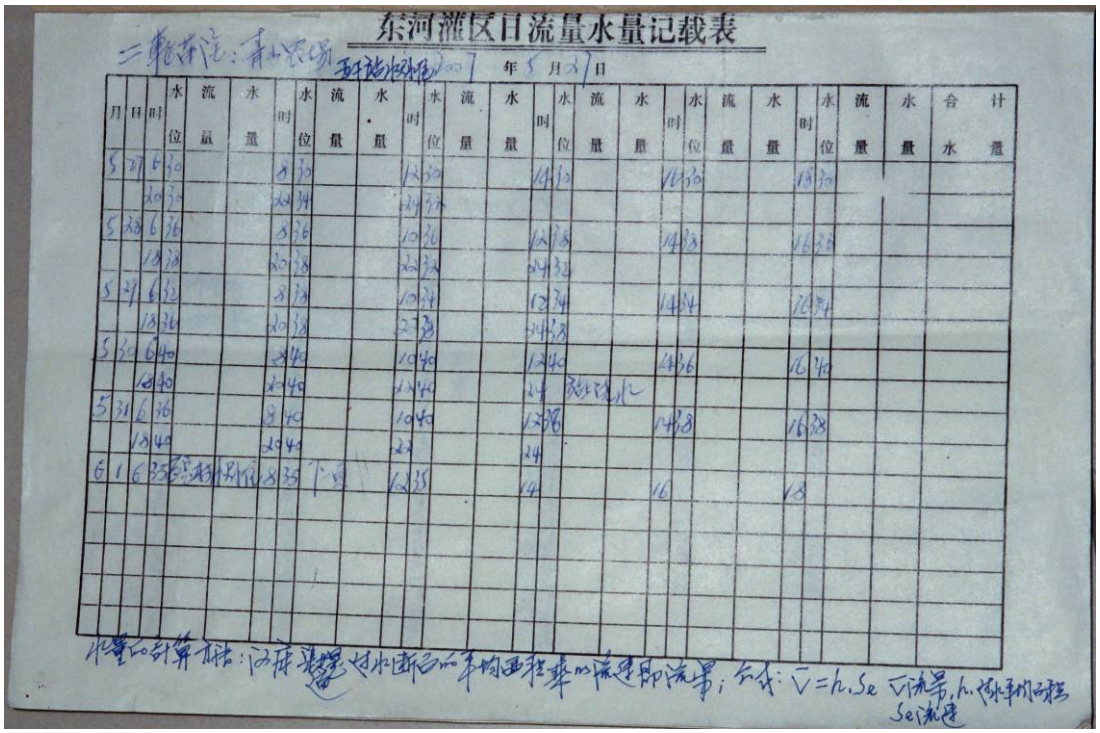
China – UK, WRDMAP
Integrated Water Resources Management Document Series

Advisory Note 5.2: Formulation of Irrigation Service Charges for Surface Water Irrigation Districts

May 2010



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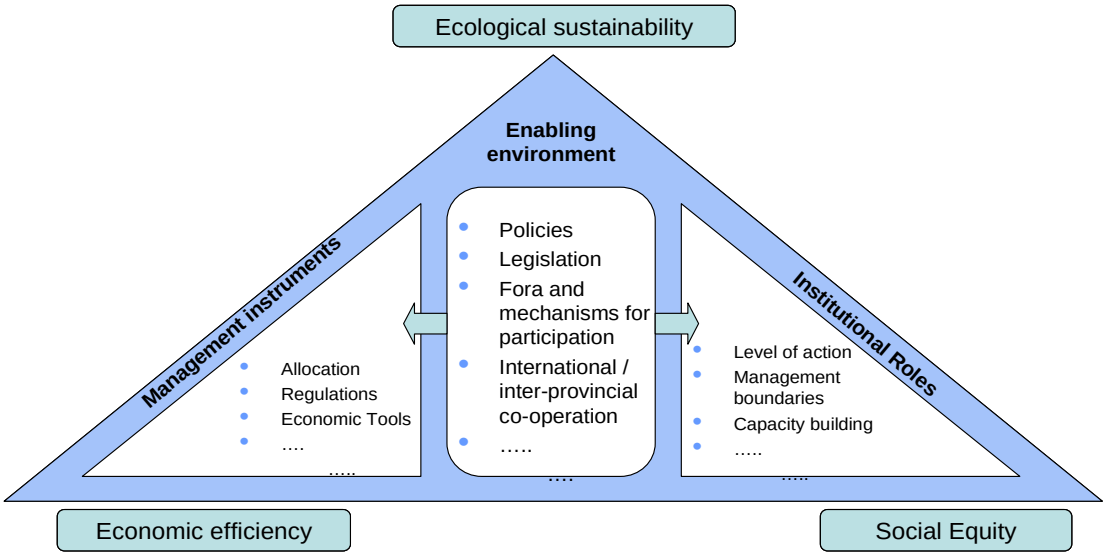
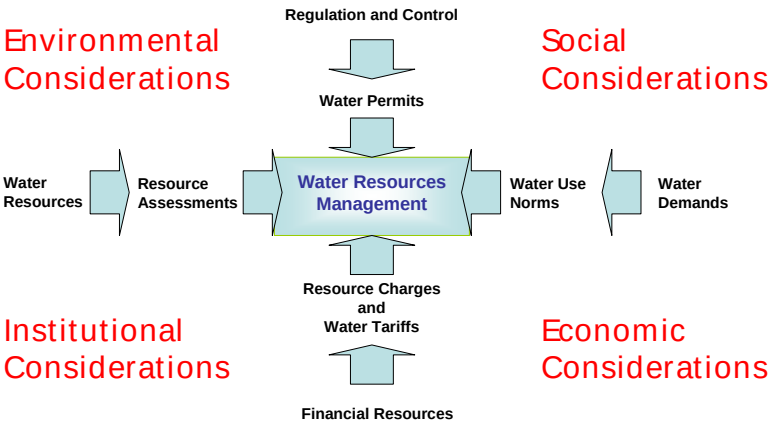
Integrated Water Resources Management (IWRM)

(Basics after Global Water Partnership)



Driving Elements of Integrated Water Resources Management



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Summary: The guidance provided in this document outlines a comprehensive process for assessing existing systems for irrigation charging, and for designing new or improved systems.

This document covers the following topics

- Introduction to irrigation charges, and their objectives
- Definitions of key terms which are important for the design of fees
- Lessons from international and national experience, covering the categories of costs to be recovered, the structure and impact of charges, collection methods and the role of WUAs
- Policy and legal framework for irrigation charges in China
- Process for assessing and designing charging systems, giving a step-by-step description of the process
- Conclusions and recommendations

This document provides general guidance and background to the process of setting fees. An example of the calculation is provided in a separate document, Example 5.2 'Assessment of an ISC System: Donghe Irrigation District (Jinchang, Gansu)'. Further information on water charging is provided in the thematic paper on water resource fees in this series.

This document is one of a series covering topics on sustainable water resources planning, allocation and management. Details are given in the bibliography.

The Ministry of Water Resources have supported the Water Resources Demand Management Assistance Project (WRDMAP) to develop this series to support WRD/WAB at provincial, municipal and county levels in their efforts to achieve sustainable water use.

1 Introduction

1.1 Overview

This paper provides guidance on Irrigation Service Charges (ISCs), drawing on international and Chinese experience, and the legal and policy context in China. These charges are required as part of the Government of China's objectives of full cost recovery for public services.

Although ISCs are often seen as an important way to reduce demand directly, the review of experience from elsewhere suggests that this is usually an unrealistic expectation. The primary objective should normally be cost recovery; this should make the management fully-financed and sustainable. This in turn should improve the standards of management and lead to effective demand management in the true sense of the term. This advisory note provides a step-by-step framework for developing a new ISC system or assessing an existing system.

The charges described in this note relate to those made by the Irrigation District or other public agency managing a scheme. It does not cover internal charges by water users' associations (WUAs), production groups, contractors, individual farmers or other entities. It must, however, be recognised that individual farmers will often need to pay some extra charges to cover local costs. Effective decentralisation of management to WUAs can have important beneficial impacts on the nature and performance of charging systems – this is discussed in Section 3.8.

The paper draws on studies in the WRDMAP (Water Resource Demand

Management Assistance Project) of surface water irrigation in Jinchang Municipality in the Shiyang River Basin (SRB) of Gansu Province, as well as literature on experience in other parts of China – the recommendations are intended to be applicable widely in other provinces of China.

An example of the application of these guidelines to the Donghe Irrigation District in Jinchang Municipality (Gansu) is presented in Example 5.2 'Assessment of an ISC System: Donghe Irrigation District (Jinchang, Gansu)'.

1.2 Background to irrigation charges

Irrigation charges have been levied for millennia, at least since the Dujiangyan irrigation system was constructed over 2,000 years ago. These charges were to cover the cost of building and maintaining the schemes, and often allowed for a profit for the developer. Even as late as the development of irrigation in Pakistan in the 1930s, the Government expected to cover the full costs and make a profit from irrigation through user charges. Charges were, however, discontinued in many countries in the period 1950-80, when irrigation was regarded as a primary means for poverty reduction and thus should be free and provided by the State.

Unfortunately, these later (post-war) large-scale irrigation schemes performed much worse than expected , (usually because of inadequate maintenance) and the view that irrigation should be free was replaced in the 1990s by the one that charges should be used to instil economic rationality to the water sector.

This view has remained dominant but it has been refined, since it has been recognised that water charges have had little impact on efficiency yet (Bosworth et al. 2002). They have not even had much impact on sustainability: the World Bank found that '*there is normally no link between higher water charges and better operation and maintenance. Revenue from water charges generally goes to the general treasury and is not earmarked for O&M'* (Jones 1995).

These findings have not changed the view that it is important to charge fees but they have reinforced the need to pay more attention to the way fees are charged and used. The emphasis should be place on ensuring that these fees are effective in improving irrigation system performance. Reductions in food prices in real terms in recent decades has made it difficult to charge sufficiently high prices for water to cover costs, and have made it important to increase the productivity of water.

Accordingly, there has been a huge amount of research on irrigation pricing and its impact, with much of the literature summarised by Molle and Berkoff (2007) in a valuable compilation of papers and analysis. They note that:

"*Charging for water use or disposal is not an end in itself, but an instrument for achieving one or more policy objectives. A water charge may be a* ***financial tool*** *aiming to recover all or part of capital and recurrent costs, recurrent cost recovery being particularly critical to preserve the physical integrity of the system when public funds are not forthcoming.*

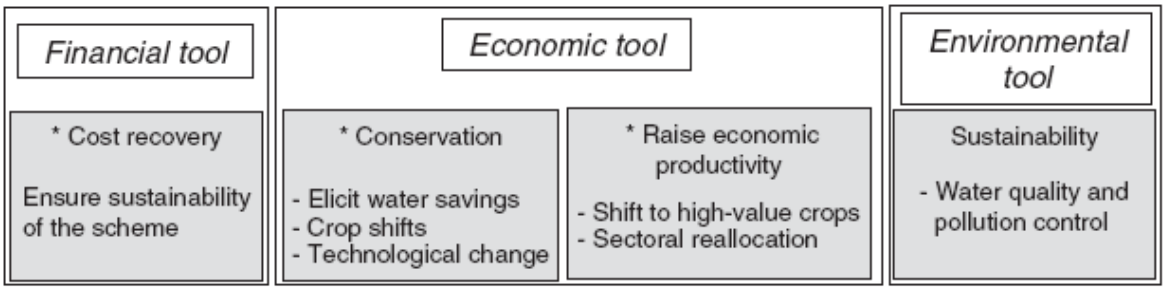
A water charge may also be an ***economic tool*** *designed to conserve water and raise water productivity by*

promoting: (i) careful management and water conservation; (ii) cultivation of less water-demanding crops and investments in water-saving technologies; and (iii) reallocation of water to high value agriculture and/or other sectors. Finally, a charge can be an ***environmental tool*** *to counter water pollution and enhance water quality*".

This paper discusses the role of irrigation service charges as a financial tool for recovery of costs incurred to ensure the sustainability of the irrigation system. Other charges can also be levied as economic or environmental tools (see Thematic Paper 5.3 'Water Resource Fees'), but their impact tends to be low in practice (at present – they may be increased in future). If such charges are levied, they will be applied to the abstraction permit holder, who will need to recover them from the users: WRFs thus become one of the costs to be included in the calculation of ISC.

This paper does not consider the design or impact of such charges, but focuses purely on cost recovery for irrigation service delivery.

Figure 1: Alternative objectives for irrigation charges



2 Definitions

The terminology used in these Notes is based on the following definitions:

- *Irrigation Service Charge*: the total payment made by a user for an irrigation service. It may comprise fixed elements (e.g. the Basic Fee per mu charged on most Chinese irrigation schemes) plus variable elements (e.g. a volumetric charge per cubic metres of water delivered or a charge per mu of land actually irrigated). It might include a 'water resource fee', but this currently not charged on surface irrigation in China.
- *Cost of the irrigation service*: the expenses incurred by the supplying agency in providing the service. Precise definitions depend on local rules, but typically include operation, maintenance, staff and fuel costs, plus some elements of replacement costs and amortisation of capital.
- *Annual amortisation charge* is the annual charge made to recover the cost of a capital investment or a loan. It includes two elements (i) repayment of the principal (the capital sum

expended or borrowed) and (ii) payment of interest charges on a loan. Depending on official policy, interest charges may or may not be applied on capital investments in irrigation projects financed by the Government.

- *Value of water*: the income received by a farmer as a result of the use of irrigation water, from the irrigated crops which he grows, divided by the quantity of irrigation water used.
- *Replacement and non-replacement capital costs.* For the purposes of irrigation charging, capital costs should be divided into two categories:
  - '*Replacement' capital costs*: items such as pumps, vehicles and other machinery and equipment, which have to be replaced at regular intervals, and for which arrangements for funding their replacement need to be made in an irrigation system's financial planning and charging system. This is done through annual depreciation charges.
  - '*Non-replacement' capital costs*: one-off capital expenditures incurred at the scheme development stage, such as land acquisition and resettlement, and major infrastructure like headworks and large canals which require replacement rarely, if at all. Recovery of these costs is not necessary for scheme sustainability, even though the Government may wish to recover them for financial reasons.

3 Lessons from International Experience

3.1 Introduction

This section is derived mainly from a major research project on "*Guidelines for Irrigation Charging*" which was undertaken by HR Wallingford of the UK and funded by DFID. The work was undertaken from 2002 to 2004 and included a detailed review of literature of experience in more than 50 countries, and field studies in four countries (Morocco, Jordan, Macedonia and India). The extensive information available from this source was supplemented by additional direct experience from Kyrgyzstan, Turkey, India and elsewhere. Thus it draws on information from a range of low, middle and higher income countries, which have a wide range of management and technical capacities.

This review is concerned mainly with public sector irrigation schemes. Although minor irrigation schemes such as tubewells which are operated by individuals, farmers' groups and other non-government entities may be charged some fees by the Government, they make their own arrangements for irrigation charging to cover the majority of the costs.

3.2 Categories of costs to be recovered

The literature on irrigation costs and charges identifies the following categories of cost:

- Full Supply Cost - operation and maintenance, replacement capital costs (i.e. depreciation costs, for items like pumps) and non-replacement capital costs like canals, drains and roads.

- Full Economic Cost - Full Supply Cost plus the 'opportunity cost' of the water used for irrigation; i.e. the additional value it would have if used elsewhere in non-agricultural sectors.
- Full Cost - Full Economic Cost plus 'environmental externalities' or 'costs', such as the value of the environmental damage which may be caused by a reduction of river flows below an irrigation diversion.

Normally, Full Economic Cost and Full Cost are substantially higher than Full Supply Cost, and the O&M cost is only small part of the full supply cost, as illustrated in Figure 1.

3.3 Objectives of charges

The two most common objectives of irrigation charging are cost recovery (as outlined above) and direct influence on demand.. In many countries there is little clarity as to which is the main objective.

Cost recovery

In almost all countries, however, including even the most developed countries, cost recovery is in practice the main charging objective. Its advantages include:

- It is easy to calculate the costs to be recovered
- it should help ensure adequate irrigation scheme maintenance and performance
- It is transparent and farmers can see that irrigation charges reflect actual costs incurred

This objective of recovering full O&M costs is accepted in most countries and in all developed countries, although in practice it is often not achieved in less developed countries.

However, it usually only covers the O&M costs and sometimes replacement costs. Few low income and many middle income countries even include depreciation costs in irrigation charges, and few of even the most developed countries attempt to recover original capital costs.

As far as is known, no countries attempt to charge the Full Economic Cost or the Full Cost for irrigation. These costs can be more than ten times greater than O&M costs (see Figure 1), and it would be very contentious to attempt to recover them directly from irrigation users:

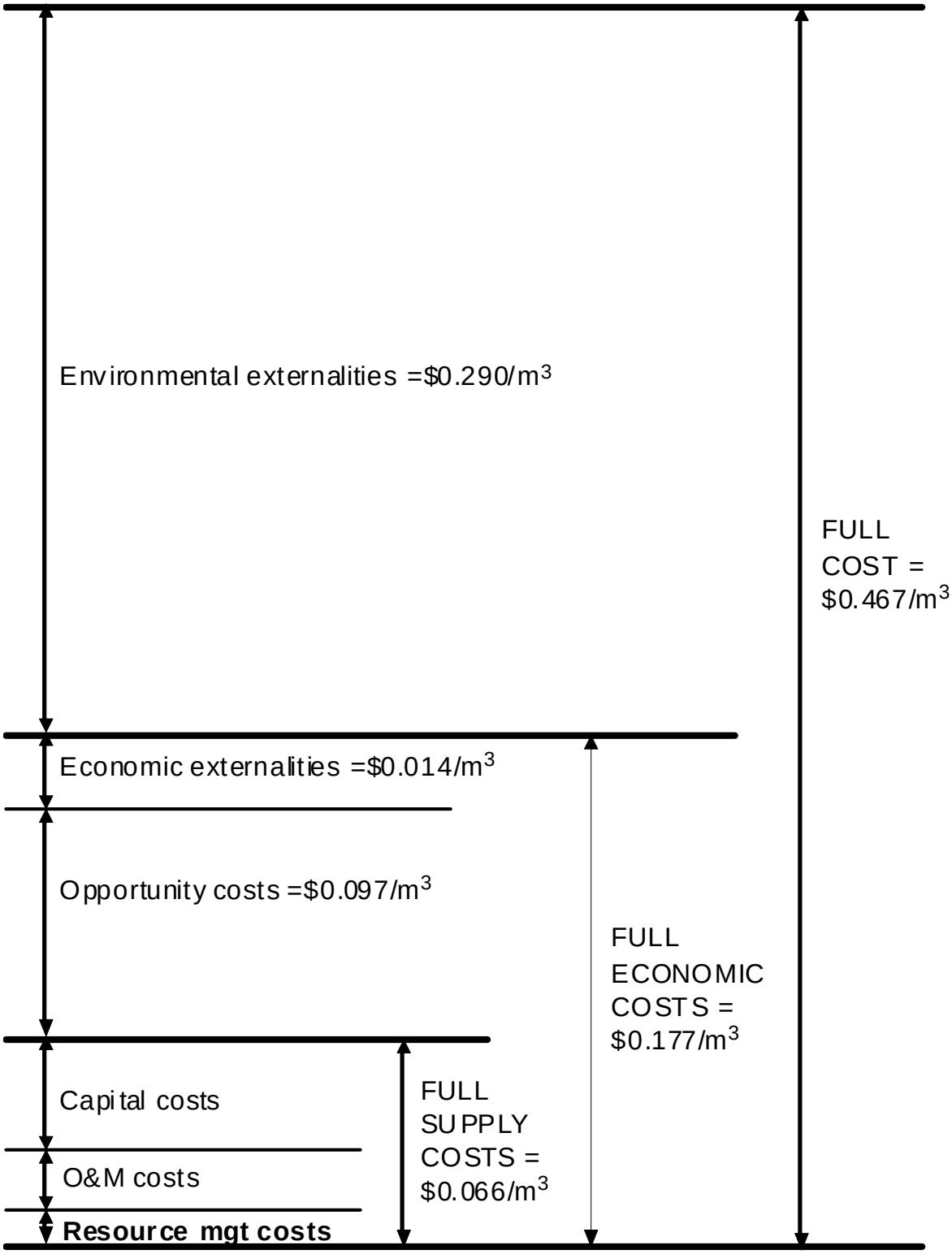
It is also extremely difficult, to value the opportunity cost of water and environmental costs accurately – this has been done in Figure 1, but that was for a research project and not as part of normal operational management.

Influence on demand

Increasing the price of water should reduce the demand for it, but this only applies if certain conditions are in place: These apply where farmers:

- can control and measure the amount of water they receive, and only pay for the amount of water they use; and
- can continue to earn a reasonable income if they use less water, and where the charge for water is close to the marginal value of water

Figure 1: Major components of the total costs of water, with estimates of actual costs from Subarnarekha basin in India



In practice, farmers often have little control over the amount of water they receive and they are unable to measure the flow. Reducing the amount of water can have disproportionate impacts on crop production, possibly even resulting in total crop failure.

Although the direct influence of price on demand is often stated, it is rarely achieved in practice. Even if there is no direct influence on demand, service charges are still an important element of *demand management* since DM requires services to be fully financed.

3.4 Structure of charges

The most common form of irrigation charge is per unit area of land irrigated, or per hectare of crop with different charges for different crops according to their level of water use or other criteria.

The use of volumetric charging for individual farmers is not widespread even in high income countries. It is done in some places with a small number of large farms, but not where farm sizes are small. In that case, the charges may be volumetric to the village or WUA and then area-based to farmers. This is applied in several countries, including in some parts of China, but the normal system in China is a two part fee paid directly by users - a fixed 'basic' fee based on area and a variable 'volumetric charge' based on water use.

This combination is intended to ensure some incentive to save water (from the volumetric charge), whilst ensuring a relatively stable income for the management organisations (as a result of the fixed charge). However, in practice, most of the total charge is now usually in the volumetric charge, in order to maximise the theoretical incentive.

This would cause financial problems for the irrigation agency supplying water in areas where year-to-year variations in rainfall influence the level of irrigation demand (such as areas where supplemental irrigation is the norm and thus the amount of water supplied varies highly, depending on rainfall). Such year-to-year variability can result in fluctuations in revenues from the ISCs, and thus in the amount of money available for scheme O&M.

3.5 Volumetric charging

Practicalities

Volumetric charges have strong theoretical attractions, and are widely regarded as the best, if not the only sensible, basis for irrigation charges. This view is supported by the positive achievements on urban water supply systems, but the reality for irrigation is unfortunately not as simple or positive.

Flow measurement in irrigation channels is difficult: it can be very expensive, because of the infrastructure, equipment and staff, and the measurements are often inaccurate. Both flow rates and durations need to be recorded to determine a total volume, but even individual measurements are inaccurate. Canal flows vary with time and it is difficult to integrate them over time to calculate the actual volume delivered. Integrating meters, such as the Dethridge wheels used in Australia (where farms are very large), do exist but they are not common elsewhere and they are expensive. The need for low cost, reliable integrating meters is widely recognised, but unfortunately satisfactory models do not yet exist.

Further complications arise when irrigation water flows to fields in informal ways as well as along designed routes - via return flows, field-to-field flows, canal seepage, and illicit abstractions and so on. Quantifying all of these flows to each farmer is highly problematic, and rarely possible for routine management.

Impact of volumetric charges on demand

For these and other reasons, experience demonstrates clearly that volumetric and quasi-volumetric (proxy) forms of ISC have little impact on water demand on SW irrigation schemes. Due to the moderate O&M cost per m^3 of most SW irrigation, the level of ISC which can reasonably be charged (i.e. a cost recovery-based charge) is too low to affect the level of farmers' water demand significantly.

This is because of the low price elasticity of demand for water under normal irrigation conditions. Irrigation charges are only a small proportion of the costs of crop production, often less than 5%., and some estimates indicate that volumetric charges per m^3 would need to be 10-20 times above cost recovery levels to reduce farmer water demand substantially.

It would only be by raising ISCs to levels which would be socially and politically unacceptable that demand by individual users could be influenced to a substantial degree. This would also raise the question of who would receive these funds and what they would be used for. The increase would take the form of an increased water resource fee, or an additional environmental tax – the practicalities and constraints to this are considerable and are discussed further in TP5.3 Water resource fees

The costs of groundwater irrigation are generally much higher and charges effectively based on a volumetric or proxy volumetric system since the tubewells are usually drilled privately, or quasi-privately and fuel/electricity costs account for the bulk of operating costs (except occasionally where electricity is subsidised or free).

Charges can only influence demand if farmers are able to control as well as measure flows. If the control structures are inadequate or the management system is based on a pre-ordained, flxed schedule, then farmers will continue to receive what is provided by the WMD. Volumetric charges would need to be combined with effective downstream control by the users if they are to influence demand.

There are cases where WUAs or farmers can control the amount of water provided, and hence there is potential for achieving water savings.

Volumetric charges to WUAs

It is logical for irrigation agencies to charge to WUAs or private contractors on the basis of the volume supplied to an intermediate level in the canal system (e.g. Water User Association (WUA) channel off-take), with the WUA then charging individual farmers on some simpler basis. This is applied in several countries, including in some parts of China, in places where management responsibilities are transferred to WUAs.

For charging individual users, WUAs have adopted various proxy forms of volumetric charge, as a practical and cost-effective means of charging their members, to the extent possible, on the basis of the amount of water they use. The most common forms of such charge are: crop area-based charges, usually with different charges for

different crops, in order to reflect their relative use of water; a charge per irrigation; and time-based charges, with a charge per hour or minute of water delivery to the farmer's field.

In China there are also some instances of farmers being charged on a per capita basis, according to the size of household. No examples were found of this type of charge in other countries. It usually bears no direct relationship to the volume of water used, but in China it may be equivalent to land area-based charging in places since land has recently been allocated to individuals on an equitable basis (i.e. with the same amount of land being allocated to each person).

Volumetric charges to WUAs will only have a beneficial impact if there is a real transfer of management responsibilities to the WUA: they should be independent of the WMD and able to make their own decisions about how much water they want to receive and pay for.

3.6 Magnitude and affordability of irrigation charges

There are large variations in irrigation charges between different countries. The data reported in the HR Wallingford study were generally from the 1990s or early 2000s. Most figures were in the range Y0.1-Y0.4/m^3, but in Israel they were Y1.4-2.3/m^3 whereas in the India and Pakistan examples the charge per m^3 was little above zero.

Irrigation charges expressed as a proportion of crop gross returns, production costs and net returns per unit area are important parameters affecting the likely potential impact of irrigation charges on farmer incomes. Typical figures are presented in Table 1, although there is surprisingly little published data on this.

3.7 Collection efficiencies and O&M cost recovery rates

General

It is one thing to assess the charges that are required to achieve cost recovery, and quite another to collect this amount of money. Collection rates are often low, and costs of collection are high. Improving collection efficiency is often a driver for setting up WUAs, but they too can face considerable difficulties

International experience indicates that:

- In most countries, much less attention is given to irrigation charge collection than to setting the charge rates.
- Irrigation charge collection rates achieved in the middle income countries covered by the HR Wallingford review were generally 70%-90%. They were much lower in low income (developing) countries but were 100% in most developed countries (Table 2).
- Low collection efficiencies are a major reason for poor recovery of O&M costs in low and middle income countries.
- Charging for irrigation supply before delivering the water, as is often applied in China, is an effective way of increasing collection rates but is not common as it is very difficult for farmers to pay in advance

WUAs are often expected to improve collection rates – but although they can do this, they lack any incentive to collect fees unless they are entitled to

keep part of the fees. Some times they pay the fee to the Government who then return part of the fees to the WUA, but this can be administratively complex and undermines part of the value of involving WUAs in the first place. It is also often too small a percentage to cover WUA costs.

The approach adopted in Nepal is for the fee to be reduced according to the degree of WUA involvement in system management. This is simpler, but there are still difficulties in collection.

More efficient fee collection systems, which cover the costs of collection, and achieve high collection percentages are still needed in most countries.

Table 1: Irrigation charges as percentages of crop costs and returns

Irrigation charges as percentages of:-	**Gross Returns**	**Production Costs**	**Net returns**
Indian Irrigation Commission (1972) guideline	5-12%		
Estimated level (2004) to influence farmers' water use*	-	10-20%	-
Kyrgyzstan WUAs (2005) for 100% of O&M costs			
Wheat	6	10	18%
Maize	4	7	8
Morocco	-	-	up to 17%
China data:			
Guanzhong (9 Districts in Shaanxi)	-	11-23	-
Ningxia, 2005	4-7	8-10	15-20
Xinjiang, 2005	-	7-10	12-20

Source Project studies

Table 2 ISC collection performance

Country	**Collection Effectiveness**	**% of O&M Costs Recovered**
Argentina	70%	100% plus 12% extra
Bulgaria		60%-100%
Government	40%	
WUAs	70%	
Colombia	76%	52%
France (3 schemes)	-	100%
Greece	-	60-75%
India	-	20%
Japan	-	100% plus extra
Jordan	-	50%
Mexico	92%	85%
New Zealand	-	100%
Philippines	58%	46%
Turkey	72%	70%
USA		100% plus extra

Source HR Wallingford

Reasons for poor collection performance

Reasons for low irrigation charge collection efficiencies include:

- Weak incentives for the irrigation agency to collect fees due, because the revenues collected often go to the Government Treasury, not to the irrigation agency for scheme O&M.
- Little 'willingness to pay' by the farmers if the quality of irrigation service is not good
- A lack of political will to enforce payment (which in turn is related to low willingness to pay).
- A lack of effective penalties and sanctions to enforce payment. Cutting off irrigation supplies is the most effective penalty, but can be socially punitive (the impact of the penalty may be disproportionate to the offence) and politically sensitive.
- Lack of participation in the design and enforcement of the collection system and penalties for non-compliance.

Timing of ISC Payments

ISCs are normally paid in arrears, when the farmers are likely to have cash available from the sale of produced. Pre-payment for irrigation supplies is not common in developing countries but is very firmly established in parts of China.

Partial or full pre-payment of ISCs is an effective means of ensuring high ISC collection efficiencies but is not popular with farmers, because they may have insufficient cash before the crop being irrigated is harvested and sold – unless they have income from other sources. The social impact of such a system needs to be carefully considered, particularly for households without off-farm income, who are generally the most vulnerable.

The fact that pre-payment is so well-established in China is a major advantage for the achievement of an effective irrigation charging system with high levels of collection efficiency. The challenge here is to design appropriate social safeguards.

3.8 The implications for ISCs of irrigation management transfer

There has been a widespread adoption of the concepts of Irrigation Management Transfer (IMT) and Participatory Irrigation Management (PIM) in many countries including China, in recent years. A key feature is the transfer of management (operation and maintenance) of the lower levels of irrigation systems from public sector irrigation agencies to farmer organisations like water user associations (WUAs) and Production Groups, and sometimes to other entities like private contractors. This has important implications for irrigation charging, depending on the objectives and methods adopted.

Until management is transferred, the irrigation agency is responsible for the management and O&M of an irrigation system right down to individual farmers (including the tertiary distribution system and irrigated area). As such, its duties normally extend to considerably more than just the supply of water. Its costs and the charges it makes for the services it provides should reflect this. In these circumstances some kind of non-volumetric charge, usually a charge per crop hectare, is reasonable.

Management transfer changes this situation, by introducing a second tier into the management and charging structure. The first level of charging is from the irrigation agency to the WUA, and the second is from the WUA to the individual farmer. In this situation the irrigation agency is primarily a bulk supplier of water. The most appropriate basis on which it should charge its customers (the WUAs), is by the volume of water supplied, since this is the major service it is providing. Essentially, it is 'selling' water. Thus volumetric charging becomes the most logical basis for the irrigation agency to apply.

The WUA then needs to charge its members. Volumetric methods are not possible, so it uses the simplified methods as described earlier.

However, financial issues are common problems for WUAs: they may lack the legal authority to collect fees for their own use, the ability to enforce collection, or local trust in their ability to manage funds.

4 Policy and Legal Framework

4.1 Government objectives

Government objectives which are of particular direct or indirect relevance to ISCs in China include the following:

- To increase rural incomes, in order to reduce the gap in living standards between the nation's urban dwellers and rural dwellers
- To maintain food grain production, so that the country can continue its near self-sufficiency in basic foodgrains
- To reduce water use and improve water use efficiency
- To achieve full cost recovery for most services provided by the public sector.

Cost recovery through suitably-structured irrigation charges should encourage more economical use of water as well as sustainable O&M.

On the other hand, increased irrigation cost recovery may well reduce farmer incomes, and reduced irrigation water use may result in a decline in food grain production. The adverse effect on rural incomes can be mitigated by the use of appropriate Government subsidies, and these can also be used to encourage food grain production. In recent years most rural taxes have been abolished, as one means of raising rural incomes. In addition, the Government introduced a Food grain Subsidy (Y23 per mu of wheat in 2006). A further subsidy of Y10/mu was also paid to farmers who use good quality improved wheat seed.

A mechanism therefore already exists to cope with the possible adverse effects of increased irrigation charges and reduced water use on rural incomes and wheat output. If there are serious concerns about such impacts, the Government could increase the food grain subsidy in order to compensate the farming community for the loss of income. This would at least benefit the wheat growers, though not those growing other crops, unless the subsidy scheme was broadened to cover other crops as well. It would also have the effect of encouraging wheat production. However, it is important to ensure that the two sets of measures (fees and subsidies) are supportive rather than contradictory

For a number of years this type of area payment has been the principal means by which the European Commission has maintained levels of income amongst the European Union's farming community. The extent to which it does maintain farm incomes is, of course, highly dependent on how much more money the Government is willing to provide for such subsidies to farmers.

4.2 History of water charging policy in China

Since 1949, there have been four phases of water tariff reforms:

1. Free water supply (1949-1965)

2. Introduction of policy for charges for water supply (1965-1985).

3. Water tariff reform(1985-1995)

4. Development of water tariff reform (1995 onwards)

'Tentative Measures for Water Charges Collection and Management' was put forward by the Water Resources & Power Ministry in 1964,, which changed water supply for free policy. In 1980, the State Council put forward "*All water resources management departments are to collect water charges in line with regulations, to achieve self-accounting, and to be responsible for its own profit and loss*". All provinces, autonomous regions and municipalities directly under the central government started to implement "*independent accounting and self-responsibility for its profit and loss*" for water resources management departments.

The State Council issued 'Measures for charges calculation, collection and management of water from water resources works' in 1985. This provided that "*water charge rates should be based on water supply cost calculations, in line with national economic policies and local water resources situation, for different usages*". Most provinces, autonomous regions and municipalities directly under the central government then issued rules for implementation.

The Finance Ministry issued 'Financial system for water resources management departments' In Dec. 1994, which contained provisions that "*the operational income of water management departments should include incomes gained from water supply, power generation and comprehensive operation*". [Document 397] It is the first time to regard water tariff as operational income.

In 1997, the State Council issued the 'Policy for water resource sector', with provisions for the water supply tariff for newly-built water works to meet operation costs, to pay taxes, and to pay loans and gain rational profit. For existing works, the tariff is to be developed on basis of national water tariff policy and cost repayment and rational profit. Changes in tariffs should be in place in three years, different tariff is for different usage.

The State Council abolished the 1985 Measures for water charges' in May 2003, and the NDRC & MWR then issued Management Measures for tariff of water supplied from water resources works' with effect from January 2004.

4.3 Current legal and regulatory framework for irrigation charging

National level

The key current legal documents related to ISCs are:

- Price Law of People's Republic of China
- Water Law of People's Republic of China
- Water Resources Sector Policy
- Management Measures for tariff of water supplied from water resources works, NDRC & MWR Decree Nr 4 (2003)
- Regulations for Water Drawing Permit and Collection and Management of Water Resource Fees', State Council Decree 460
- Standard for economic assessment of constructions of water works, SL 72-94
- Standard and procedures for final accounting of water resources infrastructures constructions completion, SL19-2008

The 2002 Water Law provides for cost recovery for water-related services under Article 55, which states that 'Water supply' fees are to be levied to recover the full costs of their provision and to allow a reasonable profit. Regulations on such charges are to be formulated by the departments of price administration (the Price Bureaus) jointly with the water supplying organisations.

The 2003 'Regulation on Water Price Management in Water Schemes'. provides detailed guidelines on irrigation charging. Amongst other things, it stipulates that:

1. tariffs should be divided into two categories, agricultural and non-agricultural, with the agricultural 'water price' excluding profits and tax whereas the non-agricultural should include them,

2. of the two forms of irrigation charge, the Basic 'Water Price' (the charge per mu) should include direct salaries and management expenses and 50% of the scheme depreciation and repair costs whereas the volumetric charge per m3 should include all other costs, including the water resource fees,

3. the charges should take account of their affordability to users and

4. for schemes funded by loans and bonds the charge should be sufficient "to reimburse the capital and interest" and obtain a reasonable profit; i.e. it provides for recovery of even the full capital costs.

SCD460 provides the framework for the water resource abstraction and the water resource fee (WRF) system, but it does not specifically cover irrigation charging. It will become more relevant to ISCs in the future if WRFs are charged for abstraction for surface water irrigation. These WRFs would then become a cost which would need to be recovered from users through the ISCs.

At the national level an adequate legal framework for the operation of an effective irrigation charging system is clearly already in place.

Provincial regulations and policy

The ISC regulations at the Province level generally follow the national regulations. In Gansu, the 'Provisional Regulations on Water Supply Cost Accounting for Water Projects in Gansu Province' were published in 1998. In their six pages they provide detailed instructions on how to calculate the capital and O&M costs of irrigation and other water projects and are the basis used for the cost estimating work done by the WRBs and other water sector organisations in the SRB. They do not, however, cover how irrigation charges should be calculated to recover these costs.

5 Framework for Assessing and Designing a Charging System

5.1 Introduction

The framework for assessing or designing an ISC system is presented in Table 3, and the steps for applying this framework are described in the following sections.

5.2 Step 1: Assess institutional setting

A full understanding of Government policy and the legal and institutional framework relevant to irrigation service charging in the particular scheme or area should be the starting for the ISC assessment. The situation in China was discussed in Section 4. The key features relevant for local design of a charging system include institutional arrangements with well-defined responsibilities for management, defined and known water rights, ability to enforce agreements, transparency and avoidance of corruption, and well-motivated and trained staff.

5.3 Step 2: Objectives of ISC

The objectives of the ISC system for the particular scheme or area should be clearly defined. These are likely to have been already set by Government policy for the irrigation sector as a whole and will normally focus on cost recovery

It will be necessary to define whether the objective is to recover just the O&M costs, or the O&M costs plus capital replacement (depreciation) costs, or these two costs plus also part or all of the non-replacement capital costs, by means of an amortisation charge.

In addition, there may be other objectives, such as use of prices to influence directly (by consideration of the price elasticity of water). If there are multiple objectives it is important to ensure that they do not conflict with each other

Table 3: Steps in Irrigation Service Charge design and implementation

Steps	**Factors, alternatives, tasks**
1. Assessment of policy, institutional & legal framework	Government fiscal, water, agricultural, social welfare, environmental & other policies
	Relevant laws and regulations
	Institutions involved in irrigation, their roles and responsibilities
2. Setting the objectives of irrigation service charging	***Alternative objectives*** *Cost recovery*: - Recovery of only the O&M costs. - Recovery of O&M costs plus part or all replacement costs - Recovery of O&M and capital replacement costs plus part or all non-replacement capital costs
	Directly *influencing demand* (to reduce water consumption)
	Economic efficiency (increasing the productivity of water, encouraging re-allocation to more productive uses)
3. Establishing the basis for irrigation service charges	***Alternative forms of charge*** *Land area-based*: charge per mu of land irrigated or land in 'effective' irrigation area
	Crop area-based: charge per mu of crop irrigated: . - Same for all crops - Different charges for different crops
	Volumetric: charge per m^3, with or without a rising block tariff
4. Quantifying the charges	*Calculation of O&M costs*, depreciation charges(for replacement capital costs) and amortisation charges
	Ability to Pay: Assessment of farmers' repayment capacity
	Allocation of charges between different categories of user, different areas etc
5. Implementing the ISC system	Assessment of the ISCs due from each user
	Billing and payment: - Timing of payment: pre-payment per season or irrigation, payment after harvest etc - Collection/payment arrangements: who actually receives the money? . - Form of payment: cash or kind. - Sanctions for non-payment or late payment
	Achieving good *revenue performance*: - Collection percentages achieved - Percentages of O&M and other costs recovered - ISC administration and transaction costs
	Use of the revenues collected: - Spent on the irrigation scheme itself (O&M etc) - Spent elsewhere in irrigation or water sector. - Passed to Provincial or Central Government Treasury
	Monitoring & feedback

5.4 Step 4 Quantify the charges

Once the objectives and basis of the charges has been decided, the ISCs need to be quantified. This should involve three main tasks:

- estimate total costs
- assess farmer repayment capacity
- analyse pricing options

Estimate the annual costs

Annual costs of the scheme should be estimated using the Provincial costing guidelines but dividing the costs as clearly as possible into the following categories:

- Annual operation and maintenance (O&M) costs of the scheme itself and of any external facilities (mainly reservoirs) which serve the scheme; staff costs, materials, routine maintenance and major repairs, operation of vehicles and equipment etc. Any water resources fees (WRFs) that may be payable for the SW irrigation scheme's right to abstract/use water should also be included.
- Annual depreciation costs, to cover the periodic replacement of capital assets like pumps, vehicles and other equipment (i.e. the replacement capital costs).
- Amortisation costs: the annual costs, with or without interest charges, of the non-replacement capital assets (headworks, reservoirs, canals, roads etc).

If the present level of O&M expenditure and depreciation charges is considered to be too low to guarantee the scheme's efficient future operation, the costs to be used in the ISC calculation should be increased so that they based on the level of expenditure required rather than on the present, inadequate, level of expenditure. Even if, for affordability reasons, it is not possible to recover all of the costs directly from farmers, it is important to know what these costs are and hence the magnitude of funding required from other sources. An example is presented in Table 4.

Table 4: Costs per unit area

Cost elements	Annual cost (Y/mu)
O&M costs alone	20
O&M + depreciation	25
O&M + depreciation+amortisation	65

This is based on more detailed breakdowns of costs for a surface irrigation districts as presented in Table 5 and 6.

Table 5 highlights the large degree of variability in O&M costs per ha between different schemes and the resultant need to vary ISCs between schemes in order to reflect the large differences in the magnitude of costs to be recovered. If cost recovery is the basic objective, which it is agreed it is, then uniform ISCs (the same ISC levels for all schemes in a given administrative or other area) should be avoided – variable ISCs are required.

Table 5: Irrigation costs for Wuwei surface water irrigation schemes

Parameter	Unit	Xiying	Huanyang	Jinta	Zamu
Area irrigated	10^3 mu	502	280	147	463
Water source					
Surface	%	82	100	86	68
Groundwater	%	18		14	32
Water supply	10^6 m^3	326	159	162	361
Annual costs	10^6 Y				
O&M costs		56	8	18	15
Depreciation		20	3	6	5
Total		76	11	24	20
Unit costs					
Cost/volume	Y/m^3	0.23	0.07	0.15	0.06
Cost /area	Y/mu	151	41	166	43

Source: project studies

Table 6: Irrigation supply costs for Donghe irrigation scheme

	2004	2005	2006
Annual water supply quantity (million m^3)	70	70	70
Expenses (Y'000)			
Salaries and wages	1,160	1,560	1,610
Management	400	619	622
Maintenance	320	516	540
Amortisation fund	3,990	7,852	7,852
Loan interest	0	500	500
Other expenses	630	421	450
Total expenses	6,500	11,468	11,574
Cost/m^3 irrigation including amortisation & loan interest (Y)	**0.09**	**0.16**	**0.16**
Total without amortisation & loan interest	2,510	3,116	3,222
Cost/m^3 irrigation excluding amortisation & loan interest (Y)	**0.04**	**0.04**	**0.05**

Source: Donghe WMD (Jinchang, Gansu)

Assess farmers' repayment capacity

This is also referred to as ability to pay (ATP) for the irrigation service charges. The main components of the calculations and particular points of importance are described below.

The farmers' ATP or capacity to pay for the irrigation service provided is based on the net income, in cash and kind, received from his use of that service; i.e. from irrigation farming. As such, the income estimates should exclude his income from non-irrigation sources like rainfed farming, livestock grazing outside the scheme and wage earnings from off-farm work.

For ATP purposes, the farmer's net income comprises the net returns from irrigated cropping; i.e. the gross returns (crop yield multiplied by crop price) minus the costs of production.

These should be calculated on a per mu basis, by means of crop budgets. Particular points to note are:

- Crop yields and prices should be based on the average levels achieved in a 'normal' year rather than, say, just those achieved in the previous year to the assessment.
- The crop prices should be on a 'farm-gate' basis; that is, what the farmer receives after deducting any transport and other costs incurred in marketing his crops.
- With the small farm sizes typical of much of China most crop labour inputs are provided by the farmer and his family and little hired labour is used. Labour costs should therefore normally be excluded from the crop budgets, except for those operations where the majority of farmers, even those with only small holdings, hire labour. This may be the case with crop harvesting, especially cotton picking.
- ISCs should not be included in the crop production costs, because the objective of the analysis is to determine what income the farmer has available to pay the ISC; his income before deduction of the ISC.

An example of a crop budget is presented in Table 7.

Table 7: Crop budget data (excluding labour costs) (Y/mu)

Item	Yongchang Tubewell Area (2006)			Minqin County (2003)		
	Grain maize	Seed maize	Wheat	Wheat	Grain maize	Cotton
	GROSS RETURNS (Y/mu)					
(i) Main output:						
Yield (kg)	650	430	420	401	850	269
Price (Y/kg)	1.44	2.00	1.50			
Value (Y)	936	860	630			
(ii) Crop residues						
Value (Y)	50	50	20			
Total output value	**986**	**910**	**650**	**521**	**765**	**1,695**
	COST OF PRODUCTION (Y/mu, excluding labour costs)					
Seed	20	50	54	40	12	18
Farmyard manure	25	35	43	0	0	0
Fertiliser	90	165	110	95	134	75
Chemicals	9	9	10	5	5	9
Plastic sheeting	50	50	0	0	40	40
Machinery operations	85	85	80	47	33	25
Pumping electricity	100	100	100	38	45	20
Irrigation charges	6	6	6	27	27	27
Total costs	**385**	**500**	**403**	**252**	**296**	**214**
	NET RETURNS (Y/mu, excluding labour costs)					
	601	**410**	**247**	**269**	**469**	**1,481**

The basic ATP parameter should be the net returns per capita rather than per household or farm. It is therefore necessary to calculate the irrigated area per capita, by dividing the total 'actual' irrigated area of the scheme (the average total area of irrigated crops per year) by the total farming population.

At present, irrigation farmers may receive substantial agricultural subsidies from Government. The largest is the food grain subsidy. In Gansu Province in 2007 this was paid only on wheat, at a rate of Y23/mu, quite a significant sum. It is probably wise to exclude such subsidy income from the crop net return and farmer income estimates. First, Government policy might change, resulting in a reduction in subsidies in the future. Second, it is desirable to leave a 'safety margin' in the ATP assessment, to allow for the fact that in some years farmers' crop yields or prices, and thus their net returns, will be below average levels.

In calculating what farmers can reasonably afford to pay as ISCs, they should be allowed an adequate 'living allowance'; i.e. a minimum income per head from irrigated farming, below which the average farmer should not be liable for ISCs. This might be based on the provincial 'poverty line' income (for example, Y1,100 per year in Gansu in 2007). Alternatively, it may be based on the average farmer's living expenditure per year. According to official statistics on rural expenditure levels, in Gansu Province this was and Y1,820 in 2005.

To allow the farmer adequate incentive and provide him with a margin of safety to cope with bad years, only part of the surplus of income above the living allowance can reasonably be taken as ISCs. In some countries this 'taxable surplus' is taken to be 30-40% of the total surplus. Other possible criteria are that the ISCs should not exceed a certain percentage of either the total crop costs of production or the net crop returns.

There are, however, no generally accepted standards on what these percentages should be. International practice is reviewed in Section 3 and this indicates that ISCs are generally in the range of 7%-10% of production costs and 10%-20% of net returns.

The analysis in this step is a technical one, based on actual costs and production, and should be calculated rigorously by the WAB.

Examples of the calculation of the ability to pay alternative levels of scheme cost are presented in Table 8, using Donghe ID in Gansu as an example.

Table 8: Indicative estimates of ability-to-pay different levels of scheme cost

Taxable surplus		O&M costs Y20/mu	O&M+Deprec Y25/mu.	O+Dep.+Amort Y65/mu
% of total surplus	Y/mu	% of costs that can be recovered		
20	32	100%	100%	50%
30	48	"	"	75%
40	64	"	"	99%
50	80	"	"	100%

Analyse pricing options

Having estimated the costs to be recovered and the farmers' ATP, alternative levels of ISC can then be analysed and compared in order to indicate (i) what costs would be recovered (O&M, O&M plus depreciation, or O&M plus depreciation and amortisation) fully (100% recovery) or in part and (ii) the average farmer net income from irrigated cropping after deduction of the ISCs.

On the basis of this analysis, recommendations can then be made as to the most appropriate levels of ISC to be adopted. This stage involves technical as well as political and other considerations. It will require the involvement of the Price Bureau and the local Government as well as the WAB.

In China, such ISC assessments would be concerned with existing ISC systems and would focus on whether the charges are sufficient to meet the objectives and would result in recommendations for potential increases to meet a larger proportion of total costs and in order to keep up with inflation.

Collection percentages

In some cases, especially where pre-payment systems are in place, the collection percentage may be very high, perhaps even 100%. But elsewhere it is prudent to assume lower collection percentages.

5.5 Step 5: Implementation

The legal, administrative and technical pre-conditions for an effective irrigation charging system are summarised in Table 4.

Once these are in place, implementation of an effective ISC system requires consideration of four main aspects:-

- Accurate assessment of the ISCs due from each user each year, as described earlier.
- Billing and payment systems, including:
- Good revenue performance, including:
- Use of ISC revenues collected:

With regard to billing and payment systems, key issues include:

- Timing of payment: options include pre-payment per irrigation or per season, payment after harvest etc. Pre-payment is better for the irrigation agency, because it usually improves the collection percentage, but often worse for the farmer, because he may not have the money to pay the ISC until he has harvested and sold his crop.
- Collection/payment arrangements: who actually collects and receives the ISC money?
- The form of payment: cash or kind (crop output). Payment in cash should be the normal objective. With payment in kind the irrigation agency has to store and sell the crop itself, rather than the farmer doing this. This involves unnecessary

time and expense on the part of the agency.

- Penalties for non-payment or late payment of the ISCs due. These should be appropriate to the problem – effective without being punitive. These can include, for example, the charging of interest on late payments and, in the case of serious non-payment, cutting off irrigation supplies..

The requirements for good revenue performance include:

- the collection percentage should normally be more than 90%achieved;
- 100% recovery of O&M costs and most replacement capital costs through the ISCs, unless clear arrangements are in place for part of these costs to be funded by the Provincial Government or other entities. The main causes of under-recovery of costs are: under-estimation of the costs to be recovered in the ISCs (e.g. the omission of depreciation costs in ISCs in many developing countries): under-assessment of the ISCs due from each water user (e.g. due to problems with measuring volumetric flows or reporting crop areas correctly); and unsatisfactory collection percentages.
- Transaction costs for ISC system administration can take a substantial proportion of the ISC revenues collected if there are a large number of water users to be charged or the ISC system is not managed efficiently. In some countries these may be as much as 20%-30% of the revenues collected.
- Reduction in irrigation agency's operation costs and hence the ISC required through irrigation management transfer. The lower levels of a surface water irrigation system are transferred to WUAs. The agency then has to deal with just a limited number of WUAs or other entities instead of thousands of individual farmers. The WUA then recovers costs from each individual

The key factor for the use of the ISC revenues collected is whether the revenues collected are retained for expenditure on the scheme itself, or at least on irrigation schemes in the local area, or whether they are passed to the Provincial or Central Government Treasury. From the viewpoint of providing adequate funds for scheme O&M and adequate incentives for the scheme staff to achieve high collection and cost recovery percentages, the former alternative is much better.

Table 4: Pre-conditions for effective irrigation charging

Aspect	Detail
Legal	– Users have legally defined, enforceable, enforced water entitlements and system of allocation. – A clear and viable judicial and police system to ensure enforcement of agreements. – Corrupt practice is the exception and is acted against rather than being the tacitly accepted norm,
Administration	– A clearly understood and agreed-upon charging and fee collection system, to include: 1. How fees are computed. 2. Mechanism for fee payment (to whom, and how) 3. How the fees are requested. 4. When fees are to be paid. 5. Penalties for non-payment of fees, or late payment of fees. 6. Whether the user(s) can refuse payment for water that was delivered, but not requested. – A specified mechanism to resolve disputes over deliveries or bills. – Sufficient human, technical and financial resources are provided to implement assessment, billing and fee collection.
Specific to volumetric charging	
Infrastructure	– Infrastructure enables control and measurement of volumes delivered to users or a user group and means exist for users to verify volumes. – Infrastructure and management system enables delivery of differential volumes to neighbouring users, and allows users to control how much they receive.
Administration	– A written agreement between the water supplier and the user(s) of the nature of water delivery service, to include: 1. Advance time required to order, change, or stop flow. 2. Other details related to the flexibility of frequency, rate, and duration of water delivery service. 3. Accuracy of the flow rate measurement device. 4. Allowable percent variation in the actual flow rate from the agreed-upon flow rate at any time. 5. Who can make the flow rate changes (the supplier or user) at the control structure. 6. How frequently the flow rate can be changed. 7. How frequently the flow rate must be verified, and how. 8. Responsibility for maintenance of the measurement and control structures. 9. Penalties to the water supplier if structures are not maintained or operated as specified, or if the quality of water delivery service is poorer than agreed upon. 10. A procedure for when, and how, any volumetric limitations are determined

6 Conclusions

Effective irrigation charging systems are needed to ensure that irrigation is managed on a sustainable manner. This advisory note describes the steps that need to be followed in to ensure that an existing system is sound is and that any new system is designed well. The system should be based on an appropriate legal institutional environment, ensuring that key pre-conditions are in place.

Although setting ISCs is partly a technical and partly a political decision, they to be designed in a rigorous on the basis of sound data, covering costs and affordability to ensue cost recovery. In some cases other sources of funding may be needed, if affordability is low, but in any case all funding sources and implicit or explicit subsidies should be quantified.

The procedure for calculating charges is relatively well defined in local practice in China, but there is less formal analysis of affordability. It is recommended that this should be done on the basis of farm and crop budgets, which will enable the fees to be expressed as a proportion of production costs or income.

ISC management systems are more problematic – there are large numbers of individual users, which makes administrative arrangements complex, expensive and difficult to enforce. The system does need to be simplified and streamlined to ensure that transaction costs are kept to a minimum and that there is sufficient revenue for management.

Prepayment of charges is an efficient system from the point of view of the WMD, but it is very onerous on the users who have to pay the cost long in advance of receiving any benefit from it. If this system is applied, as it is in some parts of China, adequate measures for social protection need to be put in place for the poorest farmers who may not be able to pay up front.

Decentralisation of management, through irrigation management transfer (IMT) to WUAs can help considerably. In this situation, the WMD only needs to deliver water to the WUA and charge for the bulk delivery to the WUA: it is then the responsibility of the WUA to manage water to individuals and collect fees from them. This is potentially a very efficient system, but it is not easy to introduce. It has been applied on some WUAs in China, but in most places, the WMD is responsible for collection of fees from individual users.

The revenue should be used in the irrigation sector, rather than transferred to general budgets, and should ensure that irrigation is adequately financed

It is unrealistic to expect irrigation charges to influence demand directly – the low prices elasticity of demand, the type of infrastructure and management systems make it difficult or impossible to affect water use directly. The impact on demand should be achieved indirectly by ensuring that O&M is fully-financed and well-managed, so that water is delivered efficiently to the right place at the right time through well-maintained canals and structures.

Document Reference Sheet

Glossary:

ATP	Ability to pay
IMT	Irrigation management transfer
ISC	Irrigation service charge
O&M	Operation and Maintenance
WMD	Water Management Division
WUA	Water User Association

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Related materials from the MWR IWRM Document Series:

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Thematic Paper 5.3	Water Resource Fees

Where to find more information on IWRM – recommended websites:

Ministry of Water Resources: www.mwr.gov.cn

Global Water Partnership: www.gwpforum.org

WRDMAP Project Website: www.wrdmap.com

China – UK, WRDMAP

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