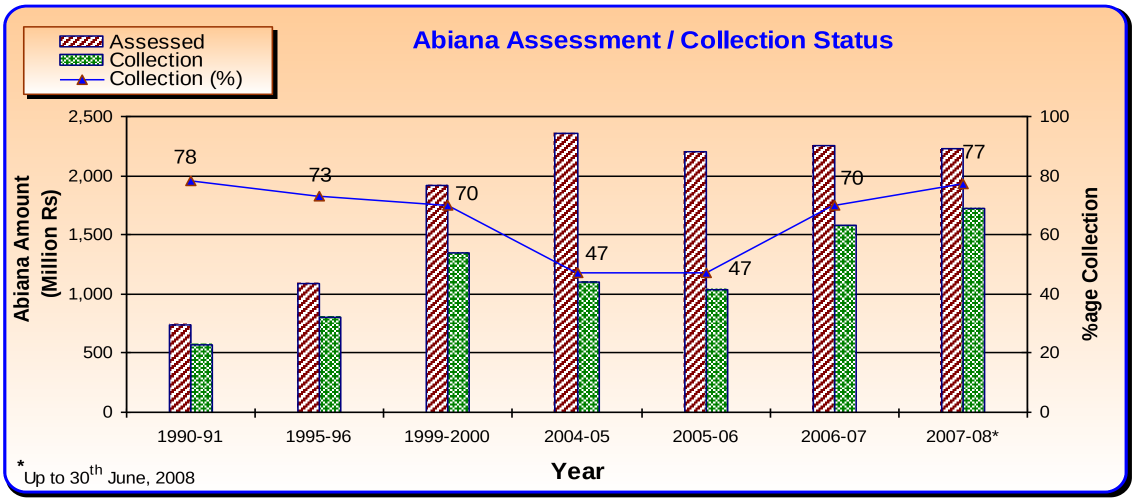
(c) In larger canal systems with a large number of farmers involved, such as those in Pakistan, the reforms cannot be implemented without an appropriate change agent (NGOs, community mobilizers);

(d) While the major thrust has been on creating users organizations to improve management, little attention has been paid to improve governance; and

(e) The accountability mechanisms are only top-down.

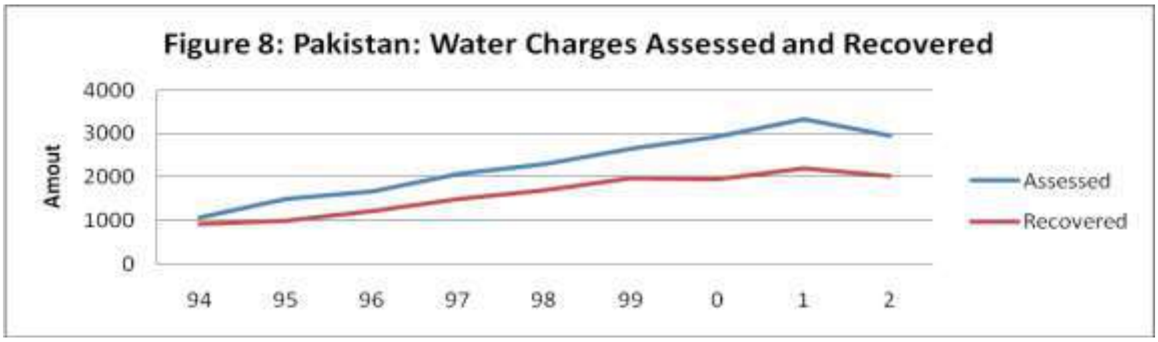
2.10 Performance of Farmers Organizations

The abiana is assessed by the Irrigation Department and collection is made by the Board of Revenue through the District Governments. Abiana collection against the current demands has been progressively declining in the recent past. The collection had declined from 79% in 1993-94 to around 47% by 2004-05 and 2005-06. While abiana assessment / collection status is presented in Figure below (Haq,1998; IPD, 2009).



In order to address the issue of declining abiana collection, special efforts were made by I&P Department during 2006 and Provincial Government was requested for according the highest priority to abiana collection. The progress was regularly monitored by the Chief Secretary in the DCOs monthly meetings. As a result of concerted efforts, the declining trend in abiana collection was reversed and abiana collection during FY 2006-07 and FY 2007-08 significantly improved to over 70%. In order to sustain the improved abiana collection, the Punjab Government has put in place the system of monthly and quarterly monitoring of provincial receipts including the abiana dues.

The water charges assessed and recovered for Pakistan, Punjab and Khyber Pakhtunkhwa province are shown below:



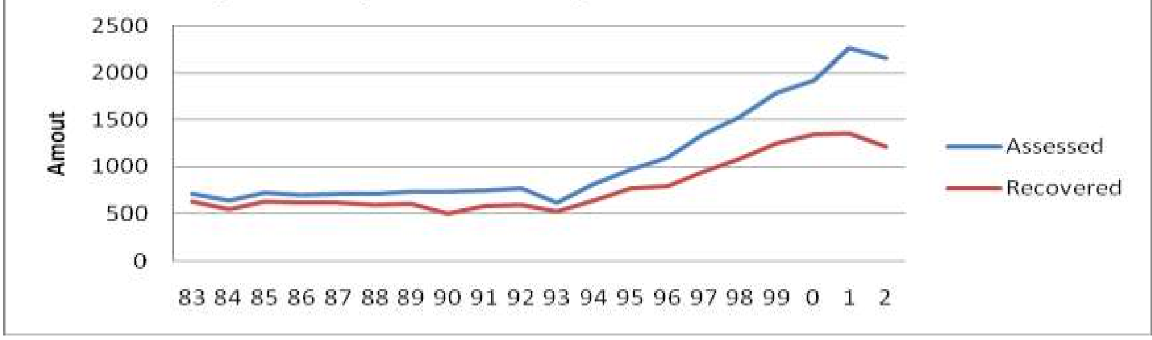


Figure 9: Punjab: Water Charges Assessed and Recovered

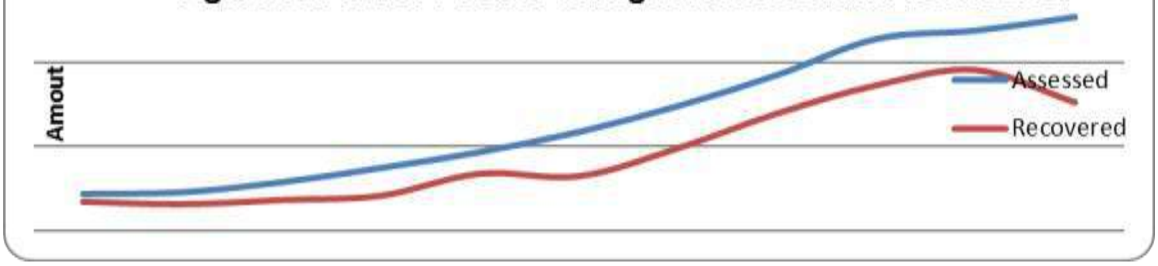
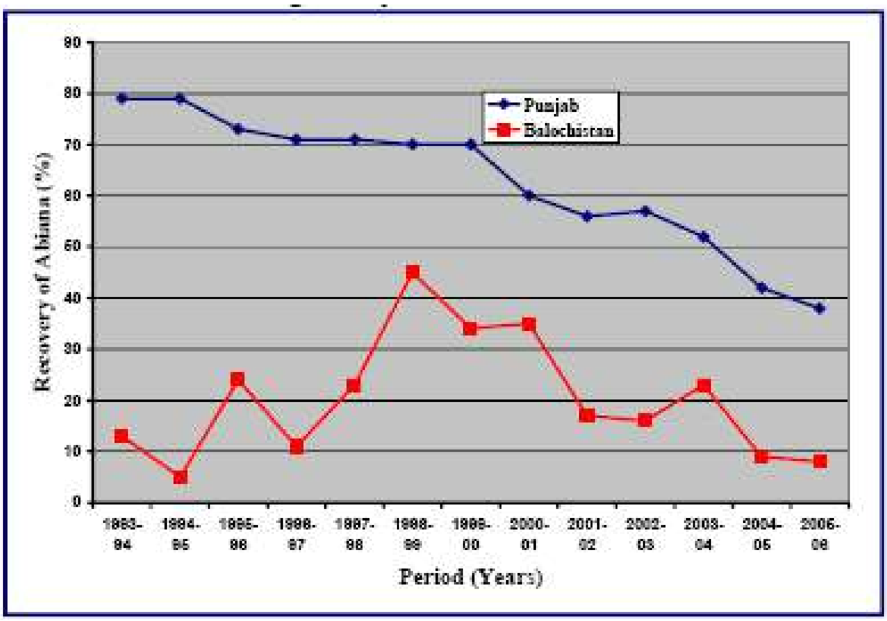


Figure 11: NWFP: Water Charges Assessed and Recovered

Source: Based on data provided by Planning Commission of Pakistan (2008)

Currently, there is a flat rate of Abiana imposed in Punjab, whereas crop-based assessment of Abiana is being practiced in Balochistan. The recovery has gone down continuously in both the provinces during the last 13 years, which may be attributed due to political and socio-economic situation prevailing in the country. The trend of reduction in Abiana recovery is almost similar in the two provinces and it cannot be attributed to the system of assessment. Case study of this abiana recovery in Punjab and Balochistan provinces are shown below:

Abiana recovery in Punjab and Balochistan Provinces



Area Water Board/LCC (E)

In AWB/LCC (E) Circle, Faisalabad, 84 FOs were formed during the year 2005. These FOs are performing functions under IMT scenario as the IMT agreements have already been signed between Management Committee of FOs and CE, AWB on behalf of PIDA. The performance of FOs has been observed in following major issues.

- Awareness has been created amongst the farmers after adopting Social Mobilization techniques and methods by the PIDAÕs professionals and FOs are regularly conducting meetings of General Body and Management Committee.
- After IMT, 84 FOs of AWB/ LCC(E) Circle, FOs of AWB/ LCC(E) Circle get able to resolve water disputes efficiently through mutual cooperation at their door step and resolved 450 water disputes.
- Water theft cases reduced to large extent due to the social pressure. FOs have build their capacity and taking legal actions against accused of water theft. 84 FOs of AWB/ LCC(E) Circle registered, 85 FIRs against accused.
- Capacity building of FOs representative showed improvement in functioning of Farmers Organizations in organizational development and other issues.
- Improve canal operation and water distribution equitably upto tails.
- Repair and maintenance work of channels has been carried out by FOs on self help basis and out of their share of 40% of Abiana collection and spent 3.8 million on repair and maintenance works.
- 38 Nos. cases of chakbandi disposed off by FOs of AWB/ LCC(E) Circle.
- FOs of AWB / LCC(East) Circle, have checked 4233 outlets and rectified 693 outlets.
- All FOs have displayed the schedule of warabandies at their notice board and delivered copy of warabandies to each Khal Panchayat of FO.
- The performance of FOs in Abiana collection is as under:

Sr. No.	Name of Division	No. of Outlets	No. of FOs	CCA (Hectares)	Assessed (M.Rs.)	Recovered (M.Rs.)	% age
1	Hafizabad	728	20	125,734	23.93	21.64	90
2	Faisalabad	810	21	118,973	21.09	19.43	92
3	Jhang	1,059	23	211,106	35.62	32.07	90
TOTAL		2,597	64	455,813	80.64	73.14	91

Hakra 4-R System

The interesting feature is of Hakra 4-R where the system was transferred to the farmers association is shown below:

Indicator	*1998 Before Transfer*	*2007 After Transfer*
Water charges [Rs/ha]	175	197
Total revenue Collected (Rupees)	4.49 million	5.40 million rupees.
Water delivery performance	0.91	1.04
Overall system efficiency	0.47	0.52
Cropped area (ha)	25614	27115
Head tail equity	NA	1.09
Farmer's response		Varied from 38% to 41% for all categories. Law cases were used to take undue advantage of the

• Increased benefits at the head. • Increased benefits at the middle. • Increased benefits at the tail. • Overall satisfaction. • Law cases successfully defended		system and this was normally done by seeking a stay order and perpetuating a powerful situation.

REFERENCES

Agricultural Statistics of Pakistan, 2006-07

Akhtar M. 1989. Charging for Irrigation Water: Review of Present Practices and Methods. M.Sc. Dissertation. Institute of Irrigation Studies, University of Southampton, UK.

Dil, Muhammad Prof. 1998. Legal Framework for Irrigation Management in Punjab and Sindh Provinces, Pakistan, International Water Management Institute Lahore

GoP. 2002. Pakistan Water Sector Strategy, National Water Sector Profile. Production and Consumption Patterns in a Rapidly Changing World. Background Report for CSD12, New York, April 2004. SIWI, Stockholm, Sweden.

Government of Punjab, Irrigation & Power Department Notification No. SO(REW)I&P/3-98/2003.

Govt. of Pakistan/US AID, PCR Engineering/Checchi, Irrigation System Management Project, An Evaluation of Existing Irrigation Water Pricing Policy in Pakistan, November 1985.

Government of Punjab. 1997. Punjab Irrigation and Drainage Act, 1997. Provincial Gazette. Punjab Printing Press. Lahore, Pakistan.

Government of Pakistan. 2004. National Water Policy (draft). Ministry of Water and Power, Islamabad

Haq, A. U. 1998. Case Study of the Punjab Irrigation Department. Consultancy Report No. C-12. International Water Management Institute (IWMI), Lahore, Pakistan.

IPD, 2009. Budget and Abiana Files of Punjab Irrigation & Power Department, Lahore – Pakistan.

IPD, 2009. Budget and Abiana Files of Punjab Irrigation & Power Department, Lahore – Pakistan.

Javed Saleem Qamar, 2007. Pakistan's Water Resources Development and Management

M. Ghaffar Chaudhry, Syed Abdul Majid, Ghulam Mustafa Chaudhry, 1993, The policy of irrigation water pricing in Pakistan: aims, assessment and needed redirections, Pakistan Development Review

Nakashima, M. 2005. Pakistan's Institutional Reform of Irrigation Management: Initial Conditions and Issues for the Reform. Hiroshima Journal of Irrigation Sciences

PIDA Report 2007. Monitoring and Evaluation Report of Farmers Organisation in LCC (East) Canal Command System, Punjab.

The Punjab Gazette, Extraordinary Issue Registered No.L.7532

Ul-Hassan, M.; Memon, Y.; Hamid, A. 1999. Returns to facilitating farmers' organizations for distributary maintenance:

Empirical results from a pilot project in Southern Punjab. The Pakistan Development Review 38(3): 253-268.

Ul Hassan, M.; Qureshi, A. S.; Heydari, N. 2007. A proposed framework for irrigation management transfer in Iran: Lessons from Asia and Iran. Colombo, Sri Lanka: International Water Management Institute. 37 pp. (IWMI Working Paper 118)

Ul Hassan, M. 2008, The Conception, Design and Implementation of IMT in Pakistan's Punjab: A Public Policy Reflection

Wahid, M. A.; Ul-Hassan, M. 2000. Union is strength: Participatory development experiences of Hakra 4-R distributary farmers in Pakistan's Southern Punjab. Special Issue on Participatory Development. Canadian Journal of Development Studies, 2000.

Water Apportionment Accord, 1991

WAPDA, 1979. Main Report of Revised Action Programme for Irrigated Agriculture, Master Planning and Review Division, WAPDA, Lahore.

WAPDA, 2009. Proceedings of Seminar on Water Costing By Water Resources Planning Organization, Planning and Design Division (Water) 202-Wapda House, Lahore

World Bank. 1994. Pakistan Irrigation and Drainage: Issues and Options, Report. No.1184-PAK. Agriculture and Rural Development Unit. South Asia Region. International Bank for Reconstruction and Development. New York

World Bank Policy Paper on Water Resources Management, 2005

❖❖❖❖❖

3.7 Country Policy and Strategies on Financing and Implementation of Current Water User Charging Systems in Irrigation: Case Study of India

By Mrs. Ananya Ray (India)

After independence in 1947, construction of a large number of irrigation projects has been undertaken in the country during the successive Five-Year Plans for expanding irrigation facilities to large areas as was possible in order to meet the increasing demand for food for the growing population. However, over the years many of these irrigation projects have lost its original capacity because of non-maintenance or poor maintenance. This was because of many reasons, the main being the lack of funds for maintenance, low or nil water charges being charged, etc.

Water is a State subject under the Constitution of India meaning thereby that the states or the provincial governments have the right to legislate on it. While there is a National Water Policy, the states have also their respective water policies. The irrigation projects in the country are by and large conceived, implemented, funded and monitored by the State Governments. They are funded either through the normal budgetary resources or through external borrowings etc. The Central or the Federal Government have been giving a portion of this cost as central assistance to the states on a case to case basis basically to facilitate completion of last mile projects which have been languishing for various reasons mainly for want of resources at the state level.

Coming to the issue of maintenance of these irrigation projects, the existing systems need to be well maintained and, therefore, allocation of funds for the operation and maintenance requires to be given priority. There is a necessity for proper upkeep and maintenance of irrigation systems to remedy the paradoxical situation, namely, that while the nation spends `1.25 to `1.50 Lakh (at 2006-07 prices) to bring one additional hectare under irrigation, it is losing existing available irrigation coverage gradually by not spending `600 per hectare (approx.) annually for maintenance. Various committees and commissions have been set up in the country by the Government to go into the issue from time to time.

The National Water Policy of 2002 has laid stress on giving adequate emphasis to the physical and financial sustainability of the existing irrigation facilities. It states as under:-

> ***"There is, therefore, a need to ensure that the water charges for various uses should be fixed in such a way that they cover at least the operation and maintenance charges of providing the service initially and a part of thecapital costs subsequently. These rates should be linked directly to the quality of service provided".***

The Working Group on Major And Medium Irrigation Programme for the 11th Five Year Plan constituted by the Planning Commission in February 2006 had made the following recommendations:-

(1) Project Authorities should adopt an O&M cost norm of `600/- per ha for utilized potential and `300/- per ha, for unutilized potential as per the recommendations of the 12th Finance Commission. The subsidy on water rates to the disadvantaged and poor sections of the society should be well targeted and transparent.

(2) Full O&M cost of irrigation system taking into account the inflation rate should be recovered in phased manner at the earliest in the 11th Plan starting from 2007. Motivation policies like giving concessions and incentives can be considered by the State so as to improve the water use efficiency and recovery of water charges.

(3) State Governments to initiate appropriate action to enhance the water rates to cover 1% of capital cost in addition to achieving O&M cost fully. Wherever practically possible, water should be saved to meet the rising demand for non-irrigation purposes like drinking water, industry, thermal power generation, etc. Water rates for nonagricultural use should also be carefully rationalized. For the storage requirement for non-irrigation purpose, the agency demanding water for a non-irrigation use should provide full funds enabling the use of such storage. For lift Irrigation Schemes water charges need to be evolved based on non-subsidized electricity charges.

(4) State Governments may constitute Water Regulatory Authorities and adopt the Maharashtra model for fixing water rates.

(5) State Governments should follow strict financial discipline with regard to non-plan expenditure earmarked for major and medium irrigation projects. A high powered committee should review every quarter the allocation and utilization of funds provided for maintenance.

(6) State Government to concentrate on maintenance of main water distribution system leaving the sub-distribution system to Water Users' Association in order to reduce cost on staff and for better Farmers'/Users' participation and for better water management. However, before handing over the minor level systems to Farmers' Association, they should be in reasonably good shape and running conditions.

(7) Water Users' Association to take responsibility of collection of water charges from the beneficiaries.

(8) The salient features of WRCP project, which have been formulated and implemented in Haryana, Orissa and Tamil Nadu, may be taken by other states as a model Project enlisting farmer's participation and as a self-financing project.

(9) CAD Programme should be strengthened and NWMP should be taken up in the XI Plan.

(10) The aspect of limiting the establishment costs in O&M needs to be studied along with the possibility of redeployment of surplus staff presently charged to O&M expenses to some other fields like local watershed development programmes, etc.

(11) The possibilities for private sector participation in management of distribution system need to be explored further. Paragraph 13 of the National Water Policy of 2002 explicitly encourages private sector participation.

The Thirteenth Finance Commission set up by the Govt. of India has made certain important recommendations which have since been accepted by the Government of India. They have made the following recommendations:-

(1) To set up a Water Regulatory Authority for each State and specification of minimum level of recovery of water charges. The proposed regulatory authority may be given the following functions:-

   (a) To fix and regulate the water tariff system for charges for surface and sub-surface water used for domestic, agricultural, industrial and other purposes.
   (b) To determine and regulate the distribution of entitlement for various categories or users as well as within each category of use.
   (c) To periodically review and monitor the water sector costs and revenue.

(2) An Incentive Grant of `5000 Cr has been kept for this purpose. The inter-se allocation of this incentive grant to the states will be in proportion to their respective share in the total Non-Plan Revenue Expenditure (NPRE) across all states of expenditure on irrigation and their respective share in all states Irrigation Potential Utilized (IPU) at the end of the Tenth Plan, i.e. March 2007. Equal weights are assigned to each of these two shares. This amount would be released in two equal installments over the four-year period – 2011-12 to 2014-15. The states are given one year to make the necessary preparations to absorb these funds.

(3) Release of grants would be subject to the following conditionalities:-

   (a) States have to set up Water Regulatory Authority by 2011-12 to be notified latest by 31.3.2012.
   (b) States are required to achieve the projected recovery rates to become eligible for grants. This has been worked out by calculating the recovery rates for irrigation separately for various categories of states on the basis of revenue receipts as per the percentage of NPRE for the year 2009-10 base year. Based on these rates, state specific recovery rates for the period 2011-12 to 2014-15 have been normatively projected (Annexure).
   (c) The incentive grants for water sector are an addition to normal maintenance expected to be incurred by the states.
   (d) Where the state Water Regulatory Authority mandates recovery rates it shall be eligible for grants if it recovers at least 50% of the water charges mandated by the authority.

It is expected and hoped that with this new policy initiative of Govt. of India, the maintenance of irrigation projects through grants, state resources and recovery of water user charges, the capacity of the irrigation projects could be utilized to its fullest.

❖❖❖❖❖

3.8 Water use charging systems and financing of irrigation development in Australia: A case study of Goulburn Murray Water[1]

Introduction

The aim in this paper is to illustrate some of the current concerns facing the Australian irrigation industry. Using the example of the Goulburn Murray Water irrigation scheme and the impacts that the Northern Victorian Irrigation Renewal Project, it is argued that within Australia many of the mistakes that have existed over the 100 years of its existence, continue to be replicated. While the motives for investing in irrigation change (from one of encouraging development and closer settlement to saving the environment), the mistakes of not knowing the costs and effects of such actions remain the same. In Australia it is governments that coordinate these investments, financed from genera revenue, and irrigators who gain. Irrigators have never paid for the full costs constructing the systems that serve them so well, and have in the past been tardy about paying to maintain them or to reinvesting in their improvement. Much of this is well known and recent reports by the Victorian Ombudsman (2011) and by the Victorian Auditor Generals Office (unknown and get), but they are only the most recent in a long list of critics that are more than adequately documented by Davidson (1969).

In this paper an outline of the operation of the Goulburn Murray Water irrigation scheme in Northern Victoria is presented (as per the brief request). In the latter sections of this paper the problems of reinvestment are reported and discussed.

Goulburn Murray Water: Physical aspects.

Goulburn Murray Water (hereafter GMW) is the largest rural water corporation in Australia. Based in Northern Victoria, GMW supplies 2,500GL of water to more than 15,300 irrigators and manages 180GL of groundwater extractions for more than 7,500 customers. In addition, it provides bulk untreated water to six urban and rural corporations (which supply approximately 30 rural towns with water) and to over 1,200 customers for watering stock and for domestic purposes (GMW 2012). The area serviced by GMW is 68,000km^2 (see Figure 1).

Figure 1. The Goulburn Murray Irrigation System

[1] Dr. Brian Davidson, Department of Resource Management, University of Melbourne, Parkville, Vic. Australia. 3010, b.davidson@unimelb.edu.au

A paper prepared for the ICID Task Force: Financing Water for Agriculture

63rd Annual Conference of the International Commission on Irrigation and Drainage, Adelaide Australia. June 2012.

It should be noted that this is a Working Paper on work in progress. Please do not quote without corresponding with the author.

The resources it draws on to harvest the water are presented in Table 1. GMW operates 6,700km of open channels and 252km of pipelines to deliver the water and 3,142km of drains to take the excess. In delivering the water to irrigators GMW owns and maintains 23,333 structures and 8,333 drain inlets. There are also 21,335 meters measuring the amounts delivered to each irrigator. These figures do not include the assets supplying water for domestic and stock purposes. It has been estimated that the GMW's entire water storage and delivery network is worth more than $A5.9 billion (GMW 2012).

Table 1. The Goulburn-Murray Irrigation System

River Systems		Capacity (GL)	Bulk Prices by entitlement			Storage	prices
			Very high	High	Low	High	Low
			(A$/Ml)	(A$/Ml)	(A$/Ml)	(A$/Ml)	(A$/Ml)
Murray	Dartmouth	3906	-	10.6	4.8	11.6	4.4
	Hume	3038					
	Yarrawonga	117.5					
	Torrumbarry	36.81					
Ovens	Buffalo	23.34	-	34.7		11.6	4.4
	William Hovell	13.5					
Broken	Nillahcootie	40.4	-	27.5		9.4	4.6
	Eppalock	304.65					
Goulburn	Eildon	3334.16	7.7	7.3	3.7	9.4	4.6
	Goulburn Wier	25.5					
	Waranga	432.36					
	Greens	32.5					
Loddon	Cairn Curren	147.13		29.3		9.4	4.6
	Tullaroop	72.95					
	Leanecoorie	8					
Bullarook	Newlyn	3.3		236.2	143.1	9.4	4.6
	Hepburns	3					

It should be noted that GMW does not own any water as it is the Water Resource Manager for Northern Victoria, responsible for allocating and distributing water resources in the region. Of the average 2,500GL delivered, approximately 95% is used for irrigation, the environment takes 3% and the towns take 2%. The irrigation water is delivered to one of six irrigation districts (see Figure 1).

Institutional Arrangements

GMW was established in 1994 to replace the Victorian Rural Water Corporation (which had previously been responsible for delivering water to irrigators. The GMW is wholly owned by the Victorian State Government and the Board of Directors is appointed by the Minister for Water.

As stated above, GMW does not own any water. It is responsible for maintaining the network and for charging users. It harvests, stores and delivers water by regulating river flows in Northern Victoria. While individual customers (irrigators) own the water, it is GMW that is responsible for determining the amount each will receive. Irrigators have a right to pump a share from a fixed amount of water available in any one year. For example, an 80% allocation means that there are sufficient resources in the system for all customers to access 80% of their water right.The GMW also releases water in order to maintain minimum river flows, which is part of its environmental responsibilities.

As the system is not large enough to supply every customer at the same time, an ordering system is in place. Irrigators need to place an order for water four days in advance of it arriving. This time lag applies even though in some places (like Boort) it takes 10 days for the water to arrive after being released from either lakes Hume or Eildon.

Irrigators can buy and sell water within the system on an open market. In the past year $700 million worth of water was traded in the catchment. The price of each trade is determined by buyers and sellers and while GMW needs to process and approve of the transfer, it has no role to play in determining the price of water traded (GMW 2012). While irrigators have the opportunity to trade over 90% of the water they are entitled to, in reality very little is traded within and outside the region (see Table 2). In 2005-06 on average only 6% of the water that could be traded was traded on a temporary basis (within a year) within the region and a further 6% was traded from outside the region into it. Rochester would appear to have the greatest transfer to it, while Central Goulburn had the greatest internal trade. The quantity of permanat trades in 2005-06, both internally and externally was only between 1 and 2% of the amount that is allowed to trade (ANCID 2007).

Table 2. Water Trading Arrangements 2005-06

Scheme	Total transferable entitlement	Proportion of total entitlement	Internal transfers		External transfers	
			Permanent	Temporary	Permanent	Temporary
	(GL)	(%)	(GL)	(GL)	(GL)	(GL)
Murray	259.368	94.78	1.676	16.961	-1.175	5.539
Shepparton	171.605	93.93	0.405	10.486	-3.417	-7.865
Central Goulburn	387.362	84.05	4.792	31.397	-7.216	26.509
Rochester	219.431	89.21	0.585	11.901	-3.928	30.538
Pyramid Boort	220.763	95.29	5.166	11.173	-4.289	19.557
Torrumbarry	339.325	94.81	3.817	19.014	-6.599	27.767
Total	1597.854	91.16	16.441	100.932	-26.624	102.045
Benchmarking Report. Torrens, ACT.						

Farming in the region

Details of the farming activities within the region GMW supplies water are presented in Table 3. In 2005-06 a total of 2,525GL (surface and groundwater) were supplied across the region, 44% more that the entitlements allocated in that year. This water was spread over 442,161ha of crops in a scheme that has the potential to irrigate 866,094ha. In the six major irrigation districts the principle activity undertaken is the production of pasture, used to produce dairy products. That being said, the region is a significant producer of fruit and horticulture (ANCID 2007).

The number of farmers in the region and the water allocated was presented in Table 3. In 2005-06 there were an estimated 10,695 producers irrigating 41.3ha each. The average area irrigated varied greatly, from a low of 17.4ha in the older region around Shepparton to a high of 145ha in the dryer western region of Pyramid Hill Boort. The amounts diverted in 2005-06 also varied greatly, with farmers in Shepparton receiving averagely 100ML and those in Pyramid Hill Boort receiving 5 times more.

Details of the Gross Value of Irrigated Agriculture in 2010 is presented in Table 4. This data was collected from the ABS (2010) and accords with their system of regional areas, which are not the same as those of GMW. Regardless of this, GMW is the regulator of water in the four regions of northern Victoria. The four regions specified in Table 4 account for approximately 67% of the water allocated in the state and the output accounts for 54% of the total value of irrigated agriculture. In terms of returns fruit accounts for just over one third of the gross value of irrigated production from the four regions, while grapes and dairy account for less than 20% each. Yet in terms of water applied, just under 25% is applied to fruit, 14% to grapes and 42% is used to maintain pastures for the livestock industries. The livestock sector is dominated by the dairy industry.

Table 3. Irrigation Schemes within the GMW 2005-06

Scheme	**Area**	**Total**		**Diver-sions**	**Custo-mers**	**Towns**	**Main crops**		
	scheme size	**irri 2005-6**	**Entitle-ment**			**Sup-lied**	**1**	**2**	
	(ha)	**(ha)**	**(GL)**	**(GL)**	**(no.)**	**(no.)**			
Murray	122457	63000	273.66	444.18	1231	6	Pasture	Dairy	Can-ning fruit
Shepparton	82460	43981	182.69	251.32	2518	5	Pasture	Dairy	Can-ning fruit
Central Goulburn	172131	94482	460.87	534.83	2900	5	Pasture	Dairy	Horti-culture
Rochester	117066	70240	245.97	305.36	1246	5	Pasture	Dairy	Beef
Pyramid Boort	186481	86948	231.66	292.92	600	6	Pasture	Dairy	Beef
Torrumbarry	173366	83510	357.89	696.36	2200	0	Pasture	Dairy	Crop-ping
Total GMW	866094	442161	1752.736	2524.957	10695	27			

Source: ANCID (2007) Benchmarking Data Report for 2005/2006: Key Irrigation Industry Statistics and Performance Indicators. Australian Irrigation Water Provider Industry, Benchmarking Report. Torrens, ACT.

Table 4. Gross Value of Irrigated Agriculture and Water Applied 2010

	Gross Value of Irrigated Agriculture					**Water Applied**				
	Vic.	**Goulburn Broken**	**Mallee**	**North Central**	**Wimmera**	**Vic.**	**Goulburn Broken**	**Mallee**	**North Central**	**Wimmera**
	($m)	**($m)**	**($m)**	**($m)**	**($m)**	**(GL)**	**(GL)**	**(GL)**	**(GL)**	**(GL)**
Cereals for grain and seed	7.97					31.76	9.67	0.00	13.23	0.00
Hay	57.92	20.06		21.81	2.18	109.46	36.16	0.28	53.28	2.40
Rice	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other broadacre crops	2.24		0.00		0.97	0.00	0.00	0.00	0.00	3.23
Fruit	731.99	276.62	198.50	116.52	1.48	259.72	49.82	164.89	30.23	0.16
Grapes	367.43	19.19	275.66	22.05	1.75	155.29	5.82	134.87	8.62	0.38
Vegetables	511.17	44.05	39.06	86.74	-	93.80	9.17	0.00	18.96	0.00
Nursery production	323.79	32.99	17.77	18.65	-	11.25	1.35	0.93	0.00	0.00
Dairy production	906.49	196.46	0.00	151.12	0.00	na.	na.	na.	na.	na.

Gross Value of Irrigated Agriculture						Water Applied				
	Vic.	Goulburn Broken	Mallee	North Central	Wimmera	Vic.	Goulburn Broken	Mallee	North Central	Wimmera
	($m)	($m)	($m)	($m)	($m)	(GL)	(GL)	(GL)	(GL)	(GL)
Production from meat cattle	185.19	51.11	0.80	32.42	0.36	na.	na.	na.	na.	na.
Production from sheep and other livestock	159.17	31.80	3.77	34.90	27.67	na.	na.	na.	na.	na.
Livestock grazing	na.	na.	na.	na.	na.	797.76	183.37	10.91	222.18	13.68
Total	3,253.51	674.96	535.73	487.63	50.59	1,504.74	303.66	320.02	362.52	27.54

According to ANCID (2007), as a general rule of thumb, it takes 8ML of water to produce a hectare of perennial pasture in the region. However, it takes only 3ML of water to produce a hectare of annual pasture These figures can vary by up to a factor of one across the region and by even more if it is an exceptionally dry or wet year. In the central regions of Shepparton and Central Goulburn, a hectare of stone fruit requires between 3 and 6 ML of water for each hectare harvested.

Financial management at Goulburn Murray Water

The point was raised earlier that GMW does not own the water, it harvests and delivers it. GMW not only charges for the volume of water supplied, but also applies a service charge as well. Over 95% of the customers supplied have a meter. In charging for their services GMW is responsible for water allocation and distribution, the maintenance of the headworks and canal systems, drainage services and supplying the bulk water needs for urban and environmental users.

The assets of the system were estimated to be worth $A1.7billion in 2005-06, with an expected life (when new) of 109 years. The current average life is estimated to be 57 years. GMW has an extensive planning process to renew assets on a regular basis and spends approximately 20% of its total budget on maintenance (ANCID 2007).

Details of the charges for running the GMW system in 2005-06 are presented in Table 5. Bulk water is sold for between $A6 and $A8/ML, with a similar fee for water delivery. The costs of the water entitlement vary from $A18 to $A39/ML across the scheme. The service fee (the fixed charge does not vary across the scheme and is set at $A100. The government also subsidises the scheme. This subsidy can be as high as $A18.38/ML in the older parts of the scheme and as low as $A0.36/ML in Torrumbarry.

Main issues, pros and cons, discussion on both case study and national situation

It has been reputed that Australia runs its irrigation schemes well and others around the world should follow their lead. This reputation is built on the fact that volumetric charging is used and that some attempt has been made to recover costs. In addition, adding to that reputation is the fact that since 1994 water trading has been possible, that the rights to water are not tied to land holdings and that the environment is considered to be a legitimate user of water.

However, this reputation is quite at odds with the reality once one considers the extent to which governments have intervened in the sector in the past and continue to do so now. The construction and maintenance of Australia's irrigation schemes were all underwritten by government subsidies. This represented a gift from taxpayers to irrigators, something they continue to reap even today.

Table 5. The Pricing Structure at GMW 2005-06

System	Bulk Water charge	Water delivery	Water share	Fixed charge	Total charge per ML	Fixed charge	Govt. funding	Irrig revenue/ ML
	($A/ML)	($A/ML)	($A/ML)	($A)	($A/ML)	($A)	($A/ML)	($A/ML)
Murray	7.89	7.37	22.97	100	38.23	100	9.6	40.33
Shepparton	6.02	7.98	31	100	45	100	16.64	60.54
Central Goulburn	6.02	6.17	26.54	100	38.73	100	18.38	46.72
Rochester	6.55	7.27	22.66	100	36.48	100	4.22	41.82
Pyramid Boort	6.02	6.22	17.96	100	30.2	100	2.28	23.4
Torrumbarry	7.89	6.89	20	100	34.78	100	0.36	31.67

Source: ANCID (2007) Benchmarking Data Report for 2005/2006: Key Irrigation Industry Statistics and Performance Indicators. Australian Irrigation Water Provider Industry Benchmarking Report. Torrens, ACT.

Not content with receiving the initial largess from the government irrigators have not invested enough to maintain the schemes. In recent years the government has recognised that it has over allocated the water to farmers, to the detriment of the environment, and has attempted to claw some back. This has generally involved buying back irrigators entitlements and by paying for improvements that would increase water use efficiency and delivery.

It is with respect to this second program (paying for improvements) that has caused the greatest concerns and has had a direct impact on GMW. In 2007 the Victorian Government established a body called the Northern Victorian Irrigation Renewal Project (NVIRP) to plan and deliver what was known as the Foodbowl Project, a plan to spend $A2billion to save 225GL of water in Goulburn Murray region. Under the plan much of the infrastructure (which still has an average life of more that 40 years (see above) was to be renewed and the retirement of a significant proportion of the back channels and pipelines. Furthermore, it would appear that the water delivery distribution scheme was working to a fairly high degree of efficiency (see Table 6). In 2005-06 ANCID (2007) estimated that in all years somewhere between 70 and 96% of water ordered was delivered. The scheme with the lowest average was at Torrumbarry, which is at the extremeties of the system, but it stll managed a figure of 67%. Given the target rates of around 70 to 75% in the region, one can only wonder why the Goulburn Murray attracted the interest of policy makers.

Table 6. Water Delivery Distribution Efficiency

Scheme	Average all years	2005-06	Target rate
	(%)	(%)	(%)
Murray	71	73	72
Shepparton	79	82	75
Central Goulburn	71	72	73
Rochester	96	100	73
Pyramid Boort	90	100	76
Torrumbarry	67	69	71

Source: ANCID (2007) Benchmarking Data Report for 2005/2006: Key Irrigation Industry Statistics and Performance Indicators. Australian Irrigation Water Provider Industry Benchmarking Report. Torrens, ACT.

In the ANCID (2007) study, the major concerns expressed by GMW related to environmental issues and the use of natural waterways as the prime conveyency system. In addition salinity and water contamination issues were raised as threats. Only in one scheme (Torrumbarry) were water saving measures thought to be of (a secondary) concern.

Even a simple glance at the data suggests that at $A2billion to save 225GL was not a good deal. This represents a cost of approximately $A8800/ML, when the price of buying back permanent water allocations were approximately $A1200/ML. In addition, the size of the water saving, at 225GL is quite small in a system of 2400GL.

The Ombudsman Victoria (2011) found that the government committed to the project without making a Business Case for it. The Ombudsman was also critical of the Cost Benefit analysis undertaken and cast great doubt on the amounts of water to be saved. The Ombudsman also documented a range of serious problems associated with the management of the project. These problems were not only confined to the NVIRP, but also involved public servants and those employed by GMW.

The Victorian Auditor General Office (2010) concluded that the,

> "Victorian Government decisions to invest around $2 billion in irrigation efficiency and related projects between 2004 and 2007 were poorly informed. Whether these projects represent the best solution to achieve the government’s policy objectives of saving water and securing Victoria’s water, remains unclear.
>
> This was particularly evident for the Foodbowl Modernisation Project, where the decision to commit $1 billion was based on advice of water savings and cost assumptions that had not been verified, technology that had not yet proven itself and the feasibility of the project, which was unknown. As a consequence, assumed water losses have been significantly revised down, making the achievement of intended water savings less certain."

To be clear, the inference that cannot be ignored in this project was that it was made on political, rather than sound economic, grounds.

Discussion and Conclusions

Does the country learn from these mistakes? Clearly not! In late October 2012 the Federal Government committed $A1.7 billion to undertake a similar program further down the Murray, in South Australia, supposedly to save 450GL. There is no feasibility plan available for the project.

Rather interestingly, it was concerns over the environment that had a lot to do to motivate the Government to intervene and set up the NVIRP and others like it. The perceived need that in some way engineering can create water (rather than just direct it from one use to another), was enough in a drought where the government believed that it could provide more water for both the environment and irrigation by improving efficiency. The point to recognise from an economic perspective is that there is only a fixed quantity of water. The arguments about fixing leaks as such were really about having more control over the environment, as a leak (or loss) is nothing more than an entry into the environment at a place where you don't desire it. Fixing the leak means that the quantity controlled rises and then can be placed elsewhere in the environment. By sharing the efficiency improvement with irrigation really means that the environment loses.

These schemes are nothing more than a gift to the irrigators. While they are sometimes asked to make a contribution (in the case of the NVIRP, GMW contributed $100million), the amount is usually insignificant in the overall project. More to the point, it is a continuation of the thinking that led to the establishment of irrigation schemes in Australia. That is that the public pays for them and the irrigators reap the rewards. If irrigation was as beneficial as many claimed, then why is it that the irrigators themselves do not undertake the work?

It was not as if the mistakes that have most recently been made were not known from past experience or could have been avoided. Far from it! As Davidson (1969) suggested even as many schemes were in the process of being constructed, for numerous reasons irrigation did not work towards the countries comparative advantage and would not be a cost effective development. Evans (2009), in a book on Australia's disasters, devoted a chapter to the costs (both financial and environmental) irrigation had imposed on the country. The environmental basis has for many years outlined the damage done to catchments. Davidson (2007) even argued that the efforts of the Federal government in this area were not going to be cost effective.

With respect to the dollars spent, this has been a disaster. The costs of buying back irrigators licences would be less (per ML) than investing in the NVIRP. In addition, it was a gift from tax payers (and water consumers in Urban Victoria) to farmers. One can not imagine why it is that farmers did not contribute to it. After all, like a lot of schemes like this one, the vaule of the government largess becomes embodied in the fixed assets. So when water entitlements were tied to land titles, investing in water infrastructure increased the value of land supplied by that water. As water rights are now not tied to a land title, all this investment does is increase the value of the main asset which is now water. The water is owned by the same people who owned the land, so what has changed? Nothing. The holders or irrigation licences should be asked to improve the infrastructure as they are the main beneficiaries of the government largess.

References

ABS (2010). *Water Use on Australian Farms: 2008-09*. Canberra, Australian Bureau of Statistics**:** 52.

ANCID (2007). Benchmarking Data Report for 2005/2006: Key Irrigation Industry Statistics and Performance Indicators. Australian Irrigation Water Provider Industry Benchmarking Report. Torrens, ACT.

Davidson, B. R. (1969*). Australia wet or dry?: The physical and economic limits to the expansion of irrigation*. Carlton, Victoria, Melbourne University Press.

Davidson, B. (2007) "Why do good policy procedures dissolve in water", **Invited** paper to the Water in 2007: Stakeholders, policy and elections. Water Symposium, Centre for Public Policy, University of Melbourne, 30th March 2007. pp. 8.

Evans, R. (2009). Disasters that changed Australia. Carlton, Vic, Victory Books.

GMW (2012) Goulburn Murray Water Home Page, http://www.g-mwater.com.au/ Accessed June 2012 and October 2012.

Ombudsman Victoria (2011) *An investigation into the Foodbowl Modernisation Project and Related Matters*, Victorian Government Printer, Melbourne.

Victorian Auditor Generals Office (2010) *Irrigation Efficiency Programs*, Victorian Government Printer, Melbourne.

❖❖❖❖❖

3.9 Options for financing irrigation for rice production in Thailand: a case study on irrigation supply costs, use value, and commodity chain economics[1]

Sylvain R. Perret[1,2], Peerasut Saringkarn[2,3], Damien Jourdain[1,2]

[1] Centre de Coopération Internationale en Recherche Agronomique pour le Développement, UMR G-Eau – F-34398, Montpellier, France

[2] Asian Institute of Technology, School of Engineering and Technology, Po Box 4, Khlong Luang, 12120 Pathumthani, Thailand

[3] TEAM Consulting Engineering and Management Co., Ltd. 22/5 Chunlachomklao Rd., Tha Kham sub-district, Phunphin district, Suratthani, Thailand 84130.

1. Scope and goals of the paper

This paper follows a previous paper that presented the current situation of irrigation in Thailand[2], where rice has been long grown and is a far prevailing crop. The paper focuses on a case study in Central Plains of Thailand where the value of irrigation water in production, irrigation costs, and rice prices along the chain are discussed as starting points to define possible financial mechanisms. The previous paper highlighted two characteristics of the present situation in Thailand: irrigation systems are mainly publicly managed, developed, operated and supported, at high cost. Indeed, approximately 10 billion dollars[3] have been spent annually for both Royal Irrigation Department and Rice Department activities over the last 25 years (RID, 2010). As per the Irrigation Act, irrigation water has been priced at 0.5 THB per m^3, and this fee should be charged to users, but, in practice, farmers are not charged. The overall objective of the research is to provide facts and figures on Thailand's rice-water-financing nexus, from a case study basis, to fuel discussions on the possibility and feasibility of an alternative financing model for irrigation in Thailand

2. Abstract

Thailand's public authorities are spending massive budgets in the development and maintenance of irrigation systems for rice production. In view of the increased competition for budget allocation and of the decreasing weight of agriculture in the domestic economy, debates have arisen on the need for alternative internalised modes of financing irrigation water supply, including farmer-targeted charging systems.

This paper investigates the match between the use value of irrigation water and the costs incurred by water supply, on a case study basis, to assess the feasibility of charging farmers for such costs.

Analyses indicate that the use value (approximately 0.35 THB/m^3) exceeds the total costs (approximately 0.1), meaning that farmers could theoretically pay for irrigation water supply. However, these results were obtained under favourable production conditions. Furthermore, if farmers were to cover the total cost of irrigation, including capital costs (2,208 THB/ha per season), production costs would then increase by approximately 36% in both seasons. In addition, farmers would lose approximately 36% of their net income as a water charge in the wet season and 25% in the dry season. If farmers were to pay for O&M costs only (1,403 THB/ha in both seasons), their production costs would then increase by approximately 23%. In view of their low income, charging farmers is not feasible or acceptable. In addition, this study notes that farmers already pay for pumping costs at the field level and are well aware of the value of water.

---

[1] *Paper initially prepared as a presentation for the ICID TF-FIN Workshop on "Country Case Studies of Water Use Charging Systems and Available Finance of Irrigation" held in June 26, 2012 – Adelaide, Australia.*

[2] *The paper is entitled:* Policy and strategies for financing irrigation operation and development in Thailand: past and present, *by S.R. Perret. It was presented at the ICID TF-FIN Workshop on "Country policies and strategies on financing and implementing water user charging systems in irrigation" in October 12, 2010 – Yogyakarta, Indonesia.*

[3] *That is US$ 3,350 per ha of irrigable paddy field per year, or US$ 2,560 per ha cropped per year if one considers an average cropping intensity of 1.3. In 2010, the exchange rate was approximately 31 THB = 1 US$.*

This paper suggests that if alternative financing systems were to be found, broader ecosystem services approach could be used and also a charging system could be spread throughout the rice chain, down to the milling, retail and export segments.

3. Background and objectives

Irrigation systems in Thailand are publicly managed, developed, operated and supported. Approximately 10 billion dollars have been spent annually for both Royal Irrigation Department (RID) and Rice Department activities over the last 25 years (Budhaka et al., 2002; Warr and Kohpaiboon, 2007). Indeed, the public sector in Thailand covers the investment costs, costs of extraction and supply (operation and maintenance), repairs and rehabilitation, new infrastructural developments, extension, technical advice, training, research and development on varieties and rice products, experimental stations, demonstration plots, and various ad-hoc financial support schemes for farmers. In view of (1) the staggering costs incurred due to water supply, irrigation services, operation and maintenance in Thailand and (2) the recurrent and controversial domestic and international debate on charging farmers for irrigation water use (Tiwari, 1998; Briscoe, 1999; Backeberg, 2006; Molle, 2007), this paper investigates the match between irrigation water use value and irrigation costs.

There exist several justifications for assessing the value of and pricing irrigation water as an economic good, e.g., internalising natural resource scarcity effects and environmental externalities, equity objectives, supply cost recovery and financial viability, improvement and modernisation of services (Briscoe, 1997; Renzetti, 2000). In the context of Thailand, at least three of the last motives are relevant (Perret, 2012). Thailand's Irrigation Act of 1942 set up an official fee for irrigation water use (currently 0.5 THB per m^3). Yet, currently, no irrigation fee is charged, and many farmers do not even know about it.

The goal of this research is to examine whether farmers may be able to pay for irrigation water and to fuel discussions on the possibility and feasibility of an alternative financing model for irrigation in Thailand. This paper focuses on a case study in the Central Plains of Thailand where irrigation water value in production, rice farming performances, irrigation costs, and added values at different stages of the rice chain are jointly investigated.

4. A case study: the Sam Chuk project in Suphan Buri province, Thailand

The Sam Chuk irrigation scheme (or SCP) is in the southwestern part of the Central Plains of Thailand (Suphan Buri Province), 150 km from Bangkok. It was constructed between 1942 and 1955 to serve various objectives: irrigation and drainage, flood control and water storage, and navigation. The management of water in the SCP is under the responsibility of the Regional Office No. 12 of the RID. All details and schematics about infrastructure, administrative zoning and management organisation in SCP are shown in Saringkarn (2012).

The climate of the SCP is classified as tropical humid and under monsoon influence (tropical savannah). There are three seasons in a year: the rainy season from May to October (monsoon, receiving 90% of all precipitations), the cold season from November to January, and the dry season from February to April. Total yearly precipitation amounts to 1,060 mm (1981-2010 average). The soils in the SCP are black clay and loamy clay soils, suitable for most crops, including rice.

The project area is 58,626 ha, of which 50,171 ha are irrigable. Most of the command area is cropped and irrigated. Approximately 40,000 ha are cropped with rice in both the dry and wet season.

The paddy fields cover approximately 80% of the irrigated area, and vegetables, fruit, and shrimp and fishponds cover the remaining. The average yield per paddy is 5,300 kg/ha, which is higher than the national average of approximately 4,000 kg/ha under similar conditions (permanently flooded paddy).

Rice is grown in two seasons, hence twice:

- Major crop or wet-season crop: May or June to September or October
- Second crop or dry-season crop: December or January to March or April

Irrigation consists of conveying water to the tertiary canals that serve each bunded paddy field. The ponding conditions are usually sustained throughout the cycle, with approximately 10 to 15 cm of water kept in the paddy field via regular refilling. Water is lifted from the canals to the fields, usually 3 or 4 times during the growing season. Short, flexible pipes, fed by small portable diesel pumps, cross over the bunds and supply water to the paddies.

Approximately 7,300 farmers operate in the SCP; all are primarily rice growers. Their farms may be classified as small (<6 ha), medium (6-10 ha) and large (>10 ha) farms, and all three categories represent approximately a third of the surveyed farms. The farm size does not exceed 15 ha. The median farm size is approximately 8 ha.

5. Methodology

5.1. Economic value of water in rice production

A sample of 20 representative farms was semi-randomly selected from the different 4 O&M zones of the SCP, as advised by local experts. A questionnaire was developed and applied to these farms (Saringkarn, 2012). It allowed collection of primary quantitative information on production, cropping practices and factors. The gathered data referred to 2009-2010 and both the wet and dry cropping seasons. Interviews with local experts allowed access to additional information on the prices of rice and inputs.

The estimation of water use was based upon crop water demand (CWD), including water losses at different supply stages, as a proxy for actual water consumption for rice production. CWD was estimated using CropWat software (FAO, 1992), and a water balance model was applied to the paddy systems. The models required quantitative data on climate, soils, and local hydrology, which were drawn from documents of the FAO, RID, Thailand's Rice Department and Meteorological Department.

A field application efficiency (Ea) of 0.7 (70%) was applied. The irrigation system efficiency consists of the efficiency of canal (E_b) and conveyance (E_c). Doorenbos and Pruitt (1977) suggest that E_b and E_c are equal to 0.8 and 0.775, respectively, in systems such as the SCP.

The calculation of the marginal value product (MVP) of irrigation water was computed using the Residual Imputation Method (Young, 2005). The sum of all variable production costs (i.e., labour, land, fertilisers, pesticides, machinery, seeds, based upon market prices P_i and quantity used, Q_i, of production factors) is subtracted from the total revenue (yield x market price). The residual amount (value) is ascribed to irrigation water, the only factor with an unknown value. This is accomplished by dividing the residual value by the quantity of irrigation water used (Qw), as determined with CropWat.

The actual average market price for a paddy at 25% moisture content was 7,800 THB per ton for the 2009/2010 dry season and 7,400 THB per ton for the 2010 wet season.

It must be noted that the 2009-2010 seasons had relatively good conditions (no pests, no floods), resulting in high yields. According to local farmers, such favourable conditions are not always met.

5.2. Sam Chuk project water services costs

The costs incurred for irrigation water supply are estimated based on secondary data on capital costs, personnel costs, main repairs and improvement costs, and regular O&M costs. For each cost item, the initial value, salvage value, and area served (total = 50,171 ha) were considered. Because the capital costs were spread over approximately 55 years, between 1937 and 1993 (initial construction, further expansions and developments, heavy upgrades), the approach proposed by Perret and Geyser (2007) was used. All capital costs incurred and recorded between 1937 and 1993 have been transformed to 1993 values, according to yearly inflation rates. Then, the 1993 value was transformed into a 2012 value according to an average yearly inflation rate of 5.1%.

A capital cost recovery factor, CRF, is applied to all capital costs (investments during construction phase, and further large development costs), and a discount rate of 12% has been used.

5.3. Value chain of rice in Suphan Buri Province

Data were collected on the prices observed and costs incurred by operators along the supply and marketing chain. This was performed through interviews with 6 millers involved with the Sam Chuk project. In addition, secondary data were obtained from the Suphan Buri Rice Mill Association, wholesalers, local supermarkets, Department of Internal Trade, Thai Rice Mills Association, Thai Rice Exporter, and various reports. All data and information on transactions, marketing systems and chain values were collected in the Suphan Buri area, for consistency's sake.

6. Results and discussion

6.1. Consumption of irrigation water

The data, calculations and modelling related to water use, production, production factors and costs were combined to ultimately estimate the MVP of water, the economic value derived by rice production at the farming system level (N=20).

According to the calculations, irrigation water requirements amounted to 1,663 mm during the dry season of 2009-2010 (S.D.: 6.31) and to 1,012 mm during the wet season of 2010 (S.D.: 48.03) with a remarkable homogeneity of results among local farmers.

The "production to water use" ratio was 0.32 and 0.52 kg of paddy rice per m^3 of irrigation water used during the dry and wet season, respectively. Irrigation water consumption is higher than the values obtained by recent studies in Thailand (Phuraya, 2007), but these values match other studies (Rahatwal, 2010) and the FAO standards. The high level of loss may explain the relatively high consumption at the plot level (field application efficiency of 70%).

6.2. Production performances and costs

The production cost for rice included expenditures for seeds, machinery, fertilisers and pesticides, land costs (including opportunity cost), and labour costs (including opportunity cost) for the dry season of 2009/2010 and the wet season of 2010. The total production costs per ton of paddy rice in the dry and wet season amounted to 6,151 THB/ton and 6,250 THB/ha, respectively (Table 1).

Table 1. Averages of yields, variable production costs, and gross income (TVP) in dry and wet seasons of 2010 in the Sam Chuk Project (N=20)

	Yield (t/ha)	**Total production costs (THB/ha)**	**Gross income (THB/ha)**
Dry season	5.40	33,215	42,120
Wet season	5.23	32,687	38,702
In 2010, exchange rate was approximately 31 THB = 1 US$			

With dry-season production, on average, farmers are left with a net income before tax, or a gross margin of 8,905 THB per ha (or 1.649 THB/kg of paddy produced). With the wet season production, the net income amounts to 6,015 THB per ha (or 1.15 THB/kg).

Table 2 reports the productivity of water, under two water supply scenarios, i.e., at the farm and system level. The calculations made at the farm level considered water use as only crop water demand and field losses (Ea=0.7, hence 30% loss). The calculations made at the system level considered water used as the total supply, i.e., including conveyance losses at the system level (Ea*Eb*Ec=0.434, hence a 56.6% loss).

Table 2. Average productivity of water in kg of paddy rice per m^3 supplied, in dry and wet seasons of 2010 in the Sam Chuk Project, under two water supply scenarios.

	Water productivity (farm)	Water productivity (system)
Dry season	0.325	0.201
Wet season	0.517	0.32
Farm: water supply including crop water demand at paddy field level and 30% water loss in field application. System: total water supply at system level, including crop water demand, and 56.6% water loss in both conveyance and field application.		

6.3. Use value of irrigation water

Table 3 shows the data on water value, based upon two water supply scenarios (i.e., only CWD and field losses or total supply, including conveyance losses at the system level). The results according to the first scenario are very similar to those obtained by five other recent studies on rice production in other countries (reviewed by Saringkarn, 2012). The whole marginal value curve of the irrigation water was not drawn. Only one point was inferred from the given supply and given production outcome. This explains why the value of irrigation water (MVP in THB/m^3) is higher under wet season conditions (far less irrigation is needed while yield is similar, compared to the dry season).

Table 3. Average marginal value product of water in THB per m^3 supplied, in dry and wet seasons of 2010 in the Sam Chuk Project, under two water supply scenarios.

	MVP Farm	MVP System
Dry season	0.535	0.332
Wet season	0.594	0.368

These results indicate the maximum amount of money (as per m^3 used, kg of rice produced, or ha cropped) that farmers would be able to pay for irrigation water (before they exceeded their net income).

Yet again, these values only refer to the water used at the field level and ignore the necessary additional supply needed to offset losses in the conveyance system. If Eb and Ec are to be applied, to reflect these losses, all data would be affected by a factor of 0.62 (Eb*Ec), and, therefore, be significantly lower. For example, during the dry season, farmers would be able to pay up to 0.332 THB/m^3 for water supply (instead of 0.535 if only water use at the paddy level was considered).

To test the robustness of the results, we tested the influence of the different variables used to calculate the MVP. To obtain unitless measures of the influence of each variable on the proposed results, we calculated the ratio of the percentage changes in the MVP as a result of a percentage change of the model variable and the elasticity of the MVP to the given variable (Table 4).

Table 4. Water MVP sensitivity to rice price and variable costs, expressed as elasticity coefficients

MVP Elasticity	Dry season	Wet season
To rice price	4.73	6.43
To variable costs	-3.73	-5.43

The MVP of water is very sensitive to the price of rice because a 1% decrease in rice price would decrease the MVP by almost 5% during the dry season and 6.5% during the wet season. In the same manner, our model of MVP of water is very sensitive to the different production costs. An increase in the production costs of 1% would induce a 3.7% decrease of MVP during the dry season and a decrease of 5.4% during the wet season.

Given the high sensitivity of the results to prices and costs, and the potentially high variability of those variables across farmers, and across years, we conducted a Monte-Carlo sensitivity analysis to obtain a first approximation of the possible range of values of the MVP.

We calculated the MVP of 2000 simulated farmers facing variables yields, costs, rice price and use of water. Each variable was drawn from random normal variables with means and standard deviations obtained from primary observations (variability of sampled farmers increased by 10% to take into account the inter-annual variability) (table 5).

Table 5. Simulations of the MVP of water during dry and wet seasons, based upon variability (sd values) increased by 10% (costs, water use, yields), and rice prices simulated as normal variable with a st. dev. value of 700 (Monte-Carlo simulation with n=2000 drawn from random normal variables)

MVP of Water (THB/m^3)	Dry Season	Wet Season
Mean	0.53	0.60
Sd	0.2	0.4
Max	1.2	1.9
25% quantile	0.4	0.3
Min	-0.3	-0.7
Probability of being negative	1.1%	5.1%

Rice prices were simulated as normal variables centred on the 2010 price values and a standard deviation of 700 (i.e., a 95% chance of belonging to the [6028, 8772] interval, being a rather conservative appreciation of the inter-annual variability of rice prices).

Table 5 shows the results, which indicate that MVP remains relatively stable and that MVP has a low probability of being negative.

It can be concluded from this sensitivity analysis that farmers are, in most conditions, able to derive some value out of irrigation water use. It must be reiterated that this analysis considered water use that includes field application losses only (Ea=70%, hence 30% loss). Should conveyance and canal losses (Eb*Ec=62%, hence 38% loss) be factored in the analysis, the MVP of water will decline and the likelihood of having negative returns due to water use would increase.

6.4. Costs of irrigation water supply

The initial construction costs were spread over 55 years between 1937 and 1993. The capital cost transformed into a 1993 value is 265,412,747 THB, which further transforms into a 670,684,793 THB in a 2012 value (i.e., the amount that would be needed to build a similar scheme in 2012). This translates into a required investment of 13,368 THB/ha (command area of 50,171 ha).

To assess the representativeness of the investments in the case study, we compared these results with the costs of other medium-size RID irrigation investments in Thailand in the central and northern regions since 1990. Joint log-log analysis and highest density interval (HDI) tests demonstrated that the costs incurred by the SCP are representative of the diversity of project costs encountered in Thailand. Table 6 shows the range of investment costs per ha, as revealed by HDI analysis.

O&M costs (including management and personnel costs, repairs and improvements, renovation and small upgrades) amount to 140,741,037 THB per year (2012 as the reference year). This figure is actually an average of the recorded budgets between 2008 and 2012. The calculation of the cost recovery factor indicates that annualised capital costs amount to 1,610 THB/ha/year. The annual O&M costs amount to 2,805 THB/ha/year. The total annual costs amount to 4,415 THB/ha/year or 2,208 THB per ha per season. It is assumed that the annual costs can be divided equally between the two seasons.

Table 6 shows the costs of the irrigation water supply in the SCP, including the initial investment costs, annualised into recovery costs, and O&M costs. The calculations take into account all losses incurred, as captured by the efficiency coefficients discussed earlier.

Table 6. Total costs of irrigation water supply in SCP (2012 value)

	Initial investment /ha (THB /ha)	Recovery cost (THB/ha/year)	O&M cost (THB/ha/year)	Total cost (THB /ha/year)
SCP	13,368	1,610	2,805	4,415
Low	1,200	144	2,805	2,949
High	43,000	5,178	2,805	7,983
Low and High scenarios correspond to the HDI 75% values of 2012 investment cost per ha				

Although there are some small differences between the dry and the wet season, the cost of water for the Sam Chuk irrigation scheme was approximately 415 THB/ton of paddy produced. When computed with the range of possible costs for a project of equivalent size and with equivalent yields and water consumption, the cost of irrigation supply fell within an interval of 270 to 770 THB per ton of paddy produced (table 7).

Table 7. Costs of irrigation water supply during the wet season in Sam Chuk (water use and yields of 2012)

		Total Cost THB/ha/season	Yield (Ton/ha)	Water Supply (m3/ha)	Total cost THB/Ton	Total Cost THB/m3
Dry	SCP	2,208	5.4	26,823	409	0.082
	Low	1,475	5.4	26,823	273	0.055
	High	3,991	5.4	26,823	739	0.149
Wet	SCP	2,208	5.23	16,323	422	0.135
	Low	1,475	5.23	16,323	282	0.090
	High	3,991	5.23	16,323	763	0.245
Actual water supply = irrigation water use / 0.62; cropping intensity is assumed to be 2 (2 seasons per year); Low and High scenarios correspond to the HDI 75% values of 2012 investment cost per ha						

6.5. Return on capital, return on production costs and net margin

At the farm level (paddy rice production), the return on capital RoC may be expressed as the ratio between net income and capital costs. The capital costs refer to the scheme's construction costs, actualised for the year 2012 (see section 6.4. and table 6). The RoC amounts to 4.03 (between 2.23 with highest cost scenario and 6.03 with lowest cost scenario) in the dry season and 2.72 (between 1.5 with highest cost scenario and 4.07 with lowest cost scenario) in the wet season.

Similarly, the return on investment, RoI, may be determined using the ratio between net income and production costs. The production costs included both crop production costs (all production factors) and the system water production costs (O&M costs at the systems level). RoI amounts to 0.26 and 0.18 in the dry and wet season, respectively.

Net margin (i.e., the ratio between net income and gross income) is 21.14% in the dry season and 15.54% on average across the scheme.

Overall, these figures demonstrate that (mainly public) capital investments are quite productive due to high rice production, especially in the dry season (4.03). However, the return on investment remains low (0.18 in wet season). This is mostly due to the high crop production costs. This is also shown by the net margin, which is particularly low in the wet season (approximately 15%).

Rice marketing channel in Suphan Buri province

Figure 1 shows the players in the rice chain and how rice spreads through it. Farmers sell 80% of production to a local central market, a wholesaler that resells to millers.

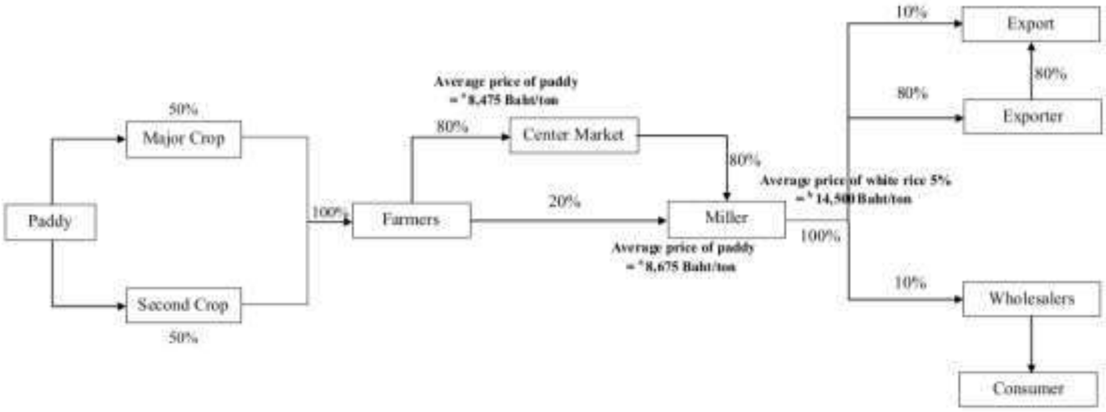


Figure 1. The marketing channel of paddy production in Suphan Buri 2009/2010

Only 20% of the rice flows straight from farmers to millers, although at a slightly higher price. After whitening, sorting, and bagging, the rice is sent by millers to exporters (80%), to local wholesalers (10%) or directly abroad through direct export contracts. Almost 100% of the rice produced in Suphan Buri province is branded as “white rice 5%” quality. Millers also sell by-products such as brown rice bran, husk, rice bran, and white broken rice. The product and value chain of rice in Suphan Buri province is shown in figure 2.

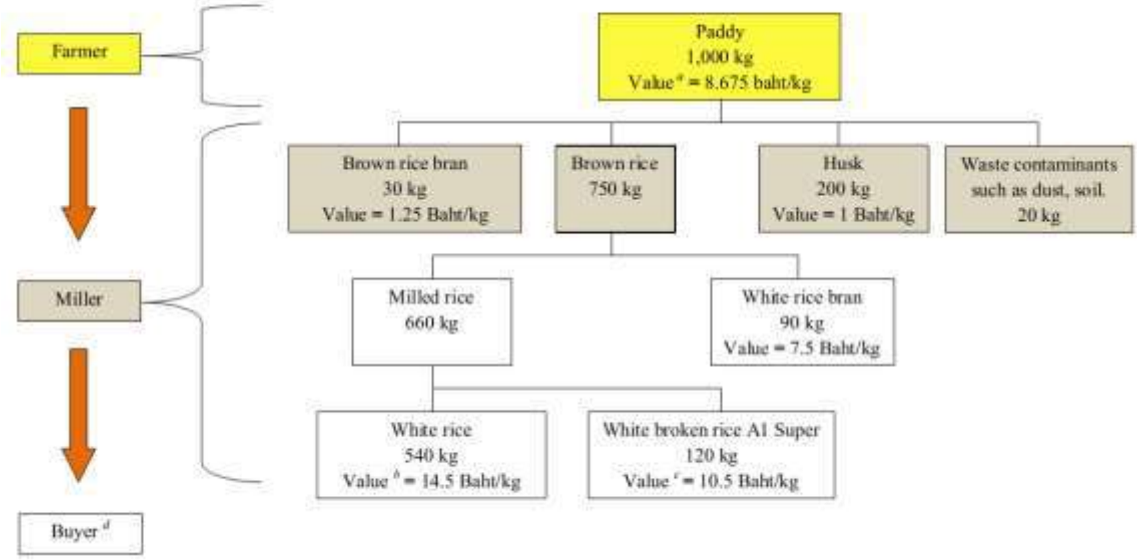


Figure 2. Product and value chain of rice in Suphan Buri (2010)

NB: *a* is the average price of dry paddy at 15% of moisture observed
b is the average price of “white rice 5%”
c is the average price of white broken rice
d is the wholesale buyer of final products, e.g., broker, rice business company for domestic or export markets.

It must be noted that the prices given by millers and the central market differ from the ones that farmers reported. The actual price paid to farmers by millers in the 2010 dry and wet seasons were 7800 and 7400 THB/ton, respectively, whereas millers reported an average price of 8625 THB/ton (as shown in figure 2).

According to the Suphan Buri Mill Rice Association (2011), the total rice processing costs incurred by millers amount to 1,190 THB per ton of white rice processed. These costs include milling costs, transport and packaging costs, and taxes. Overall, when millers process one ton of paddy rice, they incur total processing costs of 642.60 THB. In addition, they pay, on average, 7600 THB per ton to farmers (dry and wet seasons).

In turn, they sell brown and white rice bran, husk, broken white rice and white rice, for a total of 10,002.50 THB per ton of paddy processed. The balance (net income) is 1,759.90 THB per ton of paddy processed, which results in 540 kg of white rice. Hence a net income of 3,259.07 THB per ton of white rice produced (which requires 1852 kg of paddy rice).

Exporters paid 14,500 THB per ton of white rice to millers. The costs they incur amount to 1,091 THB/ton, including packing and packaging costs, transportation, management costs, overheads, quality control and management costs (Rodmua, 2009). The FOB prices for white rice export amounted to 16,417 THB/ton on average in 2009-2010 (Department of Foreign Trade, Thailand). This leaves a net income of 826 THB/ton of white rice exported. Such a figure looks very small compared with other sectors, yet there are few exporters and they handle large amounts.

Wholesalers purchased white rice at 14,500 THB per ton to millers. Their marketing costs amount to 1,382 THB per ton, including packing and packaging costs, transportation, management costs, storage costs, overheads, quality control and management costs (Department of Internal Trade, Thailand). The average retail price of these traders has been 26.42 THB per kg of white rice (conditioned in 15 kg bags). Therefore, their net income is 10,538 THB/ton.

It must be noted that the end retail price to individual consumer has been ranging between 25 to 40 THB per kg, depending on packaging type and size (from 0.5 to 15 kg), brand, retail channel, and stated quality.

6.6. Discussion

This section discusses the possibilities and consequences of charging different categories of economic agents across the rice production and supply chain.

The rationale for pricing and charging irrigation water remains irrigation cost recovery (full or partial). It may include a signal sent to farmers with regards to scarcity value of water or the need to use the resource sparingly (Molle, 2007). Also, one may consider that, as a final product, processed white rice bears a large virtual water contents, up to 9.2 m^3 per kg in the dry season. Many economic agents benefit from rice production along the supply chain, and may be included as contributors in a charging system. Finally, irrigation systems serve a number of purposes (ecosystem services) that benefit the whole society. All of these elements are factored in scenarios for charging for irrigation water in the following section.

A. Applying the user-pays principle: charging farmers

Three points may justify charging rice farmers for irrigation supply. First, even though the SCP renders several services (flood control, navigation), its main purpose is rice production, which is farmers' livelihood. Second, most water used to produce rice is consumed during the cropping process. Third, a user-pay principle potentially is a deterring factor to water squandering and overuse, which may prove relevant in the context of increased competition for quality water during the dry season.

The figures on costs may be compared with figures on use value. Table 8 recaps the results obtained per kg of rice produced. In other terms, MVP (use value) amounted to 0.53 and 0.60 THB/m3 in the dry and wet seasons, respectively, whereas the total costs were 0.082 and 0.135. Therefore, theoretically, farmers could pay; however, these figures deserve some closer attention.

Table 8. Comparison of water values and costs as per kg of paddy rice produced, from production and water supply system viewpoints (all figures expressed in THB/kg of rice)

	Use value	Total costs	O&M costs
Dry season	1.649	0.409 (0.273 – 0.739)	0.260
Wet season	1.150	0.422 (0.282 – 0.763)	0.264

Rice production costs amounted to 6,151 THB/ha and 6,250 THB/ha in the dry and wet season, respectively, in the 2011-12 seasons. If farmers were to cover the total cost of irrigation (2,208 THB/ha per season), production costs would then increase by approximately 36% in both seasons. When using the minimum and maximum total costs that were computed, the percentage increase would fall in a range of 25% to 64%. If farmers were to pay for O&M costs only (1,403 THB/ha in both seasons), production costs would then increase by approximately 23% in both seasons. In addition, farmers would lose approximately 36% of their net income to water charges in the wet season and 25% in the dry season. In view of such a low income, charging farmers is not feasible or acceptable.

Furthermore, as said, the 2010-2011 seasons under consideration were relatively high yielding years. Under lower yield conditions, farmers would find it difficult to pay. In addition, we have shown the high elasticity of MVP to rice price and production costs. Thus, farmers depend much on factors that are beyond their control.

In addition, charging rice farmers for irrigation cost recovery would contradict the current government-initiated scheme to support revenue based upon guaranteed rice prices at the farm level (the so-called government rice mortgage scheme; Perret, 2012).

Finally, as demonstrated by Molle (2007), rice farmers already pay for water use through pumping costs at the farm level (which were considered in our analysis). Therefore, they are already well aware of the value and costs related to water use.

B. Charging non-farming, indirectly benefiting players

It makes sense to investigate the possibilities of recovering irrigation costs from the other chain players who benefit from low prices and do not contribute to irrigation costs that have been so far covered by public money. The question remains as to how to internalise these costs or how costs could be charged to other sectors along the chain that also benefit from rice production under irrigated conditions.

Table 9 shows the net incomes gained by the different actors of the chain per kg of final white rice (in 2009-2010). These figures show that the value added is unevenly generated along the chain. It must be noted that the figures refer only to 2009-2010 and are based upon information given by the different sectors. The domestic wholesalers (supermarkets) gain the largest net income, by far (more than 70% of all added-value in post-harvest stages). Table 10 highlights that, conversely to net incomes, costs are quite similar across the post-harvest sectors of the chain. For each of them, charging the full irrigation costs (i.e., 0.76 THB per kg of white rice on average over two seasons) would merely add 5% to existing processing costs.

Table 9. Net incomes in THB per kg of white rice along the supply chain in Suphan Buri province in 2009-2010.

	Farmers*	Millers	Domestic wholesalers	Exporters
Dry season	3.05	3.26	10.54	0.82
Wet season	2.13	3.26	10.54	0.82
Farmers actually obtain 1.852 times less per kg of raw paddy rice produced.				

Table 10. Processing costs for the different players along the chain, in THB per kg processed white rice

Millers	Domestic wholesalers	Exporters
15.27	15.88	15.59

For millers, domestic wholesalers and exporters, the shares of net income gained per mass of rice processed and sold are 22.3%, 72.1%, and 5.6%, respectively. Table 11 shows how much each would pay if charged for the total irrigation costs or O&M costs only on a net-income pro-rata basis.

The figures shown in table 11 are very reasonable, and yet, the history of taxation in the rice chain (e.g., the rice premium system; see Perret, 2012 for details) demonstrates that supply chain players tend to pass on the extra costs upstream, back to farmers, and downstream to end consumers, leading to rural impoverishment and urban social issues. Such a charging system ought to be accompanied by regulations on both sides of the processing chain: a floor price guaranteed to farmers, paid by millers (yet subject to quality, and not subsidised), and close monitoring of the rice retail price, with ceilings and regulations if needed.

Table 11. Irrigation fee to be paid by each rice chain sector (excluding farmers) for full or O&M cost recovery, for two seasons, in THB per ton of white rice processed and sold, pro-rata of respective net income per mass of rice.

Charging	Season	Millers	Wholesalers	Exporters
Full costs	Dry	168.81 (112.8-305.3)	545.72 (365-987)	42.47 (28.3-76.7)
	Wet	174.39 (116.5 – 315.2)	563.74 (376-1020)	43.87 (29.2 – 79.1)
O&M costs	Dry	107.26	346.75	26.98
	Wet	108.82	351.8	27.38

C. Charging all stakeholders

The project was constructed to serve various objectives: irrigation and drainage, flood control and water storage (using the water gate), land setting and transportation. In addition, it benefits several non-farming economic agents along the supply chain. It makes sense to consider a joint contribution of all benefiting parties, farming and non-farming, to cover the irrigation costs through a charging system.

The previously discussed results have shown how added value was created along the chain and the net incomes gained by each player. A fair charging system could take into account all those sub-sectors and respective net incomes, on a pro-rata basis, as shown in table 12.

Table 12. Irrigation fee to be paid by each rice chain sub-sector for full or O&M cost recovery, for two seasons, in THB per ton of white rice processed and sold, pro-rata of respective net income per mass of rice.

Charging	Season	Farmers	Millers	Wholesalers	Exporters
Full costs	Dry	130.66 (87.3-236.3)	139.67 (93.3 – 252.6)	451.55 (301.7-816.6)	35.12 (23.5-63.5)
	Wet	99.47 (66.4 – 179.7)	152.18 (101.6-275.1)	492.11 (328.6-889.4)	38.32 (25.6-69.2)
O&M costs	Dry	83.02	88.74	286.92	22.32
	Wet	62.07	94.96	307.1	23.91

Because production of 1 kg of white rice requires the initial production of 1.852 kg of paddy, farmers would actually be charged 70.55 and 53.71 THB per ton of paddy sold, for full cost recovery in the dry and wet seasons, respectively. Such figures represent less than 5% of their net income in both seasons. They would be charged 44.83 and 33.52 THB per ton of paddy sold, for O&M cost recovery in the dry and wet seasons, respectively. Such figures represent less than 3% of the farmers' net income in both seasons.

The benefit of including farmers in the charging system may be to strengthen the perception of water resource value and of supply costs, although Molle (2007) insists that farmers already pay for pumping and are well aware of the use value of water. Furthermore, their inclusion in the whole rice chain as essential players would be re-stated.

With all players involved, the charging system bears the same limitations as the previous one (excluding farmers) with regards to potential "ripple effects" of costs being passed on upstream and downstream. Yet again, regulations and close monitoring by public authorities should replace subsidies and avoid such distortions.

7. Conclusion

The massive public budget that supports the rice sector in Thailand includes irrigation water supply costs, with both capital and O&M costs. Given the increased competition for budget allocation and the overall uncertainty with regards to the rice sector, such investment calls for investigations into alternative, internalised modes of financing the irrigation water supply.

This paper investigated the use value and costs related to irrigation water in the rice sector. Its objective was to assess the needs and possible options for charging farmers and other sub-sectors along the rice chain to cover the costs incurred by irrigation water supply. Analyses revealed the annualised capital costs and O&M costs incurred by irrigation water supply, the use value and rice cropping system performances from a farmer perspective.

Charging only farmers as direct water users is unfair, unrealistic and contradictory to the recurrent public support to their rice income. Alternatively, charging indirect beneficiaries along the rice chain (i.e., post-harvest, marketing and export sub-sectors) makes sense and is feasible according to our results. However, past experiences (e.g., the rice premium system between 1950-1980; Forssell, 2009; Perret, 2012) have demonstrated that fiscal measures at the rice export level (excise duty or export tax) achieved a great amount in terms of infrastructural development but at the expense of rice farmers because the tax was systematically transferred upstream by all sub-sectors, resulting in lower rice prices at the farm level and deeper rural poverty (Phongpaichit and Baker, 1995). Therefore, regulations are needed.

In addition, because paddy fields and irrigation systems in Thailand render services well beyond rice production itself (flood control, wetlands habitat, and various ecosystem goods and services) (Perret et al., 2010; Xiao Yu et al., 2011), a broader economic framework should be discussed and investigated towards financing rice irrigation systems through compensation for the provided ecosystem services.

8. References

Backeberg, G. (2006) Reform of user charges, market pricing and management of water: problem or opportunity for irrigated agriculture? *Irrigation & Drainage* 55 (2006): 1-12.

Briscoe, J. (1997) Managing water as an economic good: Rules for reformers. *Water Supply,* 15(4): 153-172

Briscoe, J. (1999) The financing of hydropower, irrigation and water supply infrastructure in developing countries. *Water Resource Development* 15(4): 459-491

Budhaka, B., Srikajorn, M. and Boonkird, V. (2002) Thailand country report on investment in water. *In: Investment in Land and Water. Regional Consultation report*, RAP Publication 2002/09, FAO Bangkok.

Doorenbos, J. and Pruitt, W.O. (1977) *Crop water requirements*. FAO Irrigation and Drainage paper, num.24. Rome, Italy

FAO (1992) (Smith, M. Coordinator). *CROPWAT. A computer program for irrigation planning and management*. FAO technical paper num.46, Rome, Italy.

Forssell, S. (2009) Rice price policy in Thailand: policy making and recent developments. University of Lind, Department of Economics, Minor Field Study Series no.189, ISSN 0283-1589, 45p.

Molle, F. (2007) Thailand's "free water": rationale for a water charge and policy shift in irrigation. In: *Irrigation Water Pricing: The Gap Between Theory and Practice*, chapter 5. Comprehensive Assessment of Water Management in Agriculture, Series 4, CABI Publication, Cambridge, MA, USA, pp126-142

Perret, S.R. & Geyser, M. (2007) The full financial costs of irrigation services: a discussion on existing guidelines and implications for smallholder irrigation in South Africa. *Water SA*, 33(1): 67-78

Perret, S.R., Babel, M.S., Rahatwal, S.D., Yarnsiri, R., 2010. Resource efficiency and ecosystem services in rice production in Thailand's central plain: Baseline Research: Inventory of ecosystem services. . AIT / CIRAD, Bangkok, Thailand, p. 57.

Perret, S.R. (2012) Policy and strategies for financing irrigation operation and development in Thailand: past and present. ICID TF-FIN, *Country policies and strategies on financing and implementing water user charging systems in irrigation*, Adelaide, Australia, June 2012, 14p

Phongpaichit, P. and Baker, C.J. (1995) Thailand, Economy and Politics. Kuala Lumpur: Oxford University Press, 1995

Phuraya, R. (2007) *The study of irrigation water requirement for rice cultivation: a case study of Rungit Tai operation and maintenance project*. Unpublished Master Thesis, Bangkok Graduate School, Srinakharinwirot University, Thailand.

Rahatwal, S.D. (2010) *Application of LCA and virtual water approaches to assess environmental impacts of rice production*. Unpublished Master Thesis, Asian Institute of Technology, Bangkok, Thailand.

Renzetti, S., 2000. The political economy of water pricing reforms. In: Dinar, A. (Ed.), *The Political Economy of Water Pricing Reforms*. Oxford University Press, Oxford, pp. 123-140.

Saringkarn, P. (2012) Investigating scenarios, conditions and applicability of alternative financing model for irrigation water services in Thailand. Unpublished dissertation, Master of Engineering, Water Engineering and Management, Asian Institute of Technology, Bangkok, Thailand, 95p.

Tiwari, D. (1998) Determining the economic value of irrigation water: comparison of willingness to pay and indirect valuation approaches as a measure of sustainable resource use. Centre for Social and Economic Research on the Global Environment, University College London and University of East Anglia, working paper GEC no.98-05.

Warr, P. and Kohpaiboon, A. (2007). Distortions to Agricultural Incentives in a Food Exporting Country: Thailand. Australian National University, Canberra, Australia and Thammasat University, Bangkok, Thailand

Xiao Yu, An Kai, Xie Gaodi, Lu Chunxia, 2011. Evaluation of Ecosystem Services Provided by 10 Typical Rice Paddies in China. *Journal of Resources and Ecology* 2, 328-337.

Young, R.A. (2005) Determining the economic value of water. Concepts and methods. RFF Press, Washington DC, USA.

❖❖❖❖❖

3.10 Financing of Raising Clan William Dam for Flood Safety and Irrigation Expansion in the Lower Olifants River Water User Association – A Case Study for South Africa [1]

1. Introduction

Irrigation farming in the Lower Olifants River area has a long history, dating back to explorations by Dutch (1660) and English (1808) colonial settlers. One of the first surveys for an irrigation scheme in the Cape Colony was done in 1858. However, due to prohibitive costs, development of the scheme did not proceed, but farmers started irrigating with individual abstraction of water directly from the river. After 1907 several investigations were initiated for construction of a dam and canal scheme. In 1911 an irrigation district was proclaimed and in 1920 the construction of a weir on the river and canal distribution network was completed. During the Great Depression the Clan William dam was eventually built between 1932 and 1935. Raising of the dam wall to increase storage capacity was undertaken from 1962 to 1964 (Van Vuuren, 2010; 2012). About another 45 years later a feasibility study was done to further raise the dam wall for reasons of dam safety linked to flood risks, as well as additional storage capacity (DWAF, 2008). The purpose of this case study is to briefly discuss alternative financing options for raising of the dam wall.

2. Infrastructure for Water Storage and Distribution

The storage capacity of the Clan William dam is 126.4 million m3 and that of the Bulshoek dam (22 km downstream) 5.6 million m3, which serves mainly as a balancing dam, diverting water into the canal network (Matthee, 2012). The canals are concrete lined with a length of 136 km on the left bank and 123 km on the right bank of the river. The delivery capacity of the canal is 325 m3 per ha per week. Although the official water allocation is 12 200 m3 per ha, the actual delivery is therefore lower at 8 400 m3 per ha. The feasibility study (DWAF, 2008) evaluates raising of the dam wall with 13 m and increasing storage capacity with 69.5 million m3 per year. Elimination or reduction of the delivery constraint of the canal network was not investigated.

3. Irrigation and Crop Cultivation

The total scheduled area of the irrigation scheme is 9 510 ha and the total area under crops in 2007 was recorded as 10 228 ha (see Table 1).

Table 1. Total area and % distribution of crops grown under irrigation on the Lower Olifants River scheme in 2007

Crop Type	Area Cultivated	%
Grapes:		
Table grape	594	5.8
Wine	7 175	70.2
Raisin	694	6.8
Lucerne:	263	2.6
Tomatoes:		
Factory	336	3.3
Market	180	1.7
Vegetables:		
Market	675	6.6
Seed	95	0.9
Other crops:	216	2.1
TOTAL	**10 228**	**100.0**
Source: Matthee, 2012		

[1] Gerhard R Backeberg, Water Research Commission, Pretoria

According to this cropping pattern it is clear that grapes for wine production are the most important enterprise. The water requirements for wine grapes are estimated at between 7 500 to 8 500 m3 per ha per year (DWAF, 2008). In this arid region on the western part of South Africa, the average annual rainfall is very low at 152 mm (Van Vuuren, 2011). It means that crop water requirements have to be supplied with irrigation. The most important methods are mainly drip irrigation and to a lesser extent surface or flood irrigation. Nonetheless, given the delivery capacity of the canal, it is possible to meet the water requirements of wine grapes without causing crop water stress.

3.1 Farming income, costs and profitability of wine grapes

The farmer typology on this irrigation scheme can be categorised as family farms which are farmer operated. Originally farm sizes were 25 ha, but over the years consolidation has occurred and farm sizes increased to about 50 ha (Matthee, 2012). Production cost analyses are done for wine grapes on the Lower Olifants irrigation scheme by the company VinPro. These are compared with other wine grape production areas as well as the industry average (Van Wyk and Le Roux, 2012). With availability of these detail income and cost figures and given the fact that wine grapes comprise 70% of the cropping pattern, further analysis of financing options for raising the wall of the Clan William dam will be based on wine grape farming.

The average farm size under wine grape cultivation is 51 ha with a yield of 25.02 ton per ha and a price of R1 768 per ton. The grapes which are produced are for 82% of the white wine varieties, which are considered as high quality grapes. In comparison with other production areas in the Western Cape Province, there is market potential for expansion of grape production in the Lower Olifants irrigation scheme (Van Wyk, 2012). The financial results of wine grape farming at 2011 price levels are given in Table 2.

Table 2. Average income and costs for wine grape production on farms in the Lower Olifants irrigation scheme (2011 prices)

Item	R/ha
Gross income	44 235
Variable cost*	22 500
Gross margin	21 735
Fixed cost	9 333
Net farm income	12 402
Management salary	4 425
Interest on loans**	5 068
Return on equity	2 909

Source: Van Wyk and Le Roux, 2012

Note: *Water use charges have been adjusted according to Matthee, 2012

**Estimated at 8% on loan capital of R63 358.67 per ha or a total of R3 231 292 per farm

The total capital investment for wine grape production at 2011 prices is R190 076 per ha or R9 693 876 per farm (Van Wyk and Le Roux, 2012). Based on the average income and costs results, the profitability analysis shows a return on total investment of 4.2% and a return on equity capital of 2.3%.

3.2 Excise duty on natural wine

As discussed before (Backeberg, 2009) there are different sources of income to cover the cost of irrigation development. These are mainly user charges; benefit taxes or betterment levies (charged on direct beneficiaries); additional new taxes (which are generated by direct and indirect beneficiaries as a result of the development project); and existing general taxes (which are generated in the economy and are available as transfer payments or subsidies for the development project). In this case study, only water use charges and additional new taxes will be considered as sources of income to finance the construction of the increased height, dam safety and storage capacity of the Clan William dam.

In South Africa, excise duty on natural wine has increased over the last 10 years from R0.89 per litre in 2003 to R2.50 per litre in 2012 (Loots, 2012). During 2011 the excise duty was R2.32 per litre and the basis for calculation of excise duty as an indirect taxation on natural wine is as follows (Van Wyk, 2012):

1 ton grapes equal 800 litre of juice which consists of: 650 litre of natural wine @ R2.32; 100 litre of fortified wine @ 20% of R4.33; and 50 litre of fresh juice. The excise duty collected on natural wine is therefore R1 594.60 per ton grapes and R39 897 per ha at a yield of 25.02 ton. It is interesting to note that government is levying this amount of excise duty on wine from consumers, which is 90% of the gross income per ha earned by wine grape farmers. The implications of this source of income as indirect taxes by government will be further discussed in the following section.

4. Water Management on the Lower Olifants River Irrigation Scheme

The infrastructure discussed under section 2 of this case study is public property and controlled by a government department, namely the Department of Water Affairs (DWA). Operation and maintenance of the irrigation scheme is the responsibility of the Lower Olifants River Water User Association (LOR WUA), the first WUA to be established in 2001 after promulgation of the National Water Act in 1998 (Van Vuuren, 2011). The management of the WUA is accountable to a board representing all farmers on the irrigation scheme. Water distribution is based on weekly orders and is calculated at 6 hour intervals. Water is released on demand through a canal network with 1 052 sluices. There are 8 sub-districts or wards on the irrigation scheme, supervised by water control officers, regulating about 130 sluices each. Canal water management is done with support of the Water Administration System (WAS), which is a computerised information system linking water orders, releases and accounts. Through implementation of this management tool, distribution losses have been reduced from 48% to 24%.

4.1 Water use charges for operation of the existing irrigation scheme

Several improvements have been made to irrigation water management on the scheme since 2001 (Van Vuuren, 2011; Matthee, 2012). These include accurate measurement of water; installation of telemetry to timeously change the flow in canals; repair and replacement of syphons; repair of canals to eliminate leakages; and actions to prevent illegal water abstractions.

The water use charges during 2011 to recover these operation and maintenance costs are specified in Table 3.

Table 3. Water use charges in 2011 for the Lower Olifants River Water User Association

Item	R/ha
Operation and maintenance	1 905.99
Depreciation	63.44
Water resource development charge*	190.32
Water resource management charge*	167.75
Water research fund**	4.49
Sub-total	2 331.99
VAT	326.48
TOTAL	**2 658.47**

Source: Matthee, 2012
Note: *Payable to the Department of Water Affairs, **Payable to the Water Research Commission

At an effective water allocation of 8 400 m3 per ha, the current water use charge is calculated as R0.32 per m3. The water use charge of R2 658 per ha also contributes 11.8% to the annual variable costs of producing wine grapes.

4.2 Financing options for increased storage capacity of the Clan William dam

The feasibility for the raising of Clan William dam (DWAF, 2008; 2009), included a financial evaluation. Capital costs were determined to make the dam safe for extreme flood events and to increase storage capacity. From a cost perspective, a 13 m raising is recommended at a capital cost of R370.6 million and at a unit reference value of R0.45 per m3, with a discount rate of 6% and 2006 as a base year. Furthermore it is stated that all charges following the dam raising will be levied in terms of the "Pricing Strategy for Raw Water Use Charges" by the Department of Water Affairs. In terms of this strategy, existing farmers are allowed to expand farming operations on condition that the full financial cost (operation and maintenance, depreciation and return on assets, in this case 6%) be paid for the development. The recommendation is made that a study on the financing of the scheme should be undertaken.

4.3 Alternative approaches to cost recovery

In the comprehensive feasibility study (DWAF, 2008), various issues are reviewed including in-stream flow requirements, yield analysis, water quality, agricultural potential and water requirements, dam design and cost estimates, financial feasibility of irrigation farming, economic implications, environmental impact and financial evaluation. However, the missing part of the feasibility study is a detailed fiscal impact analysis.

With additional storage capacity, the options are expansion of existing irrigation farms as well as development of new irrigation farms. In this regard important findings of the feasibility study (DWAF, 2008) are that (1) farmers currently receive water at an unacceptable low assurance of supply; (2) existing irrigation farming is quite profitable; and (3) expansion of existing farms is seemingly more viable than establishment of new farms. Evaluation of soils, crops and water requirements shows that at least 2 000 ha can be recommended for perennial crops (e.g. citrus and wine grapes), and with judicious irrigation practices, approximately 10 000 ha can be used for economic viable production of citrus and wine grapes. Water requirements for expansion of farming with a mixed cropping pattern are quantified as 9 100 m3 per ha. It should be noted that this volume is higher than the current canal capacity.

Based on the available information, there are three alternative approaches to cost recovery: First, full cost recovery through water use charges; second, full cost recovery through indirect taxes; and third, a combination of these two approaches. For the first option, full cost recovery at the current water allocation amounts to R3 780 per ha (8 400 m3 per ha x R0.45 per m3). This clearly means that the water use charges will more than double (refer to Table 3). In order to determine the financial viability for expansion of wine grape farming, a dynamic capital and cash flow projection over at least the next 20 years should be undertaken. In the absence thereof, a static analysis is the best method to follow. On this basis, the increased total cost of R3 780 per ha is higher than the return on equity of R2 909 per ha (refer to Table 2). The expansion of existing wine grape irrigation farms with the requirement of full cost recovery will lead to a negative return on equity capital and is obviously not financially feasible. It is therefore important to consider the second approach of funding the incremental capital cost with receipt of incremental indirect taxes, in particular excise duty on wine grapes.

4.4 Projected receipts of excise duty on wine grapes

According to the final financial evaluation (DWAF, 2009) the total capital cost for raising the dam wall is R370.6 million at 2006 price levels. Adjusting for inflation, the capital cost is estimated at R495.9 million at 2011 price levels, for the purpose of this case study. With expansion of wine grape production, excise duty on wine for which a market exists, is an additional source of new taxes paid by indirect beneficiaries, namely consumers of wine. At current yield and 2011 price levels, this excise duty has been calculated as R39 897 per ha (see section 3.2). The question then is over what period in future and what area for expansion of wine grape production, sufficient excise duty can be collected to cover the funding for raising of the Clan William dam? The reasoning is therefore that Treasury will make available R495.9 million to the Department of Water Affairs for construction, and this amount will be collected by Treasury over time by means of the excise duty on wine. Other additional sources of direct and indirect taxes (e.g. income tax and value added tax (VAT)), are at this stage not being considered for the case study.

The appropriate period is the technical life cycle of the dam, which is 45 years (DWAF, 2008). The economic life cycle of wine grapes is 20 years and grapes reach full production after 5 years (Van Wyk, 2012). Therefore, it can be expected that excise duty on wine sales will be earned over two full production cycles of grapes. The present value of excise duty of R39 897 per ha at a discount rate of 6% over 45 years is thus calculated as R448 606 per ha at 2011 price levels (Chisholm and Dillon, 1971). The expansion of the area under wine grapes which is required to recover the capital cost of the dam with excise duty on wine is therefore 1 105 ha (R495.9 million/R448 606 per ha).

It appears that expansion of wine grape production with 1 105 ha over the next 45 years can be reasonably achieved: for the existing 190 farmers (9510 ha/50 ha) it will require an average expansion of approximately 6 ha per farm. In total the expansion of 1 105 ha will be about 15% of the area currently under wine grapes (refer to Table 1). The required expansion of the area is also 55% of the minimum potential land and 11% of the maximum potential land that is suitable for wine grape production. As a whole, given the market opportunities, current levels of profitability and expansion potential, it is realistic to expect that in future sufficient additional taxes can be collected through excise duty on wine grapes, to recover the total cost of investment in raising the Clan William dam.

5. Conclusion

Following the analysis done as part of this case study of water use charging systems and available financing of irrigation in the Lower Olifants irrigation scheme, various technical and financial concerns remain: First, the capital cost to raise the dam wall will increase dam safety and storage capacity. Canal capacity to distribute and deliver the additional water is a constraint. Further investment for refurbishment and extension of the canal network is required. Second, for the economic analysis of agricultural projects, such as investment for the expansion of irrigation schemes, determination of the sources and application of funds by government as a development agent is very important (Gittinger, 1982). The lack of attention to a fiscal impact study as part of the feasibility study is a serious omission, which should be attended to in any detail feasibility study which is to follow. Third, since capital investment in raising the dam wall is for both dam safety and irrigation expansion, the total capital cost can certainly not be exclusively recovered from irrigation farmers as direct beneficiaries. An estimate should be made of the percentage allocation of capital cost for dam safety, which should be recovered from general taxes, since this aspect is a public good to the benefit of society as a whole. Fourth, since it has been shown that the full capital cost can be recovered through excise duty on wine grapes, any increase of the water use charges to recover capital cost for the raising of the dam wall from irrigation farmers cannot be financially and economically justified. If it is done for political and social reasons, it will imply double taxation through levying of water use charges and generate additional income higher than the cost of capital for this project. Finally, this case study has clearly demonstrated that critical consideration should be given to alternative sources of (1) water use charges; (2) additional new taxes payable by direct and indirect beneficiaries; and (3) general taxes available in the economic system, as options for financing capital investment and expansion of existing irrigation schemes.

References

Backeberg, GR. (2009). Development and financing of irrigation schemes: Towards a consistent approach. Introductory paper presented during an International Workshop of the Task Force on Financing Water for Agriculture, New Delhi, India, 7 December 2009.

Chisholm, AH and Dillon, JL. (1971). Discounting and other interest rate procedures in farm management. University of New England, Armidale, Australia.

Department of Water Affairs and Forestry (DWAF). (2008). Main Report. Prepared by E van der Berg of Ninham Shand (Pty) Ltd as part of the Feasibility Study for the Raising of Clan William Dam. DWAF Report No PWMA 17/E10/00/1907.

Department of Water Affairs and Forestry. (2009). Financial Evaluation. Prepared by E van der Berg and M Killick of Ninham Shand (Pty) Ltd as part of the Feasibility Study for the Raising of Clan William Dam. DWAF Report No PWWA 17/E10/00/1809.

Gittinger, JP. (1982). Economic analysis of agricultural projects. (Second edition), The Economic Development Institute, World Bank, The Johns Hopkins University Press, Baltimore and London.

Loots, J. (2012). One step too far with excise, WineLand, April 2012.

Matthee, J. (2012). E-mail communication regarding information on the Lower Olifants River Water User Association (LORWUA), 22 March 2012.

Van Vuuren, L. (2010). Olifants River - Home to one of South Africa's oldest irrigation schemes, Water Wheel, September/October 2010, Volume 9 No 5.

Van Vuuren, L. (2011). Water use efficiency - Irrigators take the lead in Lower Olifants, Water Wheel, March/April 2011, Volume 10 No 2.

Van Vuuren, L. (2012). In the Footsteps of Giants – Exploring the history of South Africa's large dams, SP 31/12, Water Research Commission, Pretoria, South Africa.

Van Wyk, G. (2012). Personal communication on wine grape production, VinPro, Paarl, 20 April 2012.

Van Wyk, G and Le Roux, F. (2012). Production Cost for Wine Grapes 2011, VinPro, Paarl.

❖❖❖❖❖

Part 4: Conclusion and Recommendations

Conclusion and Recommendations

During the course of activities by members of the Task Force, papers under three broad themes were presented: firstly, principles and approaches guiding the development and financing of irrigation schemes; secondly, country policies and strategies on financing; and thirdly, country case studies of water use charges for irrigation.

It is important to acknowledge that basic economic principles of supply and demand also apply to water used for irrigated food production. The challenge is to determine the cost of water supply and to find an acceptable basis for levying these costs from farmers in order to effectively manage demand and encourage conservation. However, incorrect use of terminology should be avoided to prevent misunderstanding. The focus should be on costing[1] of water supply services and setting appropriate levels of water use charges to recover at least some of the cost from irrigation farmers. These charges can only be set in relation to the direct and indirect taxes that are levied from farmers as beneficiaries of projects for investment in irrigation schemes. Otherwise it is impossible to make an assessment whether total cost (capital, interest, operation and maintenance) are recovered. The focus should therefore be directed at finding the balance between water use charges and different forms of taxes to cover the full cost of water supply. In cases where water use charges are set at full cost recovery levels, it will inevitably lead to double charging or taxation and may threaten the financial feasibility and economic viability of irrigation farming.

For the case studies presented, it is clear that all countries (Australia, India, Iran, Japan, Pakistan, South Africa and Thailand, in alphabetical order) have some type of policy and strategy on financing and levying of water use charges. However, it is important to remember that these countries are located in varying humid to semi-arid and arid geographic regions in the northern and southern hemisphere. Also the combination of crops under irrigation varies in these countries, from staple food crops such as rice, to a combination of vegetable, fruit, field and forage crops. Nonetheless, even if policies and strategies have been formulated, they are not necessarily consistently implemented. For example, in the case of Pakistan the water use charges recovered are lower than those assessed; and in the case of South Africa water use charges are collected on an area and not a volumetric basis, as intended in the national water resource strategy.

Regarding financing of public investment in irrigation schemes, it appears that three broad mechanisms are applicable. These are (1) mainly taxation of products, such as rice in Thailand and a percentage of income from cultivated crop production in Iran to fund investment in irrigation; (2) a combination of water use charges and explicit recognition of transfer payments or subsidies for irrigation from general taxes, as in the case of Australia; and (3) reliance on collection of water use charges to cover O&M costs and a part of capital costs, as in the case of India, while in South Africa there is a movement to full cost recovery water use charges, disregarding the past and future recovery of capital costs through various forms of taxation. It is also noteworthy that different terms are used, such as water fee, water rate or water tariff, all referring to some level of water use charge.

With reference to the issues and questions that guided the activities of the Task Force, the findings are as follows:

1. The investment required for irrigation schemes vary from refurbishment to expansion to development of new schemes. The beneficiaries are farmers themselves, input suppliers and product processors linked to irrigation farming and of course consumers of food. In order to achieve household and national food security, attention should be given to both small-scale subsistence and large-scale commercial farming enterprises. However, improvement of efficiency and productivity should receive priority attention ahead of expansion of irrigation.

[1] **Note:** The term “pricing” in this context is fundamentally incorrect since this will only apply to determining the value of water rights or water use rights and negotiating the mutually agreed to price in the market process at which rights to water are then legally transferred.

2. The presently available financing mechanisms are basically a combination of water use charges and different forms of direct and indirect taxes. Where loans are taken up for investment in irrigation, these can be paid back only through water use charges, betterment levies or taxes. In general it can be stated that for any irrigation development there will be direct beneficiaries (farmers) and indirect beneficiaries (consumers and other businesses in the food value chain). Therefore investments in irrigation should be funded through a combination of water use charges and taxes.

3. The appropriate changes to financing mechanisms for sustainable water use and food production are to recover O&M costs through water use charges, levied directly on irrigation farmers. These charges can be area based or volumetric or a combination thereof. For assessment of the extent to which capital costs are recovered, it is important to undertake a fiscal impact analysis. The different sources of revenue to cover fixed capital cost are (a) betterment levies and/or (b) direct and indirect taxes generated as a result of the irrigation development. To the extent that the budget does not balance, transfer payments from general taxes will be required. In the instance of a surplus on the budget, it implies that additional income is generated by the irrigation development.

   On completion of this report it is recommended that a new working group be established addressing the following theme:

Working Group on Irrigation Development and Management of Water User Associations (WUA)

With transfer of responsibility for water management to a local level, more attention has to be given to cost recovery of the service provided for water distribution. At the same time it is important to balance the budget, requiring detail analysis of the source and application of funds. The main motivation is the lack of attention to a combination of water use charges and different forms of taxes, including betterment levies, to finance expansion or new development of irrigation schemes. In turn this makes user-based performance assessments essential and to identify irrigation performance indicators.

❖❖❖❖❖

Appendix

Guidelines to Authors for Papers and Workshop Programmes

Background

Based on discussions at different international and local events, it is clear that there is a large degree of confusion between terms such as the price and user charge for water. A major issue is the incorrect perception that farmers are being subsidised in cases where full cost recovery charges are not levied, while ignoring the indirect financial contributions through the taxation system by both direct and indirect beneficiaries. The contention is that this difference in understanding between e.g. engineers and economists leads to incorrect policy advice and also to slow progress with application of sound financing principles in practice. This explains amongst others why little progress is made with effective cost recovery and implementation of financially viable irrigation schemes.

Purpose

The workshop is organised on behalf of the Task Force on Financing Water for Agriculture (TF-FIN) on the topic of "Development and Financing of Irrigation Schemes" with the purpose to achieve consistency on theoretical issues (value and price vs. cost and user charges), clarity on practical issues (cost recovery through different water user charging systems) and correct approaches to determine the financial feasibility of irrigation development (financial and fiscal impact analyses, with explicit or hidden double taxation). Furthermore, the purpose of this forum is to achieve interactive discussions between the engineering and economics profession as well as water managers and practitioners on irrigation schemes.

Content

The format of the workshop will be presentation of short papers followed by discussions and inputs by workshop participants. The workshop will be introduced by Dr Gerhard Backeberg (South Africa). Papers will be presented by Dr Brian Davidson (Australia) on the principle/theoretical issues of value, price, cost and charges; Dr Sylvain Perret (France) on experiences with implementation of the ICID guidelines to determine the financial cost of water services; and Dr Madhu Bhattarai (India) on practical country experiences in India to levy charges based on cost. Country representatives on the ICID Task Force on Financing Water for Agriculture (TF-FIN) and other interested participants are invited to share their knowledge and experience regarding the extent of implementing cost recovery charges for sustainable irrigation scheme development.

ICID•CIID

International Workshop on
"Development and Financing of Irrigation Schemes"
7 December 2009, New Delhi, India

PROGRAM

14:15	Welcome: Ir. Paul van Hofwegen (World Bank)
	Introduction: Dr Gerhard Backeberg (South Africa)
14:30	Principle issues of value, price, cost and charges: Dr Brian Davidson (Australia)
15:00	Experience with implementation of ICID guidelines to determine financial cost of services: Dr Sylvain Perret (France)
15:30	Financing and cost recovery of irrigation water supply as a semi-public good and service and practical experiences in India to levy user charges based on cost: Dr Madhu Bhattarai (Nepal), and Prof A Narayanamoorthy (India)
16:00	Discussion
17:00	Closure: Ir. Paul van Hofwegen

Annex 1

Workshop of TF-FIN on "Country policies and strategies on financing and implementation of current water user charging systems in irrigation" 12 October 2010 (13:30-17:00 hours), Yogyakarta, Indonesia

Background

In view of the questions to be addressed by the Task Force as part of the Work Plan, the papers for the Workshop should focus on the policies and strategies of each country regarding financing of irrigation, with particular attention to water user charging systems. The papers should briefly sketch the irrigation situation (area irrigated, water allocated, crops produced, scale of irrigation schemes, farmer typologies, etc.); this should be followed by a critical review of the most recent official policies and strategies, with priorities for expansion or increased productivity in future; lastly a clear indication should be given to what extent the strategies are effectively being implemented. These papers will set the scene for case studies and country comparisons of actual financing for irrigation development and levying of user charges for existing or new irrigation schemes, which will be the subject of papers for the workshop in Iran.

Participation

Participating countries on the Task Force representing Australia, India, Iran, Japan, Pakistan, South Africa, Thailand, USA and possibly France, are urged to consider preparing relevant papers and presentations. If individual members are not in a position to do so for whatever reason, alternate representatives from that particular country are welcome to make inputs.

Guidelines

Papers should have a length of between 3000 to 4000 words, 12 font, single spacing (including abstract, figures/tables and references). On this basis a programme will be drawn up and circulated between Task Force members. Hard copies and electronic versions of papers should be handed in during the workshop. Only papers actually completed at the time of the Workshop will be considered for inclusion in the final Proceedings or Position Paper of the Task Force.

Deadlines

Please confirm not later than 17 September 2010 by e-mail to Dr Vijay K. Labhsetwar at ICID Central Office whether a presentation will be made with copy to Workshop Chairman.

The Internal Workshop is being organized by ICID's Task Force on Financing Water for Agriculture (TF-FIN) during its 61st International Executive Council (IEC) Meeting and 6th Asian Regional Conference from 10-16 October 2010 at Yogyakarta, Indonesia.

Contact co-ordinates:

Workshop Chairman: Dr. Gerhard Backeberg (South Africa), Director : Water Utilisation in Agriculture, Water Research Commission, Private Bag X03, 0031 Gezina, Pretoria, South Africa, Tel.: (012) 330-9043, Fax : (012) 331-1136, E-mail : gerhardb@wrc.org.za

Workshop Coordinator: Dr. Vijay K. Labhsetwar, International Commission on Irrigation and Drainage (ICID), 48 Nyaya Marg, Chanakyapuri, New Delhi 110021, India. Tel: +91 11 26115679/26116837/24679532, Fax: +91 11 26115962; E-mail: icid@icid.org.

Website: Please access conference website: http://www.icid2010.org for more information on events during 61st IEC and 6th Asian Regional Conference at Yogyakarta, Indonesia

Annex 2

Workshop on "Country Policies and Strategies on Financing and Implementation of Current Water User Charging Systems in Irrigation 13:30, October 2010, Indonesia

In view of the questions to be addressed by the Task Force as part of the Work Plan, the papers for the Workshop should focus on the policies and strategies of each country regarding financing of irrigation, with particular attention to water pricing strategies and water user charging systems. The paper should briefly sketch the irrigation situation at the national level; this should be followed by a critical review of the most recent official policies and strategies, with priorities for expansion or increased productivity in future; lastly a clear indication should be given to what extent the strategies are effectively being implemented. These papers will set the scene for case studies and country comparisons of actual financing for irrigation development and levying of user charges for existing or new irrigation schemes, which will be the subject of papers for the workshop in Iran.

Members on the Task Force representing Australia, India, Iran, Japan, Pakistan, South Africa, Thailand, USA and possibly France, are urged to consider preparing relevant papers and presentations. If individual members are not in a position to do so for whatever reason, alternate representatives from that particular country are welcome to make inputs. Papers should have a length of between be 3 000 to 4 000 words, 12 font, single spacing (including abstract, figures/tables and references). Please confirm not later than 17 September 2010 by e-mail to Dr Labhsetwar at ICID Central Office whether a presentation will be made. On this basis a programme will be drawn up and circulated between Task Force members. Hard copies and electronic versions of papers should be handed in during the workshop. Only papers actually completed at the time of the Workshop will be considered for inclusion in the final Proceedings or Postion Paper of the Task Force.

Oral presentations based upon those papers shall be brief (provisionally 15 minutes, allowing for another 10- to 15-minute discussion); slideshows should contain about 12 slides, focusing onto the following items:

General information per country

1. Irrigation area (ha)
2. Percentage of agricultural area (country ratio; irrigation area/agricultural area) (%)
3. Agricultural share of Gross Domestic Product (%)
4. Main crops under irrigation, and purpose (food security, export, agri-industry and processing…)
5. Percentage of water extractions dedicated to irrigation (%)
6. Main water resources for irrigation (rivers, storage dams/reservoirs, groundwater…)
7. Size of irrigation schemes and type of irrigation technology
8. Country's water availability index

Elements of policy, legislation, strategy and regulations on irrigation water user charging per country

1. Policy and legal framework (date, name, some details of contents)
2. Existence of water rights and water market frameworks and practices, some key elements
3. Objectives and strategy supporting water user charging systems (water use efficiency, crop productivity enhancement, cost recovery, water savings, irrigation management transfer or river basin management, environmental protection, etc…)
4. Water user charging principles (based on O&M costs, crop, output value, assurance-of-supply principle, scheme size, area-based charging, water use/ volumetric charges, tiered/block charges, etc …)
5. Water charging systems (centralised or decentralised per scheme, farmer-managed or under public sector / government control, fiscal and financial practices linked to charging system)
6. In case of no irrigation water user charging policy, strategy and/or practice; reasons why?

Optional

Case studies (1 to 3, which best illustrate country situation and possibly diversity)

Scheme size, main crops, infrastructures (map, schematic)

1. Main institutional and organisational arrangements (water use authorization/ water license, farmer-managed, government-managed, etc...)
2. Simple typology of farmers
3. Water distribution, scheduling system
4. Water charging system and principles (collection system, financial management, measuring device…-)
5. Fee recovery rate (%)
6. Main issues, pros and cons, discussion on both case study and national situation

Synoptic presentations, making use of tables and figures are to be favored.

Workshop on Country Policies and Strategies on Financing and Implementation of Current Water Use Charging Systems in Irrigation
12 October 2010, Yogyakarta, Indonesia

PROGRAMME

13:30	Welcome
13:35	Dr Brian Davidson (Australia) "Policy and Strategies on Financing and Implementation of Current Water User Charging Systems in Irrigation in Australia"
14:05	Dr Sylvain Perret (France) "Policy and Strategies for Financing Irrigation Operation and Development in Thailand: Past and Present"
14:35	Prof Kazumi Yamaoka (Japan) "Policies and Strategies on Irrigation Charging Systems for Rice Paddies in Japan and the Asian Monsoon Region"
15:05	Dr Gerhard Backeberg (South Africa) "Policy and Strategies on Financing Water and Implementation of Water Use Charging Systems for Irrigation in South Africa"
15:35	Discussion and closure
16:30 – 18:00	Task Force Fourth Meeting

Annex

Final Revised Guidelines for TF-FIN Workshop
Dr. Gerhard R. Backeberg, Chairman: TF-FIN

Workshop on "Country case studies of water use charging systems and available financing of irrigation", is to be held on 25 June 2012 in Australia, starting at 11:00.

In view of the questions to be addressed by the Task Force as part of the Work Plan, the papers for the Workshop should focus on actual case studies of water use charging systems and financing of irrigation development of each member country. These papers on case studies will form the basis for country comparisons of actual financing for irrigation development and levying of user charges for existing or new irrigation schemes, which will be included in the report of the Task Force to conclude activities.

Members on the Task Force representing Australia, India, Iran, Japan, Pakistan, South Africa, Thailand and possibly Malaysia are urged to prepare relevant papers and presentations. If individual members are not in a position to do so for whatever reason, alternate representatives from that particular country should make inputs. Papers should have a length of about 5 pages, 12 font, single spacing (including abstract, figures/tables and references). Please confirm not later than 31 March 2012 by e-mail to Dr Labhsetwar at ICID Central Office whether a presentation will be made. This will enable finalization of the draft programme attached hereto. Hard copies and electronic versions of papers should be handed in during the workshop. Only papers actually completed at the time of the Workshop will be considered for inclusion in the final Report of the Task Force.

Oral presentations based upon those papers shall be brief (provisionally 20 minutes / 30 minutes, allowing for another 10 / 15 minutes discussion); slideshows should contain about 12 slides, focusing onto the following items:

Case studies (1 or 2) which best illustrate country situation and possibly diversity

Scheme location, size, main crops, infrastructure (map, schematic illustration)

1. Total area irrigated, water allocated, irrigation methods, crop yields/income/costs
2. Main institutional and organisational arrangements (water use authorization/ water license, farmer-managed, government-managed, etc...)
3. Simple typology of farmers
4. Water distribution, scheduling system
5. Water charging system and principles (collection system, financial management, measuring devices, etc…)
6. Other financing mechanisms available
7. Cost recovery rate (%)
8. Main issues, prospects for sustainable irrigation, farmer and government perspective, discussion on both case study and national situation

Synoptic presentations, making use of tables and figures are to be favored.

CO-OPERATION BY ALL TASK FORCE MEMBERS AT THIS FINAL STAGE OF ACTIVITIES IS ABSOLUTELY ESSENTIAL

Workshop of TF-FIN on "Country case studies of water use charging systems and available financing of irrigation"
25 June 2012 (11:00 -12:30, 13:30-15:00 and 15:30-17:30 hours)
Adelaide, Australia

DRAFT PROGRAMME

Time/ hours	Particulars
11:00	Welcome
11:15	Country case study for Australia (Dr. Brian Davidson)
11:45	Country case study for India (Mrs Ananya Ray)
12:30	Lunch
13:30	Country case study for Iran (Mr E Z Farhadi)
14:15	Country case study for Malaysia (To be confirmed)
15:00	Tea/Coffee
15:30	Country case study for Japan (Prof. Dr. Kazumi Yamaoka)
16:00	Country case study for Pakistan (Mr Bashir Ahmad Sial)
16:30	Country case study for South Africa (Dr. Gerhard Backeberg)
17:00	Country case study for Thailand (Dr. Sylvain Perret)
17:30	Closure and way forward