Proceedings of the Workshop on the Use of Economic Principles for the Integrated Management of Freshwater Resources

Compiled by David Smith, Meeting Organiser

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The Use of Economic Principles for the Integrated Management of Freshwater Resources

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These proceedings are published to communicate the results of the workshop informally with the least possible delay. The typescript of this paper has therefore not been prepared in accordance with the procedures appropriate to formal printed texts and papers are essentially as provided by the authors. (Some typesetting changes have been made). The views expressed are those of the author(s) and are not necessarily those of the United Nations Environment Programme.

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Introduction

David Smith, Freshwater Unit, UNEP.

This workshop was organised by the Freshwater Unit, with assistance from the Environment & Economics Unit. The purpose of the workshop was to provide a practical introduction to how economic principles and tools could be used to improve the environmental sustainability of water use. The workshop was aimed at water and environmental managers and policymakers, with the objective being that participants would return to their countries and promote the use of economic principles and tools. That is, the workshop was not designed to teach participants the details of how to design and apply economic tools but rather to indicate their benefits.

The perspective behind the workshop was that it was not necessary (or even desirable) to apply sophisticated economic instruments to achieve marked improvements in the sustainability of water use and economic welfare. Rather, that applying some basic economic principles would significantly improve the efficiency of water use and thereby provide more people with clean water on an environmentally sustainable basis. Thus, for example, the workshop discussed the financial and environmental opportunity costs of inefficient water use - if water is inefficiently provided and used, less money will be available for other uses, such as road construction. Additionally, fewer people will have access to clean water, which will increase health costs.

Following on from this workshop, it is intended to conduct a number of regional case study based training courses in 1996 and 1997. These courses will be less introductory in nature and participants will use more practical working examples based on the freshwater management issues they deal with in their work. (A number of case studies were presented at this workshop, copies of these and overhead projector transparencies used as part of presentations are available on request.)

I would like to thank the Freshwater Unit administrative staff, in particular Mrs Rebeccah Muluhya, for their help in organising the workshop.

SUMMARY OF DISCUSSION AT THE WORKSHOP ON THE USE OF ECONOMIC PRINCIPLES FOR THE INTEGRATED MANAGEMENT OF FRESHWATER RESOURCES

Thomas Panella, University of California-Berkeley

Water is a unique good. It is necessary to human survival, but only one half of one percent of the Earth's total water can be considered readily available for human use. Ninety seven percent is salt water and of the three percent that is freshwater, two and one half percent is held in polar ice caps or stored too deep underground for economical extraction.

As water is vitally important to human survival and because many people do not have access to adequate supplies of clean water, it is critically important that it is used as efficiently as possible. Therefore it is very important that the value of water is signalled to consumers to discourage waste and decrease environmental degradation resulting from the waste and pollution of water.

Water as an Economic Good

An effective way to ensure that water receives its appropriate valuation is to treat water as an economic good. Like other goods, this involves attaching a price or tariff to the use of water. This most basic application of economics sends a signal that water has a value and that its use incurs a cost. Both direct costs and opportunity costs arise from the supply and use of water. If a dam is constructed for hydro-electricity generation and to supply irrigation water, then less water will be available for other uses - such as supporting a fishing industry or maintaining the river ecosystem. That is, the use of water in one application decreases or denies the use of water in other applications.

The costs associated with foregone alternative uses of water may be very difficult to quantify, but they should be identified when water use decisions are made. The cost of physically supplying water and operating a water distribution system can be identified, however, and tariffs for water should cover these costs to reflect the value of providing water. It is most important that it is understand that water is not a free good.

In addition to being a necessary element for human survival, surface water also provides waste disposal services from industries, cities and villages. While waste is pumped into the freshwater system, which imposes a cost on society, those who dump the waste often pay nothing. The costs imposed by polluted water include damaging health effects, the loss of aquatic life and fisheries, plus lower quality water which may be unsuitable for agriculture or human consumption.

It is often possible to produce goods or dispose of society's wastes in ways that are less damaging to the environment, thus avoiding many of the negative costs associated with pollution. Attaching a price to these environmentally degrading activities and making those who pollute responsible for these costs provides an incentive for polluters to decrease such activities and helps relieve society from bearing the burden of pollution.

Issues raised included the ability to apply economic instruments in less developed nations and there impact on poorer people. It is possible to design economic instruments that ensure the poor can afford enough water to meet their basic needs. That is, their basic water needs can be protected even though water is treated as an economic good.

Water may also be viewed by some as an essential element that is a social right that should not be treated as an economic commodity. However, it is the very importance of water that requires it to be highly valued. When water is treated as a right with no cost, this too often leads to wasteful water consumption or the pollution of freshwater systems. Attaching a cost to the use of water sends the correct signal - that water is indeed very valuable.

It must also be recognised that many policies, such as subsidies to supply irrigation water at less than cost, encourage excessive water use and the degradation of freshwater and land quality. It is also important to ensure that government policies not directly related to freshwater do not inadvertently provide the incentives that lead to excess consumption or the pollution of water. For example, agricultural subsidies can encourage excessive fertiliser consumption, which pollutes waterways.

The application of economic principles and instruments provides a more flexible approach to addressing a multitude of problems including ground water management. (In some countries ground water may account for 80% of water supplies.)

Economic principles and instruments are not intended to be the final answer for freshwater management. They are tools which can be very helpful for countries with limited resources to ensure that freshwater flows to its most valuable uses and is not wasted through excess consumption or pollution. Economic instruments can be combined with other regulatory measures so that freshwater resources sustain development without jeopardising the environment or the quality of life for current and future generations.

Benefit-Cost Analysis

Benefit-cost analysis has been used extensively world-wide to evaluate the economic feasibility of many projects. The specific criteria used to determine whether a project passes a benefit-cost test vary. One criterion is whether the benefits from a project make society better off in overall terms without making any portion of society worse off. This criterion is usually viewed as too restrictive. Most benefit-cost analysis relies on the criterion that, if the aggregate gains to those benefiting from a project are larger than the aggregate costs to those who lose from the project, then the project is worthwhile in benefit-cost terms. This criterion may also assume an equitable redistribution of the project benefits.

Concerns were raised by participants about the fact that it may be difficult to assign a monetary value to environmental and social costs and benefits. Even though valuation may be difficult, benefit-cost analysis is extremely useful since it systematically identifies all of the costs and benefits associated with a project. This allows policy makers to examine and weigh the trade-offs within a project, even if an exact monetary value cannot be assigned to the costs and benefits.

However, it is most important that the benefit-cost analysis identifies all the project impacts. A number of BCAs have not included all project impacts - for example, ignoring the traditional values of indigenous people affected by projects. Public participation in the analysis by those persons affected by the proposed project or policy improves the identification of project impacts.

The perspective and scope of the analysis was recognized as extremely important by workshop participants, as the results of a BCA can vary according to whose perspective it is conducted. Economics generally attempts to take the perspective of society as a whole. However, the results of this perspective may be different than if the analysis is conducted from the perspective of the water or environment ministry or if the BCA is conducted from a regional perspective which does not include indirect effects occurring at a national level.

Questions about the appropriate discount rate, which is used to express future costs and benefits in present value terms, were raised. In many cases, the interest rate that could be earned by the agency sponsoring the project is the appropriate discount rate used.

In relative terms, a high discount rate favours projects with benefits occurring soon after its completion while a low discount rate favours projects with benefits occurring further in the future. An agency may wish to assign a lower discount rate to projects that provide critical social benefits for current and future generations.

While BCA provides a solid framework to evaluate the economic merits of projects and programs, it is not the only criterion available for assessing projects. Equity, uncertainty and other factors may make the results of a BCA part of the decision making process rather than the sole decision making criterion. Even if a project decision cannot be based solely on a BCA, BCA is extremely useful for identifying the project impacts and making trade-offs transparent.

Water Pricing

Pricing is a basic economic principle. However, when setting water prices there are a large number of different factors that should be considered - including equity and environmental values - which make the application of this principle less than straightforward.

There are numerous methods to structure a water tariff, and different tariffs encourage different types of water use behaviour. In a number of countries increasing block rate tariff structures are being introduced. Such tariff structures mean that as consumption increases, the consumer pays more per unit for additional consumption. The encourages the water user to conserve and reflects the general condition that it is more expensive per unit of water to develop and increase the water supply than to provide the existing supply.

A major concern for less developed nations is to avoid placing an additional cost burden on the poor, especially for a basic necessity of life such as water. However, it was noted that in many cases the poor already pay a substantial amount for water supplied by vendors - up to twenty percent of their income in some cases. Using a tariff which helps pay for creating a reliable water supply may actually provide water more cheaply than current water distribution systems (eg water vendors or kiosks). It is also possible to design tariffs that recover water supply costs but protect the poor's access to an inexpensive water supply. Increasing block rate structures can do this by charging very little for the small amount of water needed to cover basic human needs. The tariff then increases per unit of water sold as consumption exceeds the basic consumption level and water is used for less vital purposes such as landscape irrigation in urban areas.

Even if a tariff is not charged for water, society and government must still pay to supply water. This usually occurs through general taxes which are used to subsidise the water supply system. If this is the case, water is perceived as free which leads to excessive use and waste. With or without a tariff, supply water costs money, therefore countries with limited resources will benefit from tariffs that eliminate wasteful water consumption.

A problem noted by workshop participants was that in may areas there is a large loss within the water supply system - as much as forty percent. This loss must be accounted for when the tariff is designed. This also means that reducing systems losses, which does not produce revenue, should be a high priority for water agencies. Water agencies may also wish to invest in water conserving technologies if the cost of the water savings from the technology is less than developing a new water supply.

Seasonal tariffs which place a surcharge on water consumption during high demand and low supply situations are used in a number of countries. This seasonal surcharge is used to help reduce the demand for water and to pay for building capacity into the supply system to meet high seasonal demand. A concern was expressed that the lower tariff charged during the lower demand and high supply season may encourage excessive yearly water use that is not adequately curtailed by the seasonal tariff. For this reason, some countries may not wish to use a seasonal tariff structure.

It is also possible to attach a surcharge to water to help pay for environmental or social costs caused by a water supply project. In Brazil, a surcharge is placed on water taken from a dam project and this money goes back to the municipality that lost land under the lake created by the dam. Water tariffs offer many options to help water agencies pay for the cost of water supply as well as to ensure that water is not wasted. It is also possible to design water tariffs that can vary with different qualities of water supplied since not all water uses require the same level of quality.

Water tariffs have been employed successfully in the agricultural sector which uses approximately eighty percent of the world's freshwater consumption. Again, there is significant concern that the rural and agricultural sectors, which are often poor and produce most of the food in less developed countries, are not adversely impacted by high water costs. Since agriculture uses so much of the freshwater supply it is very important that waste be eliminated in this sector. Attaching a tariff to water helps send the message that use of water involves a cost.

Rural agricultural water users associations have been successful in improving the efficiency of water allocation . The associations have been given more control over water supply management. This, coupled with water pricing, has helped increase productivity and has worked to the satisfaction of farmers, even though they are now paying a higher price.

Water tariffs should be the starting point for the use of economics to assist with freshwater management. In general, tariffs should be designed to recover the full cost of supplying water and to provide for the expansion of the water supply to meet growing demand. If this is not possible, tariffs should at least recover the operation and maintenance costs of the system.

Additional Economic Instruments

Economic instruments can be used to increase the efficiency of water allocation as well as to mitigate pollution and improve water quality. The use of economic instruments as policy tools requires the policy maker to:

1) clearly define the freshwater management problem to be addressed;

2) identify the possible intervention points in the system where the freshwater management problem is located;

3) select the intervention point that will be the most effective to address the problem;

4) make a choice concerning the economic instrument to be used and then structure the details of the policy.

An effluent charge is a common economic instrument used for pollution control. This involves applying a charge based on the amount of polluting effluent discharged. It is most important that the charge is large enough to cause a change in polluters behaviour. Setting the appropriate level, however, is a difficult task and requires careful economic analysis. It is also important that, if possible, the effluent charge be based directly on the substance causing the pollution to improve its effectiveness.

Effluent charges have a number of benefits - in addition to sending a signal to reduce polluting effluent discharge, they raise revenue for the agency collecting the charge. What the agency does with the revenue from the effluent charge is also very important. To help ensure political acceptance as well as ease the burden on those affected by the charge, the revenue can be targeted to help subsidise the costs of pollution abatement equipment for business who must pay the charge. Or the revenue could be used for other environmental improvement purposes - such as creating a park or cleaning up a polluted river. For social acceptance, it is important that the charge be perceived as equitable and that all polluters be treated uniformly unless socially acceptable reasons exist for discrimination in application of the policy.

It was remarked that businesses forced to pay this charge will simply pass the additional cost on to the consumer. Whether or not this is the case depends on how much power the individual firm has over setting the price in the market. In many cases, individual firms do not have adequate power to set the market prices so they will have to pay for the pollution they create. In cases where it is difficult to monitor the pollution discharge or attribute it to an individual source, it may be more convenient to place a tax on the polluting substance before it is used in the production process (input tax) or to place a tax on the final product which was made with the polluting process (output tax). While less precise, these types of policies may be easier to administer. All effluent charge policies can be subjected to a benefit-cost analysis to ensure that the improved environmental conditions and associated benefits are greater than the cost that the effluent charges impose on society.

Another economic instrument for pollution control is the use of tradable effluent discharge permits. These permits give their holders the right to discharge a specific amount of polluting effluent. The total aggregate amount of pollution allowed with these permits is limited to ensure the achievement of the desired level of environmental quality in the freshwater system into which the effluent is discharged. For this system to be effective, the demand for the permits must be greater than supply and there must be a number of firms, including some who can reduce pollution at less cost than what other firms will pay for the effluent discharge permits.

There is a concern that firms that were able to purchase the discharge permits would simply do this and have no incentive to reduce their pollution discharge. This is acceptable, however, since the aggregate amount of effluent that can be discharged is limited to ensure the environmental quality of the freshwater resource. While water quality is maintained, the social cost to reduce pollution is reduced.

This economic instrument suffers from the problem of how to initially distribute the effluent discharge permits. Various methods exist such as auctions or awarding the permits based on past effluent discharge history. In less developed nations, especially in those places were corruption and nepotism is a problem, an efficient and equitable initial distribution of the effluent discharge permits may be problematic.

For both effluent charges and tradable emission permits, accurate scientific assessment of the acceptable levels of pollution as well as extensive monitoring is essential. For many less developed nations, this expertise along with the required economic expertise to structure the policies may require capacity building.

An additional economic instrument is the use of transferable water rights. Transferable water rights are an economic instrument that give private individuals or organizations the right to use or transfer (sell or lease) a specified amount of water. For transferable water rights to succeed, the rights must be clearly defined, the demand for water must greater than the supply, and it must be politically and socially acceptable that rights to water can be held privately. With transferable water rights, those persons who have extremely high value uses for water will be able to purchase or lease water rights from those who will receive more value from selling or leasing their rights than they would from using the water. This helps to ensure that water will move from lower to higher value uses.

Although water rights can be allocated on a permanent basis, it is possible to place conditions upon the transfer of rights to ensure equity and protect high priority uses. It is possible that the water transfer could significantly affect some third parties and communities who do not directly own the rights.. When the water rights are structured and granted, in-stream uses for environmental or other purposes can also be held in reserve. The water supply for cities can be protected and only water beyond essential supplies be granted through transferable water rights. These decisions will need to be made when policy is developed.

It is also possible to use transferable water rights for ground water, yet it is necessary that the sustainable yield of the aquifer be known and not exceeded. Seasonal and statistical variations in the reliable supply of freshwater need to be taken into consideration when the condition of the transferable water rights are developed. As with tradable emission permits, there is also the problem of how to initially allocate water rights. Again, for countries that have the problems of corruption and nepotism, this could present problems.

Institutions

The term institutions has a very broad definition which encompasses not only existing agencies or ministries but includes accepted norms of behaviour which may or may not be codified. Institutions are responsible for implementing programs and policies to ensure the environmental management of freshwater. The failure of institutions, however, is the most common reason why policies fail to achieve their intended objectives - not unsound technical or analytical work. This institutional failure is also relevant to the application of economic principles and instruments.

There is no one optimal institutional framework that should be adopted for the environmental management of freshwater by every country. Hydrologic, economic, and institutional conditions vary, and the appropriate framework to implement policies and programs needs to be tailored to meet the circumstances of each individual country. One rule that may be helpful under all conditions is the subsidiary principle - that is assigning program or policy decisions to the lowest level of government consistent with the issue addressed.

Although institutional frameworks may vary, there are four problems that are common to the management of freshwater resources:

1) lack of coordination between surface and ground water management;

2) poor coordination of water quantity and quality management;

3) how to encourage greater economic and physical efficiency in water use;

4) how to protect in-stream and other public values related to freshwater systems.

These problems are exacerbated by the fact that within a single river basin there are often multiple jurisdictions and government agencies that do not co-ordinate planning and management activities. The entire river basin should be the natural planning unit for freshwater management, yet this is rarely the case.

Although economic instruments offer effective means to address problems related to the environmental management of freshwater resources, their usage faces numerous obstacles. These barriers include:

1) philosophical and political barriers;

2) equity concerns and inadequate economic development;

3) lack of understanding about the functioning and impacts of economic instruments;

4) theoretical problems structuring economic instruments;

5) non-existent markets;

6) institutional barriers; and

7) a lack of capacity.

These factors have limited the use of economic instruments in developed as well as developed countries.

The UNEP workshop has introduced the conceptual basis for the use of economic principles and instruments. Having the courage and resolve to overcome the above barriers and institutional failure is what will lead to the successful implementation of economic instruments for the environmental management of freshwater resources.

WATER AS AN ECONOMIC GOOD - CONCEPTS AND THE ROLE OF PRICING

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Content

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1. Introduction

Two things make water a unique natural resource. One is that water is essential for human survival. The other is that, unlike other natural resources, the total amount of water in the world is constant and can neither be increased (like timber or fish) nor diminished (like petroleum or coal) (2).

Clean fresh water is essential for health, agriculture and industry. People cluster along ocean, lake, and river shores because water courses provide natural transportation routes and disposal grounds, because aquatic ecosystems are sources of fish and other wild protein. Its control and distribution have been functions of government since antiquity (2).

The main problem is, that water is not equally distributed among the peoples of the world. The total volume of water on earth is about 1400 million cubic kilometers -some 1019 tons. But more than 97 per cent of this amount is seawater. Of the rest, 22 per cent is groundwater and 77 per cent is ice locked away in the glaciers and polar ice caps - leaving less than one per cent of the supply of freshwater to take part in the hydrological cycle. About half of that one per cent is found in rivers, lakes and swamps (10).

Although global renewable water resources average 7,240 cubic meters per capita per year, many countries have far more limited resources. In Egypt, for example, potential per capital internal renewable water resources totals only 50 cubic meters. Egyptians depend mainly on Nile River water flowing from other countries to insure sufficient water for their survival. In contrast, Canada's supply of over 100,000 cubic meters of water per person per year ensures not only sufficient water for survival, but for ecosystem health, wildlife needs, recreational uses, and abundant hydroelectric power as well. Only a small fraction of the Nile's flow ever reaches the sea. When water does return to river flows, it has usually been altered either chemically or thermally (10).

Nevertheless, there are quite a lot of environmental problems related to the use and consumption of water. One is the overuse of ground- and freshwater for agricultural purposes. Since globally 69% of the freshwater is used for agriculture these huge quantities consumed manly for irrigation purposes lead to many environmental problems (10). First, if irrigation is not done properly, it may result in salination. This reduces in the end the ability of arable land to produce crops or serve for cattle feeding. Consumption of water also may result in a lowering of the water table, leaving too little water left for the plants growing in these areas that is finally leading to desertification. Very often water for agricultural purposes is transported over long distances in open channels where only a small percentage actually reaches the fields and most of the water had evaporated on its way.

Another threat to freshwater is its pollution with chemicals and faeces that result in increasing health problems and decreasing aquatic life. There is a wide variety of sources of pollution, ranging from private household waste, runoff and leaching of agricultural chemicals into rivers and groundwater, waste disposal of various industries and others. In many countries, developed as well as developing countries, drinking water has to be treated before consumption to reduce the environmental impacts. Water treatment is very expensive and could be avoided or at least reduced by avoiding its pollution.

Since freshwater is a scare natural resource and there are costs for distribution and cleaning the water it has to be considered as an economic good. So, there are environmental and economic benefits from using water as efficiently and effectively as possible. Environmental economics has an important role in realizing those benefits.

This paper is designed to elaborate on some ideas of water as an economic good and how environmental economics can be used for environmentally sound freshwater management. After a brief overview on property rights and water pricing the paper will also present two programmes for freshwater management that have been launched in Germany and the lessons for developing countries that can be learned from these activities.

2. The role of environmental economics

The reasons for above-mentioned problems are a combination of institutional (absence of secure property rights), market (environmental externalities) and policy failures (distorting subsidies) that result in the underpricing of the use of freshwater resources. As a result water consumers do not receive correct signals about the true scarcity of the water resources they consume or the environmental damages they cause. This gap between the private cost of a product (cost they have to pay for per unit of water) and the total cost to the environment (including health and damage cost) causes incorrect signals. Since the social cost environmental damages are not internalized, this results in overproduction (unsustainable use of groundwater) and over-consumption of freshwater which are resource depleting and environment polluting (1,4,5).

Economic instruments aim to bridge the gap between the private and social costs by internalizing all external costs to their sources, namely the producers and consumers of resource depleting and polluting commodities. According to a definition from OECD (3), economic instruments are "instruments that affect costs and benefits of alternative actions open to economic agents, with the effect of influencing behavior in a way that is favorable to the environment".

2.1 Water as a public good

Public finance theory and welfare economics proved the analytical framework for examining the public and private good characteristics of water resource activities as well as other attributes determining the efficiency of market forces. The provision and some of the production of pure public goods are essentially the responsibility of the government while pure private goods can be handled efficiently by markets. Most water activities, however, are not strictly public or private goods. Frequently they require some form of government regulation or involvement if the resources are to be used reasonably efficiently. The following paragraphs provide information to support judgement about the relative roles that the public and private sector should play in specific activities (7).

Public Goods

The basic criteria for assessing the degree to which a good or a service is closer to being public than private pertain to subtractability and excludability. Subtractability occurs with most traditional goods, such as ice cream, where one person's use or consumption of the good or service decreased or subtracts from its value to others who use the same good or service (if one person eats the ice cream, another person cannot have it). For public goods, there is no conventional consumption during use (zero subtractability), and the goods can continue to provide the same benefits to everyone, as long as they are not damaged or congested (for example, navigation as long as there is no congestion). When used can be increased without any cost to society or subtraction from benefits to other consumers (the marginal cost of serving another use is zero), increased use adds to total economic welfare. Low subtractability characterizes facilities such as were and water lines and navigation channels as long as they are being used below full capacity.

A second characteristic of public goods is the inability to exclude, or the high cost of preventing a consumer, who does not meet the conditions set by the supplier from using the resource. Many water-related activities are characterized by the difficulty of excluding people from their use (for example, large irrigation schemes on gravity flow, where the monitoring of individual use is costly; village wells; and flood control). If a dam is built to provide flood control on a stream, no one along the stream can be excluded from receiving the benefits of flood control. This is quite different from a park, around which a fence can be erected and from which persons who do not pay the entrance fee can be excluded (7).

These two characteristics (subtractability or excludability) can be used to set up a broad two-way classification of goods and services: (a) public goods (low subtractability and excludability) include goods such as flood control and large multipurpose dams, (b) private goods (high subtractability and excludability) include goods such as ice cream and bread, (c) tool goods (low subtractability and high excludability) involve goods such as conventional sewerage systems and navigational facilities, and (d) open access goods (high subtractability and low excludability) include resources such as aquifers with low recharge rates and many ocean fisheries. Private firms do not engage in activities with low excludability, because it is difficult to get consumers to pay. Thus governments may have to provide funding to establish such activities. Where low excludability causes the resource to be overused, such as occurs with groundwater, government regulations may be necessary. Where low subtractability exists, market forces do not produce an optimal level of output, and government investments or subsidies may be required. If both characteristics (public goods) are present, then government investment is needed, but management may be contracted to the private sector or user groups (7).

Market Power

Market forces can generate an efficient (economic) allocation of resources when the market is competitive. However, economic activities in which there are economies of scale (a large fixed cost relative to variable costs) or economies of scope (lower unit costs of producing several products in combination rather than separately, such as multipurpose water projects) tend to become "natural" monopolies. Beside those natural monopolies there are also "real" monopolies that are common in water provision, where there is no threat of competition by law. In such a monopolistic situation, the market is dominated by a single supplier. When the market is characterized by a monopoly, resource allocation is deficient, since monopolistic entities tend to produce less and charge more for any good or service than would be the case under competitive conditions. Furthermore, because the threat of entry by would-be competitors is minor, incentives for innovation and dynamic efficiency are diminished. Market forces thus do not bring about a desired resource allocation when a natural monopoly exists. Examples of natural monopolies are large dams, main canal networks, and large urban sewerage and water systems.

The extent of inefficiency in such a situation is determined by the perceived risk of potential entry of competitors, since this perception influences the behavior of the monopolistic entity. If large fixed costs need to be invested that cannot be recovered in the case of unsuccessful entry, the degree of contestability is limited, and the potential for inefficiency is high. Many of the facilities for water-related activities require large fixed costs and are thus prone to the problems of natural monopolies. However, operating and maintaining these facilities, once they are built, may not require a high setup cost fixed cost). For example, systems that supply piped water entail expensive infrastructure, but their operation and maintenance do not and, therefore, could be handled by small private firms. These aspects are thus characterized by a high degree of contestability (7).

Externalities

Because water activities have many physical interactions within the ecosystem and with other economic activities, they are often characterized by externalities. That is, the benefits and costs of production and consumption affect individuals or entities other than those involved in a transaction. Negative externalities imply overproduction of the activity involved, while positive externalities include the contamination of surface and groundwater by sewage and chemicals and saline water from irrigation, degradation of wetlands due to the diversion of water resources, and the lowering of the water table (thus increasing the cost of pumping) by drawing on a common aquifer. An example of a positive externality is the health benefit to the general population of connecting individuals to a sewer system.

Related to the issue of externalities is the limited amount of information available to the consumers (and sometimes producers) of water services. The complexities of the ecosystem within which water is a component, the variability of the water supply, and the intricacies of the hydrological cycle make it difficult for those transacting with water to consider all aspects. Consequently, market prices do not necessarily reflect all these interrelations (7).

Property rights

Property rights are rights that are assigned to an individual or a company either by giving them the ownership of a previously public good or by giving them the right to use this good over a given period of time. The government or the local authorities can either sell a lake to an individual or the right to use the lake for fishing or recreation purposes can be transferred. In both cases the owner of the property or the owner of the usage right will ensure the sustainable use of this lake to make sure that there is a continuous flow of income over the years. In order to secure that the owner of a natural asset is using it in a sustainable manner the property rights have to be transferrable. To exclude other parties from the use of the property the property rights also need to be enforceable (7).

Transaction Costs

The difficulty of establishing enduring and secure water rights has been an important factor in raising the cost that users pay for water transactions, particularly in the agricultural sector. In addition, the bulky nature of water generally requires expensive conveyance infrastructure to move significant quantities upstream or outside river basins, thus preventing the development of national water markets, except for bottled water. In many water systems based on gravity flow (as are many irrigation systems), water rights are defined by a share of flow in the canal or river. In such cases, transactions between individuals who are not adjacent to one another require changes in the physical apparatus controlling the intervening use of water or changes in the scheduling of flows. These changes have to be agreed to by all individuals affected, even those who are not parties in the transactions. If the transacting parties are located at different outlets of a canal, the cost of introducing the adjustments to all users affected can be high. Transactions between groups may require fewer physical adjustments or simpler scheduling revisions, but they typically entail the complexities of organizing for collective action. Thus there can be a high transaction cost to trading water among users, which tends to create fragmented markets (7).

Policy Implications

The range of potential market failures in the water management activities viewed here justified government actions or other forms of collective actions to ameliorate the inefficiencies likely to result without government action. In determining the role of government, it is useful to distinguish between the provision and the production of infrastructure. The provision of infrastructure involves the set of decisions and actions that enable infrastructure facilities and services to be made available. Examples are a legal framework that allows water user organization tax landowners and invest in irrigation systems or a direct government investment in the construction of a water supply system. Production is the act of executing investment and generating services, such as a private contractor building a dam or managing a government-owned sewer plant. Provision and production need not necessarily be done by same organization.

Analysis of specific water activities leads to the conclusion that provision of network facilities, especially at the primary (or trunk) level, investment planning, and some technical assistance have a significant public good nature, and that the facilities are by and large natural monopolies (for example, piped water supply and sewerage, large-scale irrigation networks). However, the generation and maintenance of many of the services from these networks can often be implemented under conditions of excludability, and they can be subject to some competitive market forces (for example, by opening the market for a contract to operate and maintain a sewerage system for a specified time period to competing bids that may or may not be renewed). Furthermore, many of the externalities related to the extraction and use of water can be internalized through taxes and subsidies and, where effective monitoring is feasible, through the enforcement of regulations. Some of the impediments to the creation of markets or to the ability to conduct transactions in water can be ameliorated through the use tradable water rights, institutional mechanisms to resolve conflicts over water use, and technologies that facilitate the monitoring of individual water use and enable conveyance between users. Because this can be expensive, the gains in efficiency need to be weighed against the costs of installing the new technology (7).

The establishment of secure (and tradeable) water rights can, at least for certain sectors, lead to more appropriate pricing of freshwater. Establishing secure and transferable property rights will ensure that cost of depletion is internal to the user and that will ensure the sustainable use of his water resources (1).

However, the assignment of water rights cannot solve all environmental problems. It is only useful under certain circumstances and conditions and it might be still necessary for the respective governments to be involved and provide the owner with basic services.

Nevertheless, the assignment of secure and tradable water rights would have the following advantages (4,5,9):

- once the water rights are assigned and secured, externalities are internalized forever and no further intervention is necessary
- administrative costs are low (after property rights are assigned)
- they adjust automatically to changing circumstances
- unlike changes of prices, the market distortions are very low

Limitations (4,5,9):

- it is a politically sensitive issue, since it can be used to achieve political objectives (e.g.reward political supporters)
- it is difficult to distribute property rights. Since they carry much value (rents from future activities) they should not be given away, but selling them in an open market would exclude poor people from buying them and therefore would have social implications

2.2 Water pricing

A more appropriate pricing of water can be used for full cost pricing of production and consumption of this natural resource. Typically, current water prices do not incorporate the social costs. Their effects on human health or the environment are not considered at all. Water pricing therefore tries to bridge the gap between the private and social cost. Ideally, the total price water consumers have to pay should be equal to the marginal environmental damage caused by a certain activity. If this is the case, it would adjust the price of a good exactly by the amount of reduction in social welfare caused by the externalities associated with unsustainable water use. Increasing the prices or taxation of the use of natural resources such as water is an old instrument that was already proposed by Pigou in the early twenties of this century. Nevertheless, it is only rarely used by national authorities to change humans' behavior. In most countries the water price people or enterprises have to pay is below the total cost of water if externalities were internalized. By introducing higher prices for water, especially developing countries have to look into the social impacts of an increased price for this product. Since clean water is essential for human's well-being, governments have to find means to ensure that even the poorest people in the country can afford to buy a certain amount of water. This could, for example be done, by giving each single person the right to use a certain quantity of water for free.

Increasing the price for water has quite a lot of advantages (4,5,8,9):

- from an economic and an ecological point of view, pricing is very efficient

- after imposing a higher price for water, every further reduction of the use of this product leads to a win of revenues or income, since individuals or companies save the money for each unit of water they do not
- even low price increases (below the social cost) will induce a more environmentally friendly use of water resources
- higher prices encourage individuals and enterprises to develop or introduce water efficient techniques
- this instrument will leave private enterprises the freedom to decide whether they pay higher prices or invest in water efficient technology

On the other hand one has to consider the following disadvantages of an increased water price prior to a final decision on the level of pricing (4,5,8,9):

- increasing the price for water does not solve the problem of non-point source pollution of ground- and surface water
- politically there is a tendency not to raise the price as much as to cover the whole social cost. This decision is usually pushed by different lobbies.
- there is also a tendency to use higher prices to create revenues for the government and local authorities.
- it is difficult to consider regional aspects of water contribution
- inflation may decrease the effects of an increased water price
- high administrative costs
- low willingness to accept by the public as well as by the target group concerned

3. Environmental sound water management-two case studies from Germany

Since water pollution caused by agricultural production is considered as one of the major environmental problems in the European Union (EU), new limits for contamination of drinking water with nitrates and pesticide residues were introduced in the 1980s. The EU limits for nitrates in drinking water are 25 mg/l. For pesticides, since 1.10.1989, the limits are 0.1 mg/l for one single pesticide and 0.5 mg/l for all pesticides together, if there is mixed contamination (6). This causes high external costs for the water plants, since they had to purify the water or mix it with unpolluted water to reach above limits. To internalize the high social costs of these procedures it is necessary to avoid water pollution from the agricultural sector.

To address this problems and force farmers to change their production habits, Baden-Wuerttemberg one state in the southwest of Germany has launched two programmes for environmentally sound surface and ground water management. One is called SCHALVO (Schutzgebiets- und Ausgleichsverordung) and the other one is called MEKA (Marktentlastungs- und Kulturlandschaftsausgleichs Programme). The two programmes discussed were designed to address this problem and they have many common properties. They both can be seen as pilot projects even for the situation in Germany, where environmental protection is of high public interest.

3.1 SCHALVO (water protection and compensation programme)

The water protection and compensation programme (SchALVO) was launched in January 1988 and revised in January 1992. This programme is applicable for 16% of the area used for agriculture. The programme itself consists of different parts (6):

(1) forbidden management practices:

Grassland ploughing
liquid manure application near wells
nitrogen fertilization during winter time
restricted use of pesticides (must be registered for watersheds)

(2) recommended management practices:

nitrogen fertilization level 20% below the requirements by the plants
mixed cropping
(reduced) soil conservation practices
careful use of irrigation

(3) increase extension service:

75 consultants advise farmers and control and monitor the programme

(4) additional services

experiment fields and pilot projects to find out the effects of different farm management practices on nitrate and pesticide leaching and runoff
nitrate information system for provision of additional information
subsidies for increasing the storage capacity for manure

In exchange do the farmers get a lump sum of 310 DM/hectare (US$ 240) or individual compensation for yield losses if they can prove that the lump sum does not cover their economic losses. The programme is financed by the water consumers who have to pay a levy of 0.10 DM/m3 (US$ 0.07) drinking water. The budget of the SCHALVO programme adds up to 80 million DM/year (US$ 55 million). The control and monitoring measures cost another 12 million DM/year (US$ 9 million) (11).

The water consumers as well as the farmers appreciated this programme, because it was very well implemented and monitored. Nevertheless, the environmental benefits of the programme will only occur in the long run due to time lag of the nitrogen and pesticide leaching in the soil and water system. Therefore, it was not possible to reduce the nitrate level in the groundwater significantly during the last five years. However, recent results show that slowly the groundwater contamination is decreasing. Nevertheless, additional programmes support the effort to protect the scarce water resources.

3.2 MEKA (compensation for market relief and cultivated areas)

In the year 1992 the state of Baden-Wuerttemberg offered to its farmers to participate in a programme called "MEKA" (compensation for market relief and cultivated areas) which has been financed by the government of Baden-Wuerttemberg and the European Union.

The goal of MEKA is to indemnify for the care and retention of cultivated areas and to offer a compensation for yield losses or increased costs that result from farming practices used to protect the environment and to relief the market. Furthermore, MEKA should improve the prerequisites for existence of a sufficient number of farms to ensure an appropriate care and maintenance of the cultivated area through the agricultural sector. The financial budget for this programme is 140 million DM/year (US$ 95 million). The participation in this programme is voluntary, whereas the participation in above described SCHALVO programme has been compulsory (11).

The main component of the programme is that farmers can collect so called "eco-points" for using one or more environmentally sound production techniques. Each "eco-point" carries a value of 30 DM/hectare. Points can be collected for various production sectors, such as farmland, poultry or dairy farming. The following example should make the system how this programme works more clearly:

The assumption is that a farmer has one hectare of wheat and had undertaken the following practices:

Practice:	Value:
- no herbicides used	6 points/hectare
- no insecticides used	3 points/hectare
- no ploughing	2 points/hectare

- mixed cropping 6 points/hectare

This adds up to 17 points/ hectare which entitles the farmer to receive 510 DM/hectare (US$ 380) for the respective year.

4. Conclusions and recommendations

Although there are huge freshwater resources available on a global level, due to the fact that they are not equally distribute and due to an increasing population and therefore higher demands for freshwater resources this good is becoming more scare. Since the global distribution of this good cannot be changed national and regional authorities have to undertake steps to ensure a more efficient use of water.

In this respect environmental economics can provide some answers and propose solutions to tackle this problem. Beside other instruments such as polluter charges or tradable pollution permits, assigning water rights and increasing the price for water use are promising means to start with. Nevertheless, these instruments can only solve some of the problems, and a case by case approach is necessary to select and implement the most appropriate solution.

There are many lessons that can be learned from the two programmes launched in Germany for a sustainable use of freshwater resources. First, before considering to use such programmes in developing countries, the high cost for monitoring and enforcing those programmes should be considered. The German experience with this two programmes show clearly that it is very important and expensive to monitor them. For many developing countries this might be one of the min reasons for not using similar strategies. Second, the administrative costs for implementing such instruments for freshwater management are very high and they require an established and working administrative body.

One has to bear in mind that the above mentioned projects have been designed and implemented to address the specific problems of groundwater pollution in Germany. Although they can be seen as pilot projects, even for developing countries, it has to be considered that if such programmes are launched in LDCs major adjustments would be necessary. One needs to bear in mind the overall objectives of the programme and one should not try to serve to many goals with one instrument or programme. The instrument should be targeted towards the country's most pressing environmental problems.

In most LDCs there will be no external funds available to implement sophisticated programmes for sustainable use of water resources. In the case of Germany, there were funds necessary to establish an administrative body that is handling all the organizational work involved for implementing those programmes.

Although, at least the SCHALVO programme was more or less self-financing because the water users had to pay a water levy, one has to admit that the increase of the water price was far too little to influence water consumption of individuals and companies. On the other hand it has to be considered that a substantial price increase would have major social impacts. Those social impacts would be even more severe in LDCs than they are in developed countries.

In case a country decides to adopt parts of the German programmes this needs to be done very carefully, taken into account financial and social impacts. One also should consider that the case studies from Germany were only targeted towards water pollution and not to the use of water for irrigation purposes. This is in many countries probably the most severe problem and need to be addressed by other means, such as a substantial increase of the price for water.

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Benefit-Cost Analysis: An Introduction

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I. Introduction

Goods that flow through markets have their prices determined by the free play of supply and demand. This means that private decisions made by thousands or even millions of people can adequately direct resources into producing the goods. However, for many water resources, no markets exist and questions about how water resources should be developed or managed must ultimately be answered through political rather than economic means.

But because countries seldom have enough financial and other resources to invest in all potential water development opportunities, politicians often turn to economists for advice on where investments should be undertaken. In response, economists have developed procedures to evaluate the market and nonmarket activities of water policies and projects. Benefit-cost analysis (B-C analysis) is one such procedure. Because of its prominence in water resource studies and because of its application in many other areas of economic and natural resource policy, this paper provides an introduction to the method.

Benefit-cost analysis is a method that estimates and compares the economic benefits and costs of a policy or project. If the benefits exceed the costs, then the policy or project is justifiable on grounds of economic efficiency. That is, the economic welfare of a society would improve by undertaking the policy or project.

This paper briefly reviews the historical development of B-C analysis and discusses several key theoretical issues that underpin B-C analysis. Major operational issues of B-C analysis are then addressed: defining the characteristics of the project, measuring and valuing the changes, and calculating a return.

II. Historical Development

Benefit-cost analysis has existed for centuries. By the 19th century, authors had published works on both the theoretical and pragmatic developments of B-C analysis. For example, in France, economist Jules Dupuit's theoretical work on B-C analysis appeared in his 1844 paper "On the Measurement of Utility of Public Works." In the United States, the notion of relating benefits and costs occurred as early as an 1808 report to the U.S. Senate by Albert Gallatin, Thomas Jefferson's secretary of state. Gallatin advocated construction of an extensive federal network of roads and canals and linked benefits from the project to the required public investment [Hines].

During the early 20th century, B-C analysis in the United States evolved largely as a result of legislative and administrative concern over the development of water projects. Beginning in 1902, Congress enacted several pieces of legislation, including the Rivers and Harbors Act, the Reclamation Act, and the Flood Control Act, that provided a basis for evaluation of federal water projects. Each of these required U.S. government agencies to consider economic feasibility as a condition for federal financing water resources projects and eventually legitimised the principle of comparing estimated costs with resulting benefits.

In 1950, a U.S. government committee that was foormed especially to investigate B-C analysis published official guidelines for using B-C analysis in evaluating federal water projects. This "Green Book" became the wellspring for a series of documents that provide guidelines and procedures for B-C analysis for federal projects.

Concurrent with these U.S. administrative initiatives in B-C analysis, economic research in the benefit-cost area grew rapidly during the 1950s and 1960s. Two major works in the 1950s, published independently by Eckstein and McKean, sought to bring consistency to the evaluation of water projects. In efforts to outline a comprehensive approach to B-C analysis, Eckstein drew heavily from welfare economics while McKean relied on public finance. Numerous other technical publications in the 1960s developed the theory and practice of B-C analysis. These owed their existence largely to the growth of large investment projects, the growth of the public sector, the development of operations research and systems analysis techniques, and the increasing sophistication of welfare economics.

By the late 1960s, numerous authors both in and outside the U.S. were producing a virtual flood of manuals, guidelines, procedures, and theoretical works on benefit-cost analysis and its use in numerous applications. For example, B-C analysis was adopted in the United Kingdom with the application of the method to the London-Birmingham motorway [Beesley, et al]. In 1967, the UK government gave formal recognition to B-C analysis and assigned it a role in nationalised industries. These industries were required to seek an eight percent return on a new investment and benefit-cost was the tool used to estimate projected returns [Pearce].

B-C analysis was extended to developing countries beginning in the 1960s, spurred by the publication of Little and Mirrlees' Manual of Industrial Project Analysis, which was prepared for the Organisation for Economic Cooperation and Development. In 1972, the United Nations Industrial Development Organisation published its guidelines on the use of B-C analysis [Marglin, et al], and by 1975 the World Bank published its first manual on the use of B-C analysis [Squire and van der Tak]. Today, all multilateral funding agencies use benefit-cost analysis and most bilateral aid programmes also employ the method to evaluate a variety of projects and policies.

III. Key Theoretical Considerations

A B-C analysis attempts to calculate the effects on economic welfare that will occur in response to a change in policy or implementation of a project. Benefits of the change increase welfare, while costs reduce it. Traditional B-C analysis emphasizes economic efficiency as the primary criterion for measuring welfare and ignores distribution and equity issues. For example, if a B-C analysis shows a net gain of $1 million attributable to a certain policy change or project, then the society as a whole will be better off by the $1 million. The $1 million net gain calculated by B-C analysis ignores the possibility that certain individuals in the society may gain while others lose because of the change.

Pareto Improvement

The theoretical basis for B-C analysis can be found in the literature of welfare economics. In particular, the "new welfare economics," a school of thought developed largely around the work of Vilfredo Pareto, provides economic arguments for using B-C analysis. Pareto suggested a basis for evaluating social welfare that relies heavily on a criterion of economic efficiency.

So-called Pareto optimality for a society exists when no individual's well-being can be improved without the change adversely affecting the well-being of at least one other individual. A Pareto improvement is then defined as a change in economic arrangements that makes at least one member of society better off without making anyone worse off.

According to the new welfare economics, an economist conducting a B-C analysis will test to determine whether a Pareto improvement could arise from a policy change. As a practical matter, however, only a very limited number of policy changes could pass a test of Pareto improvement. A result of many economic policies, especially those designed to alter the economic character of an area, is that some individuals will gain and others will suffer. Thus, a B-C analysis that relies on the Pareto optimality criterion would seem to nearly always favour the status quo.

To get around this, two economists, Nicholas Kaldor and John Hicks, defined a complementary criterion for measuring changes in welfare - the compensation principle or potential Pareto improvement. When an economist conducts a B-C analysis, it is usually this criterion that is tested.

Compensation Principle

The compensation principle states that policy A is preferred to policy B if, in making the change from policy B to policy A, those who gain **can** compensate those who lose. The compensation need not actually take place. Sugden and Williams explain the principle as follows:

> Undertaking a project provides a potential Pareto improvement if it is in principle possible to secure an actual Pareto improvement by linking the project with an appropriate set of transfers of money between gainers and losers - even if in fact these transfers will not take place. In other words, a project provides a potential Pareto improvement if the total sum of money that the gainers from the project would be prepared to pay to ensure that the project were undertaken exceeds the total sum of money that the losers from it would accept as compensation for putting up with it. [p.89-90]

Other prominent economists have studied and refined the compensation principle. For example, Little developed a two-step test that considers both efficiency and equity aspects of a change. He suggests that first, the amount of income to society after a change should not be less than the amount of income earned before the change - passing the potential Pareto criterion. Second, it should not be possible to make all individuals as well off before the change as they can be after the change.

This work suggests the importance of tracking welfare changes and their distribution in the society both before and after a policy change. And policymakers should be aware that, because the compensation principle is more extensive than the Pareto improvement criterion, a B-C analysis conducted according to the compensation principle could become quite complicated.

Criticisms of the Paretian Approach

One criticism of the potential Pareto improvement criterion stems from the work of Scitovsky. He noted a "reversal paradox" could exist, in which a policy change initially passes the potential Pareto improvement criterion - those who gain can compensate those who lose and still be better off. However, after implementation of the policy, reverting back to the original situation could also pass the potential Pareto improvement criterion. Thus, even when gainers can potentially compensate losers to implement a policy, a conclusion that the policy should be implemented does not necessarily follow. Only in the case where losers cannot also bribe the gainers not to implement the policy will the policy pass the reversal test.

A second, more sweeping criticism of the potential Pareto improvement criterion notes that changes in the distribution of incomes are ignored. Arguing against the potential Pareto improvement criterion, social philosopher Rawls advocates a criterion that explicitly includes income distribution. Called the difference principle, Rawls' criterion states that one should judge changes in economic distribution by the amount of gain that accrues to the least fortunate individual in society. Under this criterion, society reaches an optimal social welfare position only when the worst-off individual's position cannot be improved through changes by the better-off individuals.

A more comprehensive welfare criterion would include both Pareto efficiency and distributional improvements and would force a policy or project to pass at least one part without violating the other. Such a criterion could allow for a Rawlsian fairness improvement (or other change in the distribution of income) without violating the efficiency characteristics inherent in the compensation criterion.

Pragmatically, the potential Pareto improvement criterion remains tolerable for evaluating the marginal adjustments which most water policies or projects create and it is from this criterion that most B-C analyses begin.

Willingness to Pay

The theoretical standard for measuring changes in economic welfare lies in the concept of willingness to pay. This provides the basis for conducting an empirical B-C analysis and in particular the basis for measuring economic benefits.

Consider the following example of an individual's price-quantity relationship for drinking water. At a price of $8, the individual will buy one cubic metre of water; at $4, the individual will buy 4 cubic metres of water; and so on. If the individual is charged the same price for each cubic metre purchased, the third column above indicates the total amount that the individual **actually** pays. If the individual could be made to pay the maximum he is willing to pay for each individual cubic metre, (for 3 cubic metres, he would be willing to pay individually $7 + $6 + $5 = $18), the last column above indicates the individual's total **willingness to pay**.

The difference between the amount the individual actually would pay and the amount he is willing to pay is called consumer surplus - the extra value received beyond the price paid for a good. For all cases where there is a positive price, the total willingness to pay is the actual amount paid plus the consumer surplus for that quantity.

By plotting the price-quantity pairs shown below, the resulting curve is the individual's demand curve for drinking water. Since the curve presents every possible combination of price and quantity, the accumulated area under the entire demand curve equals the consumer's willingness to pay. These are the benefits from using or enjoying the good.

Price of water ($)	Quantity purchased (cu metre)	Price times quantity	Accumulated price times incremental quantity
8	0	0	0
7	1	7	7
6	2	12	13
5	3	15	18
4	4	16	22
3	5	15	25
2	6	12	27
1	7	7	28
0	8	0	28

For goods that are traded in markets, such as shoes, an economist can usually estimate the total willingness to pay for the good - the sum of all individual willingnesses to pay - by observing prices and quantities of the good as it is bought and sold in the market. However, for goods that are not traded in a market, as may be the case for water, willingness to pay cannot be readily observed and must be estimated through other techniques.

Nonmarket Valuation

Goods not traded in a market usually have characteristics as to why they are not. In the first instance, a nonmarket good may give rise to externalities - a situation where those who receive the benefits from the good do not pay all the costs. For example, pollution exists in rivers to a large extent because polluters are not required to pay the full costs of using the river to dispose of pollution.

In the second instance, a good may be nonmarket because they are not easy to divide and use by one person does not diminish the availability of the good to others. These public goods are not produced by markets because many people may benefit from the good at the same time, which does not provide an incentive for any individual to pay for the good. For example, rivers also have public good characteristics - many people may benefit from keeping a certain amount of clean, free-flowing water in the river, but logically no individual would exclusively pay for those river flows.

For nonmarket goods, and this includes water in many situations, the willingness to pay -or benefits - from a policy or a project must be estimated using special methods. One popular approach is contingent valuation, where an economist will ask individuals to state their willingness to pay for a certain quantity of good. In essence, the economist is creating an imaginary market by asking individuals how much of their income they would be willing to give up (perhaps through paying a higher tax) if they in return would receive a higher quantity of the nonmarket good.

For example, individuals in a rural village might be asked their willingness to pay for a drinking supply to be installed close to their village. Or individuals might be asked their willingess to pay to improve the water quality of a river. Individuals could also be asked their willingess to pay to reduce the probability of illness due to improving drinking water quality.

A major concern about asking individuals their willingness to pay is whether or not the answers received are anywhere close to what might be observed if the good in question actually could be traded in a market. Individuals may choose to bias their answers because it may suit a strategic purpose (such as trying to ensure their taxes are not raised) or because the individual does not have complete information on the hypothetical choice.

Nonmarket valuation methods have been used extensively over the last 25 years to estimate the benefits associated with water policies or projects [see, for example, Mitchell and Carson]. Although they are not reliable enough to determine a specific point estimate of benefits, they do give policymakers a realistic range of the level of benefits.

Cost Effectiveness

In some instances, a good estimate of benefits from a policy or project may simply be unobtainable. At the same time, there may be broad agreement in a society about a specific objective that should be pursued. In this case, policymakers may not consider whether any economic justification exists for pursuing the objective but rather seek the least-cost way to achieve the objective.

This cost-effectiveness analysis systematically seeks to identify the least-cost approach and the trade-offs likely to be encountered by using that approach. For example, a desirable standard for water pollution in a lake may be defined. Cost-effectivenss could be used to determine the least-cost means of meeting the standard and, using that as a baseline, making estimates of cost increases if alternative policies are adopted instead. In this example, alternative policies might raise issues such as "should all firms that pollute the lake be required to reduce their pollution in equal proportion or should the greatest reductions come from those firms that can achieve them most cheaply?"

If several alternative policies or projects would achieve the exact same type and level of benefits, cost-effectiveness analysis would estimate the costs of each alternative and then select the lowest cost alternative. However, in most cases, alternatives with different costs yield different levels, and perhaps also types, of benefits.

If the benefits are of the same type but differ in amount according to the alternative selected, a cost effectiveness ratio could be calculated (cost per unit of benefit). In this event, but also in the case where the types of benefits are not the same, the cost-effectiveness ratio will not determine the economic efficiency of the alternatives under consideration. Least-cost does not necessarily imply that a policy or project will contribute to the increase of economic welfare (that is, is economically efficient).

IV. Operational Constructs

Economic changes, both positive and negative, occur because of a policy or project. B-C analysis must identify those changes. The application of B-C analysis hinges on the comparison of an economy without a suggested policy or project to the same economy with the policy or project. This "with-and-without" principle was outlined from the very earliest writings on B-C analysis. As Eckstein wrote:

> The "with and without" principle requires that the economic analysis contrast those two hypothetical situations. These remarks may seem perfectly self-evident, but the principle forestalls application of the fallacious basis of comparison, "before and after." It prevents attributing to a project effects which

are not caused by it, but which occur because of the passage of time or for other irrelevant reasons. The "with and without" principle is no more than a restatement of the fundamental analytic idea that any action be evaluated in terms of the difference it makes, that is, in terms of the effects which it specifically causes. [p.52]

In applying the "with-and-without" principle, B-C analysis consists of three steps: (1) identifying the physical characteristics and changes attributable to a project, (2) valuing the changes, and (3) calculating a measure of return. The following sections consider each of these steps.

Physical Characteristics of the Project

This initial step of B-C analysis describes the effects, particularly those that have economic consequences, of a proposed policy or project over time. The inputs and outputs, whether tangible or intangible, are specified for each year of the project's expected life. Also, this phase identifies alternatives, if any, to project design and estimates the expected project life. Important economic concepts considered during this phase include both positive and negative externalities.

Project Scope

In most cases, a proposed water policy or project subjected to B-C analysis will have a clearly identifiable scope. Small projects, such as a small hydroelectric project, have a limited number of inputs and outputs and as a result, cause a fairly limited chain of interactions for an economist to trace. With larger projects, an economist may find it more difficult to define the scope of the project and the resulting interactions. For example, a major irrigation project could have impacts that might involve hydropower production, fish populations, flood control, recreation facilities, and levels of water quality.

When an economist conducts a B-C analysis, the limit to the scope of a project is usually a relevant geopolitical area, perhaps as large as an entire nation or possibly considering a province, region, or other subset of a nation. Those activities that occur outside of the selected area generally hold little interest to the involved decison makers. Within the selected area, however, an economist should endeavor to include all of the relevant economic activity attributable to a project in the analysis. In any event, a B-C analysis needs to include all the economic interactions from the proposed project that change the welfare of the area's residents.

Indirect Benefits and Costs

Direct costs are the costs of those goods and services used for the construction and operation of a project or to implement a policy. Direct benefits are the value of those immediate products and services for which the direct costs were incurred. Indirect benefits and costs are those benefits and costs which have been dispersed through an economy by passing from market to market.

Indirect benefits and costs include those that affect economic activity either prior or after the direct benefits and costs have been incurred. For example, assume that an irrigation project results in a direct benefit of increased wheat production. Indirect benefits that occur after the direct benefits and costs could include increased activity by such enterprises as wheat brokers, transportation systems, millers, and bakers. Indirect benefits that occur prior to the direct benefits and costs could include those changes in the production of fertilizer and an increase in sales of seed dealers or equipment brokers.

In general, an economist will not include indirect benefits and costs in a B-C analysis that is conducted from a national perspective. In this case, the assumption is that a policy or project will yield no net benefits beyond its own net income. Any expansion of complementary activities (indirect benefits) will be offset by a fall in these activities elsewhere in the country.

If a B-C analysis is conducted from a subnational perspective, it may be appropriate to include indirect benefits and costs in the analysis. One region may gain from indirect benefits that occur in that region, although that region may also incur indirect costs (such as increased demand for public services such as schools). Although the estimation of indirect benefits and costs is a potentially important component of a subnational level B-C analysis, it is likely that sophisticated economic models, such as input-output analysis, would need to be employed to be able to accurately measure these.

Project Life

An estimate of a project's life ordinarily is a subjective one. One basis for the estimate is the assumed physical life of a project. But changes in technology, shifts in demand for project outputs, and the existence of competing products can all have an impact on the useful economic life of a project. In the case of water projects which affect consumptive uses of water, physical life estimates will usually govern the estimates of project life. It is possible that demand shifts could lessen the quantity of water needed or that technological change or development of a competing product could impact project life, but these effects are difficult to determine in an ex ante B-C analysis.

Estimates for the useful life of many water projects range between 50 and 100 years. Current United States federal guidelines for water project evaluation mandate that a maximum useful life be set at the actual life of a project or 100 years, whichever is lower. However, the estimate of project life used for a B-C analysis can safely be set at no longer than 50 years, for two pragmatic reasons: the present value of a dollar is nearly nothing after 50 years and an economist will find it difficult to accurately predict economic conditions beyond 50 years.

Valuation of Costs and Benefits

After the physical nature of a project has been detailed, the next step in B-C analysis estimates the dollar value of each impact. Key concerns in this process include the selection of prices to be used for valuation; the impact of certain macroeconomic conditions, such as market imperfections, taxes, and unemployment, on the valuation of benefits and costs; and special types of benefits and costs, such as collective goods and intangibles. Each of these is discussed below.

Selection of Prices

In general, an ex ante B-C analysis uses current market prices to value the costs and benefits of a project. In so doing, an economist assumes that relative prices will remain constant over the life of the project and avoids the difficult problem of forecasting future price levels (which would allow for changes in relative price levels) for 50 years. However, it would also be appropriate for an economist to assume changes in relative prices over time, if the analyst has grounds for anticipating the changes. Similarly, the prices used should not account for expected changes in the general price level. The general price level existing in the first year of the project is usually the one used throughout the analysis.

Demand analysis and cost studies are used to evaluate benefits and costs. On the benefit side, the appropriate measure calculates the addition to the area under the demand curve, the consumers' willingness to pay, for each benefit. On the cost side, either actual cost or the opportunity cost - the value of that which is foregone - is used. If the policy or project does not affect prices and if there are no other complications with the market prices, then price times change in quantity provides an accurate interpretation of benefits and costs. This may or may not not be the usual case, however.

Projects, especially water projects, may be large enough to affect the prices used to value the benefits and costs of a project. For example, an irrigation project may be large enough to affect prices of commodities produced or of materials used to grow the commodities. In either event, benefits cannot be measured by multiplying the change in quantity times either the price without the project or the price with the project. If the price without the project is higher than the price with the project, then using only the former price will overestimate the benefits; using only the latter price will underestimate them.

If a linear demand (or supply) curve is assumed to exist, using an average of with-and-without project prices will provide a reasonable middle-ground estimate of benefits (or costs). For example, a large irrigation project could increase the supply of a certain crop such that its price is reduced. This would occur when a high percentage of a national crop is grown in a certain region or when a crop only has a local, in-region market. In that event, an economist can use the averaging procedure to estimate the benefits attributable to changes in crop price.

When a project output is an intermediate good, the relevant demand curve is derived from the demand for the final product. For example, the domestic demand for feed grains can be derived from the final demand for beef, chicken, or milk. For most intermediate goods, the estimate of benefits is found by calculating the change in the market value of sales plus any increase in the consumer surplus of the final products that are linked to changes in the price for intermediate ones.

Special Types of Goods

As noted previously, the existence of public goods - those that are difficult to divide and make exclusive to one individual - presents a major challenge for B-C analysis. These goods either have no price or a price which does not reflect consumer preferences. Thus, the demand relationship for a collective good is obscure and an economist must estimate the dollar value of willingness-to-pay using methods such as contingent valuation. Essentially, the B-C analyst attempts to ascertain how consumers would behave if there were a market and elicit from them their willingness to pay.

Macroeconomic Impacts

When conditions other than perfect competition exist in either product or input markets, quantities and prices of outputs and inputs are different than they would be under competitive conditions. The valuation of costs and benefits theoretically requires corrections to account for distortions in market prices. Failure to correct the market prices could lead to a misallocation of resources.

In principle, there are two ways of making the necessary corrections. A correction can be made to the actual level of costs (benefits), or the costs (benefits) arising from the market can be taken as they stand but a corresponding correction has to be made to the estimation of benefits (costs). In practice, price corrections are easily made only if the appropriate change is known and can be justified. Thus, an economist conducting a B-C analysis in many cases will accept unadjusted market prices even in the absence of perfect competition. However, this acceptance should occur only if the matter is relatively unimportant to the overall evaluation.

Government can impact the magnitude of costs and benefits through taxes and regulatory actions. The government can levy sales or income/profit taxes. Sales taxes essentially create a two price system, with the consumer paying one price and the producer receiving another lower price. A proportion of the tax ultimately transfers to consumers (with the proportion being determined by the elasticity of demand for the product). As a result, at the national level, an economist conducting a B-C analysis generally excludes sales taxes from the estimates of factor costs. The same should hold true at the subnational level.

Income/profit taxes that are derived from income generated by a project do not correspond to the use of real resources. For a national level B-C analysis, these taxes should be considered as a transfer item and not as part of the cost of the project. The same rule holds for a subnational level B-C analysis, if the tax is levied by the subnational government. However, a subnational level B-C analysis should treat a national income/profit tax as part of the social cost. This is because a national income/profit tax represents an outflow of resources from a subnational region, whether or not the tax corresponds to services rendered by the national government.

Government regulatory actions, such as agricultural price supports and production/supply controls, can directly affect market prices. If the price of a commodity is partly determined by national regulatory actions, an economist conducting a B-C analysis at the national level will need to adjust the price to correct for the induced distortion. For a subnational level B-C analysis, prices distorted by national regulatory actions need not be corrected. This is because all residents of the relevant area will receive the distorted price and this reflects the marginal value to area residents. When future changes in national regulatory actions are difficult to predict, at best, an economist may assume that the current regulatory scheme will hold over the life of the project.

An excess supply of an input at a certain market price means that use of its price in B-C analysis will overstate the social cost of using that input. This may be the case for land, capital, or labour. Thus, if general unemployment exists in the economy, the wage rate, even when determined under market conditions, will be higher than the social cost of labour. Correcting the wage rate to reflect the social cost of labour may not be straightforward, however. As McKean noted, it is easier to allow for the overpricing of labour for a project rather than to also correct other factors which are overpriced because they include in their costs some overpriced labour. Also, correcting future labour costs requires estimates of future unemployment. This is a difficult forecasting task.

Another issue regarding B-C analysis and unemployment is the validity of the claim that, in times of less than full employment, public projects will absorb otherwise idle labour. From the perspective of a B-C analysis of a project, the social cost of using labour for a project is measured by the opportunity cost of that labour. Thus, an increase in total employment due to a project cannot, by itself, justify the project. However, from the perspective of the overall economy, unemployment could be reduced if an investment in a public project generates indirect effects that result in the creation of additional aggregate income and employment.

Whether or not a project increases primary employment depends on the probability of drawing project labour from the unemployed. This is determined by the rate of unemployment, the specific factors required by the project, the location of the unemployment with respect to the project, and the rise in prices (if any) that will occur when the project is introduced into the employment situation [Mishan].

Regardless of the opportunity cost of labour, government can choose between a proposed public project and other ways of reducing unemployment. This is a separate issue from that of deciding the economic feasibility on a proposed project. At the subnational level in particular, an increase in employment in and of itself is not a good reason to undertake or not undertake a project.

Calculation of a Measure of Return

This step of B-C analysis consists of two parts, both of which have been subject to intense theoretical debate: discounting the values assigned to the benefits and costs and choosing an investment criterion. Discounting is necessary because the time path of the benefits and costs attributable to a project may differ, and society will value a future dollar less than a present dollar, since a present dollar could be invested to earn a return. To ensure comparability, the value of each benefit and cost is generally adjusted to reflect present-dollar terms. That is, the value of each benefit and cost that occurs in the future is discounted to present-dollar terms.

The numeraire used to discount the value of benefits and costs is the social discount rate. Two major theoretical approaches to the selection of a social discount rate are social time preference and social opportunity cost of capital. Both of these seek to estimate for society the marginal rate of preference for consumption in different time periods. That is, this marginal time-preference rate measures preferences between small changes in consumption in different time periods.

Social Time-Preference

A proposition advanced by the economist Pigou suggests that social time-preference should attach more weight to the future than individual time-preference. This stems from the belief that living individuals are short-sighted with regard to the welfare of young or unborn generations. Therefore, a social institution such as government must address the issue of social time-preference. This is unlike the investment scenario of the private sector, where individuals are free to match their marginal time-preference rates with those of private firms.

In establishing a social time-preference rate, the preferences of government must be accepted by society, at least for the short term. Through voting and other forms of political pressure, social time-preference rates may be altered. But this assumes a uniformity of preferences and an ability to express them, both of which are unlikely. This means that, for an economist seeking a social discount rate to use in a B-C analysis, the social time-preference rate may be difficult to estimate.

Social Opportunity-Cost

This approach, also called the social opportunity cost of capital, focuses on the interest rate at which a public agency can borrow and lend capital. The approach suggests that, if an agency of the society can borrow and lend freely at a given interest rate, then the interest rate approximates the social opportunity cost and should be used as the social discount rate, regardless of the marginal time-preference rate of society.

Estimating the opportunity cost of capital for a public agency is appropriate only when the agency has an opportunity cost of capital. That is, the agency must be able to borrow and lend freely. The estimation process assumes that the interest rate used by an agency approximates the marginal efficiency of private investment, which may not always be the case. Also, the estimation process may adjust the agency's interest rate to account for the way capital, if not invested in a project, would be divided between private investment and private consumption [Mishan].

Public investment projects contain some measure of risk. As a result, it can be argued that a public agency's interest rate should be adjusted upward to reflect this risk [Baumol]. However, an adjustment to the interest rate presumes that the involved risk is a strict compounding function of time, which may not necessarily be true. Also, there is a question as to whether risk is already built into market interest rates. In other words, an interest rate, including one for a public agency, may already reflect the riskiness of the potential uses of money.

For an economist seeking a social discount rate to use in a B-C analysis, the opportunity cost of capital is a straightforward proxy for the social discount rate. Although this rate may not match the marginal time-preference rate of many residents affected by the policy or project, it is at least identifiable as well as theoretically defensible. One example of an opportunity cost of capital is the interest rate on long-term government bonds. Because many governments issue bonds on a project-by-project basis, this rate can directly identify the opportunity cost of capital, including risk, for a specific project. Although an economist may have difficulty predicting the exact opportunity cost of capital for a project, a close approximation can usually be made by evaluating the interest rates obtained on bonds previously issued for similar projects.

The following table illustrates the value of $1000 for different discount rates and various periods of time. With a discount rate of 10 percent, an individual would be indifferent to $1000 now or $909 in one year's time, $621 in five year's time, $386 in 10 year's time, and so on. As the discount rate increases, the present value decreases. As the length of time increases, the present value decreases.

	5%	10%	15%
1 year	$952	$909	$870
5 years	784	621	497
10 years	614	386	247
15 years	481	239	123

Investment Criteria

An investment criterion is the decision rule that a B-C analyst uses to compare the streams of discounted values of benefits and costs. Although numerous decision algorithms have been developed, this section reviews three commonly used criteria: net present value (NPV), the benefit-cost ratio, and the internal rate of return (IRR).

Net Present Value

This criterion sums over all years the discounted value of the difference between the values of the benefits and costs, including investment costs associated with the project. If the net present value is greater than zero, then the project is feasible from the standpoint of economic efficiency. If the net present value is negative, then the project is not economically efficient. In other words, an economically efficient project passes the potential Pareto improvement test such that project beneficiaries receive sufficient benefits to compensate those who lose as a result of the project.

Mathematically,

$$NPV = -K_0 + \frac{B_1 - C_1 - K_1}{(1+r)^1} + \frac{B_2 - C_2 - K_2}{(1+r)^2} + \frac{B_3 - C_3 - K_3}{(1+r)^3} + \ldots + \frac{B_n - C_n - K_n}{(1+r)^t}.$$

where

NPV is net present value
Kt is investment (construction) cost in time period t
Bt is the amount of benefits in time period t
Ct is the amount of costs in time period t
r is the discount rate
n is the number of years of useful life

More concisely,

$$NPV = \sum_{i=0}^{n} \frac{\beta_t}{(1+r)^t}$$

where
ß is the stream of net benefits (Bt-Ct-Kt) in time period t
r is the discount rate
n is the number of years of useful life

Consider a project that requires an initial outlay of $1000 and yields benefits of $400 at the end of the first year, $600 at the end of the second year, and $500 at the end of the third year. Using a discount rate of 10 percent, the net present value would be as follows:

Year	Benefit	Discount factor	Present value
0	-$1000		-$1000.00
1	$400	.909	363.60
2	600	.826	495.60
3	500	.751	375.50
Net present value			234.70

The net present value criterion is based on two key assumptions. First, it hinges on the availability of an acceptable discount rate. Second, the application of NPV requires reasonable estimates of project starting time and the time path of benefits and costs.

Comparison of several projects is feasible under the NPV criterion, although project ranking should be approached with caution. As Gittinger notes, the net present value criterion is an absolute, not a relative measure. Thus, a small, highly attractive project may have a smaller net present value than a large, marginally acceptable project. But as long as both projects have a positive net present value, resources exist to implement both, and are not mutually exclusive, the difference in net present values is not important and both projects should be undertaken. If both projects cannot be undertaken because of a lack of funds, the implication is that the estimate of the opportunity cost of capital is too low. By increasing the estimate of the opportunity cost of capital, only those projects with a positive net present value and for which sufficient funds are available will be selected.

The NPV criterion is also appropriate for comparing mutually exclusive projects. In this case, undertaking a small, highly profitable project may preclude generating more wealth through a moderately profitable but larger alternative. Thus, the absoluteness of the NPV is relevant to the decision choices among mutually exclusive alternatives.

Internal Rate of Return

This criterion is similar to the net present value criterion. The major difference is that the discount rate is a product of the calculations rather than a variable introduced into the calculations. The IRR is that rate of discount which makes the present value of the net benefit stream equal to zero. A project is economically efficient when its internal rate of return is greater than a selected target rate of return. For example, if decision makers set 12 percent as the target rate, then the relevant question for project evaluation is whether the internal rate of return on a proposed project is less than, greater than, or equal to 12 percent. Those projects with an IRR greater than or equal to 12 percent are judged economically efficient and pass the test of potential Pareto improvement.
Mathematically,

$$IRR = -K_0 + \frac{B_1-C_1-K_1}{(1+r)^1} + \frac{B_2-C_2-K_2}{(1+r)^2}$$

$$+ \frac{B_3-C_3-K_3}{(1+r)^3} + \ldots + \frac{B_n-C_n-K_n}{(1+r)^t} = 0$$

where

IRR is internal rate of return
Kt is investment (construction) cost in time period t
Bt is the amount of benefits in time period t
Ct is the amount of costs in time period t
r is the discount rate
n is the number of years of useful life

More concisely,

$$IRR = \sum_{i=0}^{n} \frac{ß_t}{(1+r)^t} = 0$$

where

ß is the stream of net benefits in time period t
r is the discount rate
n is the number of years of useful life

To calculate the internal rate of return, the terms representing the present value of the entire stream of net benefits are set equal to zero. The solution yields the IRR. Unlike the NPV criterion, IRR does not require a predetermined discount rate. Like NPV, results depend on the time path of benefits and costs from a project.

Consider a project that requires an initial outlay of $1000 and yields benefits of $452 at the end of the first year, $500 at the end of the second year, and $278 at the end of the third year. To find the IRR, a discount rate must be selected that sets the present value of the benefits equal to the present value of the costs. To solve this by hand requires selecting a discount rate and testing whether that rate makes discounted benefits equal to discounted costs.

At a discount rate of 8%:

Year	Benefit	Discount factor	Present value
1	452	.926	$418.60
2	500	.857	428.50
3	278	.794	220.70

Present value of benefits $1067.80
Present value of costs $1000.00

At a discount rate of 15%:

Year	Benefit	Discount factor	Present value
1	452	.870	$393.20
2	500	.756	378.00
3	278	.658	182.90

Present value of benefits $954.10
Present value of costs $1000.00

At a discount rate of 12%:

Year	Benefit	Discount factor	Present value
1	452	.893	$403.60
2	500	.797	398.50
3	278	.712	197.90

Present value of benefits	$1000.00
Present value of costs	$1000.00

The internal rate of return does not provide a measure of magnitude of project impacts. The criterion is stated in percentage terms, so that the magnitude of the numbers used in the calculation is not readily apparent. The IRR can be difficult to calculate, particularly if the flows of benefits and costs are uneven and the project is long-lived. In that case, an investment stream could have more than one internal rate of return. That occurs if the costs of a project exceed the benefits in more than the initial time period. When more than one IRR exists, the solution of the above equations will have more than one solving rate and the question arises as to which rate is the appropriate one.

McKean advocated use of the IRR criterion as a method of allocating a given capital budget among several investment projects. Such a comparison or ranking of several projects with the IRR criterion is possible, but similar to ranking using the NPV criterion, difficult. The results obtained from an IRR-based ranking process will not necessarily be the same as those obtained with the NPV criterion. The divergence depends on the discount rate used and on the ratio of operating expenses to construction expenses. The IRR will rank projects of different sizes the same as the NPV criterion only when the internal rate of return is equal to the discount rate of the NPV analysis. In addition, projects with a high ratio of operating expenses to construction expenses will be ranked more favourably with the IRR criterion than those with a lower operating expense/construction expense ratio.

Benefit-Cost Ratio

This criterion has achieved a high degree of popularity. To calculate a B-C ratio, the stream of discounted benefits is divided by the stream of discounted costs. If that ratio is greater than one, then the project passes the test of economic efficiency. Conversely, if the ratio is less than one, then the project is considered inefficient. As with the other criteria, economic efficiency is based on the concept of potential Pareto improvement.

Mathematically,

$$B/C = \frac{\dfrac{B_1}{(1+r)^1} + \dfrac{B_2}{(1+r)^2} + \dfrac{B_3}{(1+r)^3} + \ldots + \dfrac{B_n}{(1+r)^n}}{K_0 + \dfrac{K_1+C_1}{(1+r)^1} + \dfrac{K_2+C_2}{(1+r)^2} + \ldots + \dfrac{K_n+C_n}{(1+r)^n}}$$

where

B/C is the benefit-cost ratio

Kt is investment (construction) cost in time period t

Bt is the amount of benefits in time period t

C_t is the amount of costs in time period t
r is the discount rate
n is the number of years of useful life

More concisely,

$$B/C = \sum_{i=0}^{n} \frac{B_t}{(1+r)_t} \Big/ \sum_{i=0}^{n} \frac{C_t}{(1+r)_t}$$

Consider a project that requires an initial outlay of $1000 and yields benefits of $400 at the end of the first year, $600 at the end of the second year, and $500 at the end of the third year. The discount rate is 12%.

Year	Cost	Benefit	Discount factor	Present value
0	-	$1000	-	$1000.00
1		$400	.909	363.60
2		600	.826	495.60
3		500	.751	375.50
Total benefits				$1234.70

Benefit-cost ratio = 1234.70/1000 = 1.23

As with the net present value criterion, the B/C ratio depends on an acceptable discount rate that is determined externally to the criterion. The timing of benefits and costs also affects the outcome of a B/C ratio.

Eckstein suggested use of the B/C ratio for project comparison, but only under certain conditions.

> The economic nature of the costs must be reasonably uniform; there must be no extreme variations of capital intensity. The benefits must be uniform at least at the conceptual level and must have roughly equal degrees of uncertainty. And the life spans of the projects among which choices are to be made must be of the same order of magnitude. [p.55]

As with the IRR criterion, the discount rate used and the operating expenses/construction expenses ratio affect project rankings using the B/C ratio. A less-restrictive project ranking process using the B/C ratio employs a relatively low discount rate, but selects projects only if the B/C ratio is well above one.

Although an economist conducting a B-C analysis could select and defend any of the above criteria, the use of the net present value criterion is highly recommended. The format of the net present value criterion readily indicates the dollar magnitude of a project. In addition, the results of the net present value criterion can be easily converted into a B-C ratio, if comparability with other evaluation results is necessary.

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PRICING WATER FOR SUSTAINABLE DEVELOPMENT

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I INTRODUCTION

In many developing countries raw water is considered a free good especially if it is plentiful. Although the two main sources of raw water, rainfall and groundwater, may be plentiful, raw water still has to be captured or pumped out, stored, treated and distributed before it can safely be consumed by human beings.

When water is captured, stored, treated and distributed value is added to it because capital, operating, maintenance and environmental costs are incurred. Capital costs include the cost of dams, treatment plants and distribution pipes. operating and maintenance costs include the cost of chemicals, electricity, materials and labour. In addition to these costs, there are environmental costs because dams cause flooding and deforestation. The cost of using capital, chemicals, labour, energy and the environment are all opportunity costs to society because these resources could have been used to produce other outputs equally desired by society.

Even if a developing country has plentiful supples of capital and labour, there are competing uses for these resources. Instead of developing water resources, the country can build, for example, schools or hospitals. In fact, in many developing countries there is a critical shortage of capital and hence there is a need to allocate capital to its most valued use. In other words, capital should move to economic activities where the returns to it are the highest. If capital is perfectly mobile then it will be used in activities where its value is the highest or where the returns to its use are the highest. If capital moves to its highest value use then it will be allocated efficiently and its market price will reflect its scarcity value.

Similarly, water should be allowed to move to its most valued uses and priced to reflect its scarcity value so that it is allocated efficiently and the money spent on developing water resources can be fully recovered to finance or sustain future water resources development. Water cannot be provided free because it will be wasted. For example, if farms waste free irrigation water, then other competing users for the same water, that is, households and industry, may be deprived of the use of the same water. This represents an opportunity cost to society, especially if the same water can be used to produce higher valued products. Water users, therefore, have to be given a financial incentive to conserve water. If more than the necessary amount of water is consumed, more resources will have to be committed to expand capacity to satisfy demand. The use of scarce resources to expand capacity will not only waste scarce resources and lead to a contraction of economic activities in other sectors - it will also lead to environmental degradation because nature will have to bedestroyed or at least modified to build new dams or to extract water from the ground.

Damming a river to create a reservoir causes an essentially permanent loss of alternative uses of the flooded valley. A flooded valley may endanger aquatic life and cause local inhabitants to lose their jobs and livelihood. This economic cost must be considered when deciding on the financial feasibility of a water development project. The overextraction of groundwater leads to aquifer depletion, pollution, salinization, alkalization plus land subsidence and the general lowering of the water table. In the long run groundwater sources may become badly depleted with little potential for artificial recharge of aquifers, especially if surface water resources are polluted or there is a shortage of surface water. It is estimated that irrigation-related soil salinity alone is the cause of damage to over 60 million hectares or about a quarter of all irrigated land in the world (Repetto,1986). More efficient use of water will thus result in increased output and environmental conservation.

Ideally, then, prices should include an estimate of the likely adverse environmental effects of water resources development. In some countries, the costs associated with environmental protection is already passed on to consumers. For example in Manila, a 60% surcharge is imposed on the combined water and sewage tariff for environmental depletion and damage (Munasinghe, 1992, p.275). This is the estimated cost of mitigating adverse environmental impacts. In Phoenix and Scottsdale in Arizona, for example, a separate line-item charge for the recovery of certain environmental compliance costs is included in the monthly water bills. This is a means of letting consumers know the economic effects of meeting new regulatory requirements (Duke and Montoya, 1994, p.22).

The efficient pricing of water may be objected to on equity grounds. The argument has been made that water may not be affordable to the poor. To get around this problem some countries, for example Chile, have subsidized the cost of supply to poor households (Rosegrant and Schleyer, 1994). This will ensure cost recovery as long as the subsidy comes out of the State budget and is paid to the utility company. In some self-financing water schemes in Malaysia, the utilities have subsidized supply to the poor and taxed supply to the rich (sivalingam and Vincent, 1993). In this way not only is water conserved but the scheme itself is sustainable.

II EFFECT OF PRICING ON CONSUMPTION

Many countries that did not price water found that pricing water did reduce consumption by households. In a study of the USA in 1982, Flack found that with metering water consumption fell by up to 30%. In another study in Rangoon, Burma, Metcalf and Eddy found that when water meters were first introduced, there was a reduction of 30% in consumption.

Water was conserved after metering because consumers were forced to compare the costs and benefits of using water. If the next unit of water that they plan to consume does not bring them benefits equal to the cost of consuming the next unit of water, then they do not have any financial incentive to consume that next unit of water. In other words, consumption would stop at the point where the marginal cost of consuming the next unit of water equaled the marginal benefit of consuming that unit of water.

However, metering does not automatically produce results. It must be introduced in conjunction with promotional campaigns, public education and community participation. Otherwise the meters may be immobilized, tampered with or even destroyed. In the Rangoon study, for example, it was found that after 15 years, 90% of the meters were not functioning properly. It should also be pointed out that meters are not cheap, especially if they have to be imported. Countries that are short of foreign exchange may find it an expensive option for conserving water. Countries should carefully consider the costs and benefits before introducing meters. In most cases, however, the evidence seems to indicate that the benefits from water and environmental conservation exceed the cost of metering (Sims, 1978).

III OBJECTIVES OF WATER PRICING

Water pricing, although beneficial, is complex because of the conflicting objectives of water pricing. A pricing scheme that reflects the true costs of supply may conflict with the equity goals of a society because, as stated earlier, the poor may not be able to afford the true cost of water supply. At the same time, if water is provided at a low price or for free, it may lead to unsustainable levels of consumption, environmental damage and a misallocation of scarce resources. A water pricing scheme, therefore, has to reconcile conflicting objectives before it is acceptable to society. However, before we describe the various water pricing schemes and their relative usefulness, it may first be appropriate to state explicitly the various objectives of water pricing.

The main objectives of water pricing are: (i) to facilitate the efficient allocation of water resources; (ii) to ensure a fair and equitable distribution of water resources; (iii) to promote conservation of water and the environment; (iv) to recover the full costs of supply; and (v) to generate revenue by implementing a simple tariff structure.

(i) The efficient allocation of water resources

Water can be allocated efficiently among various users only if prices reflect the true economic costs of producing water. In other words, water will flow to those who value it most if it is priced to reflect its true cost to society.

(ii) Equitable allocation of water resources

If water flows to those who value it most then the scarcity price charged may not be affordable to the poor. Those who cannot afford to pay will, therefore, be without water. This is socially inequitable and unacceptable. To get around this problem, the minimum basic water needs of the poor are priced low or subsidized so that water is affordable to the poor.

(iii) conservation of water resources and the environment

If water is priced to reflect its true economic and environmental cost then water will be used more efficiently and conserved. This will result in a more sustainalbe level of water consumption and less environmental damage. Society can also postpone the construction of capital intensive dams.

(iv) Cost recovery

Water should be priced to reflect its true cost to enable water authorities to raise sufficient revenue to meet the financial needs of the sector and to promote sustainable development. Water resources development is not financially sustainable if there are insufficient funds to meet the increasing demand for water.

(v) Simple tariff structure

A simple tariff structure that is easily understood by the staff of water authorities and consumers will facilitate easy metering and billing. Customers will be able to calculate their monthly water bills with ease and hence realise the cost of using water. This may lead to reduced consumption because customers are able to understand the relationship between cost and volume of usage and compare the costs and benefits of consuming additional units of water.

It is obvious that the only serious conflict between the various objectives is between the efficiency and equity objectives of pricing water. The other objectives are not in conflict. The challenge then is to devise a system of water pricing that will accommodate these conflicting objectives. Of the various methods of pricing it has long been argued by economists that the Long Run Marginal (LRMC) cost pricing rule, incorporating modifications to it, will best be able to accommodate the conflicting objectives of water pricing. However, before we discuss the merits and demerits of the LRMC pricing rule, we shall briefly describe the various approaches to pricing water.

IV APPROACHES TO PRICING WATER

There are basically three approaches to pricing water. They are (i) the traditional bureaucratic approach, (ii) the accountant's approach; and (iii) the economist's approach.

(i) The traditional bureaucratic approach

Using this approach water prices are set arbitrarily. Prices are seldom based on accurate cost data because no attempt is made to collect or estimate this data. The water allocation problem is not an economic problem but a political and administrative problem. As a consequence water is provided to the upper and middle classes of society at heavily subsidized prices. The poor are usually denied access to water on the grounds that the Government does not have sufficient funds. No effort is made to ascertain whether the poor are willing to pay the full cost of recovery.

(ii) The accountant's approach

The accountant bases his decision on historical data because he has records of the cost of water supply. His task is to price water to raise sufficient revenue to meet operating expenses and debt servicing requirements. He also makes a provision for depreciation to cover capital requirements for future expansion. However, his cost figures are historical costs obtained from ledger books. These book values do not reflect present or future market values. If the cost of water capacity expansion remains stable into the future then the accountant's provision for depreciation is sufficient to meet the cost of future capacity expansion. If, however, the cost of capacity expansion rises then the accountant's provision for depreciation may not be sufficient to finance capacity expansion. It should be mentioned that there are very few areas in the world where the cost of water supply is not rising all the time.

(iii) The economist's approach

The economist's approach is based on future costs and market values and not on historical costs and book values. The economist's focus on future costs and future market values is appropriate because supply costs tend to rise over time and space, especially as we move from urban to rural areas. Supply costs in the rural areas are much higher because of higher transaction and transportation costs. Future costs also tend to increase because of the dwindling availability of low cost water resources. If the cost of capacity expansion is everywhere rising then the cost of producing the next unit of water would be higher than the cost of producing the previous unit of water. To recover costs, prices should reflect the marginal cost of producing an additional unit of water. If, for example, 20 units of water are produced for a total of 20 dollars and the twenty-first unit is produced at US1.10, then under the marginal cost pricing rule, the price of the twenty-first unit of water should be US1.10. The average cost would be US$1.0048 but using the average cost for the twenty first unit of water, the utility would not be able to recover the marginal cost of producing that unit of water. Under the marginal cost pricing rule the price of each additional unit of water is set equal to the incremental or marginal cost of producing that additional unit of water. In this way the full cost of producing each additional unit of water can be recovered to promote sustainable development.

V THE MARGINAL COST PRICING RULE

There are two types of marginal costs that are usually calculated, that is, the short run marginal cost (SRMC) and the long run marginal cost (LRMC). The SRMC assumes that existing capital costs are sunk costs. In other words, the capital costs of the storage dams, treatment plants and distribution pipes are all sunk costs because their opportunity costs are zero. If they are not used for supplying water, there is little that can be done with them in the short run. It is assumed that in the short run that there is excess capacity and therefore there is no need to expand storage or build new storage to supply the next unit of water that is demanded by the consumer. All that is needed to produce the incremental unit of water that is demanded are chemicals, energy and labour. No capital costs need be incurred in the short run because it is assumed that there is excess capacity. The marginal cost of producing an additional unit of water is then the cost of the marginal units of labour, chemicals and energy used to produce the marginal unit of water. The price that is set equal to the SRMC will then recover all costs of producing the marginal unit of water.

Under the LRMC pricing rule, the story is a bit different because it is assumed that in the long run (10-15 years), existing capacity will not be able to meet incremental demand. New capacity will have to be built and hence capital costs will be incurred. These new investments in dams, plants and pipes are avoidable because they have not been incurred. If they are not incurred then they can be used to produce other goods and services and so building them has have an opportunity cost. So the LRMC is calculated by taking into account future opportunity costs of capital and other inputs used to expand capacity and to operate and maintain the expanded capacity.

To calculate the LRMC we need to know all annual incremental (additional) capital investments in plant and the distribution network; the annual incremental operating and maintenance costs and the annual incremental environmental depletion and damage costs, plus the annual incremental amount of water produced over the long run, that is, the next 15 years. The next step is to discount the incremental costs (that is, capital, operating and maintenance and environmental costs) and the incremental benefits (that is incremental water produced). The discount rate chosen will be the opportunity cost of capital to the water authority. If we divide the sum of the discounted incremental costs of supply by the-sum of the incremental quantity of water produced we will obtain the Average Incremental Cost (AIC) of supplying the average incremental unit of water. The AIC is a close approximation of the LRMC. If the water rate is set equal to the AIC, there will be full recovery of the cost of capacity expansion.

By focussing on the incremental cost of future capacity expansion, the LRMC provides a more realistic estimate of future financing requirements than other pricing rules. Also if the AIC is used to price water, the authority may be able to generate sufficient revenue to expand capacity and promote sustainable development into the future because discounted future costs and benefits play a prominent role in the calculation of the AIC and the LRMC. The LRMC also promotes the efficient allocation of resources because it takes into consideration the opportunity cost or shadow price of capital, labour and other inputs.

There may be objections to using the LRMC pricing rule because the LRMC of producing the last unit of water may be much higher than the LRMC of producing smaller quantities of water. In other words, there are objections to using the LRMC of producing the last unit of water as the price of all water produced before the last unit. This is because the LRMC may generate supra normal profits to the water authority as the unit cost of supplying less is less than the unit cost of supplying more. To limit the profits of the water authority, the government can introduce block rate pricing. Under block rate pricing, the price to be charged will be equated to the LRMC of each block of supply.

For example, if the LRMC of supplying Block A is less than the LRMC of supplying Block B, then the price of Block A would be set less than the price of Block B. If the price of Block A is set equal to the LRMC of supplying Block B, then the water authority will make supra normal profits. Limiting the profits of regulated utilities is in fact one of the chief motivations for block rate pricing in developed countries (Tietenberg, 1988, p.205). The ADB in recommending block rate pricing argues that "both equity and efficiency objectives could be served by progressive water charges that reflect long run supply costs." (ADB:1991, p.257).

While it has been suggested that using the strict efficiency or LRMC criteria to price water promotes conservation because users will adjust their consumption of water to the point where the marginal cost of using an additional unit of water will equal the marginal benefit of using that same additional unit of water, it should be pointed out that the LRMC criteria may not be socially or politically acceptable because the poor may not be able to afford prices that are set equal to the LRMC of supplying water. In other words, although the LRMC pricing rule may be efficient it is not equitable. However, instead of rejecting the LRMC criteria outright it can be modified to make it more politically and socially equitable and acceptable.

VI MODIFICATIONS TO THE LONG RUN MARGINAL COST (LRMC) PRICING RULE

If prices are set equal to the LRMC of supplying each successive block of water, then water authorities will have sufficient funds to reinvest in the system and expand capacity to meet any increases in demand in the future. This will ensure sustainable development especially if the LRMC includes the cost of environmental depletion and damage. However, in reality there may be public resistance against using the LRMC pricing rule because the price charged may be too high for the poor. While it is argued that the rich can pay the marginal cost, the poor may only be able to pay a fraction of the marginal cost. In fact, in some countries, for example Jordan, the Government provides free water to the nomadic population on the grounds that they are poor (Mohan M). Policy makers in Jordan also have strong reservations about market based decisions because of the economic and political importance of water in Jordan (Rosegrant and Schleyer, 1994, p.27).

Modifications of the LRMC pricing rule can easily be made to accommodate equity considerations. The water authority can charge below LRMC prices to the poor and above LRMC prices to the rich. This should work well as long as the total revenue collected after the modification is equal to the total revenue collected before the modification, that is, when all consumers are charged the price that is equal to the LRMC. This implies that after the modification the rich will pay a tax and the poor will receive a subsidy for consuming water. This crosssubsidisation works well to redistribute income in any society as long as there is a positive and significant correlation between water consumption and income, that is, the rich consume more water and the poor consume less water.

The rich tend to consume more water than the poor because they have larger houses, more taps, flush toilets, showers and they usually also have a lawn. The poor tend to use relatively smaller quantities of water because they usually use water for washing, cooking and cleaning only. So a water tariff can be designed to subsidise those who consume less and tax those who consume more.

Such a water tariff will be able to reconcile the conflict between the efficiency and equity objectives of water pricing. Before we recommend the appropriate water tariff, we will review the water tariffs that are widely used.

VII TYPES OF WATER TARIFFS

There are four broad different types of water tariffs. The water tariff chosen will have an important effect on how efficiently and equitably water is distributed and whether revenues collected will be sufficient to cover costs. The tariff chosen will also determine whether water is conserved or wasted. If water is conserved, the construction of capital intensive dams can be postponed and environmental degradation can be avoided. If the tariff generates sufficient revenues to recover full costs, then it may be possible for the government to utilize the revenues to finance sustainable water resources development. The four different types of most commonly used water tariffs are:

(a) the decreasing block tariff

(b) the uniform block tariff

(c) the increasing block tariff and

(d) the seasonal tariff

VIII THE DECREASING BLOCK TARIFF

The declining block tariff is designed to price water in blocks. The first block may be 0 to 20 cubic metres; the second block may be 21-40 cubic metres and the third block may be more than 40 cubic metres of water.

Under the decreasing block tariff system, the first block is priced higher than the second block and the second block is priced higher than the third block. Using this tariff, the consumer pays less per unit of water as he increases his consumption of water from the lowest block to the next highest one and so forth. In other words, the cost of water decreases as the volume of water consumed increases from one block to the next.

A. hypothetical example of a decreasing block tariff is:

BLOCK	CUBIC METRES OF WATER	RATE (CENTS PER CUBIC METRE)
A	0-20	100
B	21-40	80
C	41-60	60
D	61-80	40
E	81-100	20
F	> 100	10

As one moves from Block A to F, the rate progressively falls from 100 cents to 10 cents. In other words as a consumer uses enough water to enter a higher block, the unit price of water falls. Households, who normally use less water than industries, will pay more per unit of water consumed. The water authority will be able to recover costs only if the long run marginal cost of water is falling. This implies that there is economies of scale in the production of water, that is, as more is produced the unit cost of production declines.

Sometimes, the water authority charges a very high rate for the first block to recover capital or fixed costs. Thereafter, the rate can be reduced because variable costs are falling. If this pricing strategy is adopted it will be more inequitable to those who consume only up to the maximum of the first block.

It is quite obvious that the decreasing block tariff does not encourage conservation, because it rewards those who use more water with a price discount. The price schedule favours industries and irrigated farms more than households because industries and irrigated farms use more water. Also it does not promote the efficient use of water because it encourages wasteful consumption by giving price discounts for consuming more quantities of water.

The declining block tariff is in force in many states in the USA. However, as the need for conservation increases many states are moving away from decreasing block tariffs to uniform block tariffs or increasing block tariffs (Duke and Montoya, 1994). In many developing countries, the decreasing block tariff is not suitable because the LRMC is always rising and not falling.

IX THE UNIFORM BLOCK TARIFF

Under this system of pricing the unit cost of water consumed is constant regardless of the volume of water consumed. For example, if the first cubic metre of water is charged at 20 cents, then every subsequent cubic metre of water is charged at 20 cents. The water bill for a household consuming 20 cubic metres per month will be $4.00 and the water bill for an industrial enterprise consuming 200 cubic metres of water a month will be $40.00. The consumer is not penalized or rewarded for consuming less or more. In this sense it is more equitable than the declining block tariff. However, some may not consider the uniform block tariff to be equitable because the poor have to pay as much as the rich for every unit of water consumed.

Not only is the uniform block tariff more equitable than the declining block tariff but it is also more conservation oriented. This is because it is more expensive to consume additional blocks of water under the uniform block tariff than under the decreasing block tariff regime.

The uniform block tariff is popular with managers of water utilities because it is easy to implement and administer. For the consumers, it is easy to understand and to calculate their total monthly bill.

X THE INCREASING BLOCK TARIFF

Under the increasing block tariff schedule, the unit price of water increases as consumers enter higher consumption blocks. A hypothetical example of an increasing block tariff is as follows:

BLOCK	CUBIC METRES OF WATER	RATE (CENTS PER CUBIC METRE)
1	0-30	20
2	31-40	30
3	41-50	40
4	51-60	50
5	61-70	60
6	>70	70

The above example illustrates the case of a gradually increasing block tariff, which peaks at 70 cents. The utility can have a more steeply increasing block tariff depending on its objective in terms of promoting conservation of water supplies. The more steeply increasing block tariff provides more financial incentives to the consumer to conserve water.

In comparison to the uniform block tariff and the declining block tariff, the increasing block tariff is superior in terms of conserving water because it penalizes the consumer for moving up from one block to the next. In this way it promotes the efficient use of water because consumers who waste water risk paying a higher rate. The steeper the increasing block tariff the more efficiently will water be used.

Utilities usually adopt an increasing block tariff when the marginal cost of new supplies of water is always increasing as is typically the case in most developing countries. Each block of water is priced at the long run marginal cost of producing that block of water. Blocks of water that are produced at a lower cost are priced lower than blocks of water that are produced at a higher cost.

In this way the price of each block is matched with the long run marginal cost of producing that block to facilitate the effective recovery of full costs.

The increasing block tariff may also be designed to promote equity because the unit price of the lowest block may be set very low. It is usually assumed that only the first block of water will be consumed in poor households. Therefore, the upper limit of the first block should reflect accurately the maximum consumption per month of a typical poor household. The first block is usually subsidized because water is considered a basic necessity for survival or water is considered a social good. The rate charged for the first block is also known as the "life line" rate.

To recover the cost of supplying water at a subsidized rate to the poor, the Government may tax the rich and large consumers by pricing the higher blocks at more than the long run marginal cost of supplying the higher blocks of water. In our example, the unit price of Blocks 4,5 and 6 may be set above the long run marginal cost of supplying Blocks 4,5 and 6 to reflect a tax on consumption. The unit price of Block 1 may be set below the long run marginal cost of supplying Block 1 to reflect a subsidy to the poor. The unit price of Blocks 2 and 3 may be set equal to the marginal cost of supplying Blocks 2 and 3 of water. In this way the larger and richer consumers can be made to pay for the subsidy the utility provides the poor. Those consuming up to Blocks 2 and 3 will not pay a tax or receive a subsidy because they will pay the marginal cost or the true cost of supply.

An example of a country in which the increasing block tariff is used is Malaysia.

MALAYSIA

In Malaysia, most states charged a uniform rate of RM1.00 (US$0.40) per thousand gallons in the 1960s and the 1970s (Second Malaysia Plan, p220). The water tariff was not based on the LRMC pricing rule. The Government funded Federal Land Development Authority Schemes were provided with free water for seven years if they were planting rubber and for five years if they were planting oil palm. As a consequence, none of the water schemes were self-financing.

In the 1980s, the Government introduced increasing block tariffs because the capital, operating and maintenance costs of supply were increasing. The LRMC more than doubled between 1970 and 1980 because of inter-basin transfers within or between states and the dwindling of low cost water resources especially in the rural areas.

The increasing block tariff was designed so that the cost of water for poor households was set lower than other households and industry. This was done by setting the size of the lowest-priced block equal to a life-line quantum to be charged at a low rate to meet "the ability to pay" criterion for the low income group (sivalingam and Vincent, 1993). The rationale was that those who were able to pay more should pay more. The industries were charged a flat rate but the tariff for industrial users was set equal to twice the average for domestic users. In other words, industries were charged more than households and the more affluent households were charged more than the rural households.

In the 1980s it was estimated that the average consumption of poor families was below 20 cubic metres per month. The tariff for the first 20 cubic metres was adjusted so that poor households only spent up to a maximum of 4% of their monthly household income on water. A 4% ability to pay criteria is a rule of thumb often used by the World Bank (World Bank Water Demand Study Team, 1993).

However, using an increasing block tariff does not always ensure the financial viability of a scheme. In a study of 41 existing water schemes in Malaysia it was found that a third of the schemes were not self-financing. The lifetime of the 41 schemes was an average of 50 years. The discount rate chosen to reflect the shadow price of capital was 8%. The LRMC of each scheme was calculated using the AIC method (Sivalingam and Vincent, 1993).

The LRMC was compared to the weighted average tariff charged to domestic and industrial users. In one third of the schemes the weighted average tariff was less than the LRMC, indicating that the revenue collected was not sufficient to recover costs. It was also found that the schemes in two states., Penang and Sarawak, performed extremely well because they were decentralized and had financial autonomy. They were organized as Water Boards and Water authorities and not as government departments. However, because of increasing financial pressures other states in Malaysia are now insisting on selffinancing.

In a study of a new scheme in the state of Selangor, for example, it was found that the increasing block tariff was sufficient to recover costs. The increasing block tariff that is used is as follows;

WATER TARIFFS IN SELANGOR, MALAYSIA

(I) DOMESTIC

BLOCK	CUBIC METRES OF WATER	RATE (RM PERCUBIC METRE)
A	0-15	0.42
B	16-40	0.65
C	>40	1.05
(II) INDUSTRIAL	- uniform rate -	1.20
(III) GOVERNMENT	- uniform rate -	0.80

The weighted average tariff was found to be RM 0.66 per cubic metre and the LRMC was found to be RM 0.63 per cubic metre (Sivalingam and Vincent, 1993). In other words, the new scheme is more than self-financing. It is not clear whether the LRMC reflects environmental depletion and damage costs. If it does not then the LRMC may well be above the weighted average tariff.

It must be pointed out that more than one third of the existing 41 schemes were not self-financing-probably because of underpricing. That is, water was supplied at less than its true economic cost. This represents a misallocation of resources-especially when one considers that on the average the Government spends RM4.7 (US1.86) billion per scheme.

One of the reasons for underpricing is that an economic evaluation of rural extensions is not usually undertaken (ADB, 1986, p.36). The Government rural water supply scheme has been very costly because of individual connections at the household level. The decision makers did not make any attempt to match cost with willingness to pay. It may be that the more affluent rural households may have been willing to pay more than the government charged them for the water.

The underpricing of water is probably due to political pressure. However, it has had serious adverse consequences. For instance, it has led to the neglect of maintenance due to lack of funds. Underpricing created a vicious circle: low tariffs reduced revenues, which forced water supply agencies to skimp on maintenance. The reduced expenditure on maintenance caused leakages and meter underregistration to worsen, which reduced revenues even more.

It is estimated that the average Non-Revenue Water (NRW) rate in Malaysia is 45% (JKR and Bina Runding, 1989). This is because of old meters, meter underregistration, incomplete revenue collection, leaking pipes and fire fighting activities. It is estimated that 49% of the household meters are more than 5 years old and about 6% of them have stopped working. Incomplete revenue collection occurs because of personnel shortages, especially accountants and meter readers. There is also a reluctance to disconnect service to non-paying customers and some water authorities still use outmoded billing equipment.

If the NRW can be reduced then the average tariff needed to equal the LRMC of supply would be less.

XI SEASONAL TARIFFS

In some countries rates vary according to seasons. For example, during the summer season in the USA and Australia, rates may be set higher than during other seasons because more water is used during the summer than during other seasons. More water may be used to water the lawns and because of increased outdoor activities. The extra charge is justified on the grounds that it costs more to produce the incremental units of water. So to recover costs when marginal costs are rising, the tariff in summer is set higher (Duke and Montoya, 1994, p.20; Munasinghe, 1992, p.282). Similarly there are two tariffs in Chile, one for the dry season and the other for the normal season. The rates during the dry season are normally set higher because of the higher marginal cost of supply during the dry season (Rosegrant and Schleyer, 1994).

XII PRICING RURAL WATER SUPPLY

One common problem in all developing countries is that the urban water supply coverage ratio is much higher than the rural water supply coverage ratio. One reason for this disparity is that the LRMC of water supply to rural areas is much higher than to urban areas because of the relative remoteness of rural areas.

To avoid the cost of capital intensive dams it may be more appropriate to promote groundwater as a source of water supply in rural areas. The use of handpumps and wells with reticulation systems and multi-family standpipes, for example, may reduce the cost of supply. The lower supply costs may better match the poor rural households' valuation of water as indicated by their willingness to pay. The lower the cost of supply, the higher also the probability of cost recovery.

Several communities have been successfull in establishing their own water supply by forming their own water users, organizations and with some initial financial assistance from the government. Below we discuss two case studies, one from China and the other from Kenya, which provides support for the argument that community based water supply systems may promote sustainable water resources development in the long run.

(i) CHINA

In China villagers are responsible for providing their own water supply. Typically a village is expected to pay 90 to 100% of the capital cost of the system and full maintenance and operation cost. The 10% they do not pay comes from the State (Briscoe and de Ferranti, 1988).

The rural community plays a leadership role in initiating water projects, selecting the source, the system technology and service levels, that is, full house connection or one tap in each yard or public standpipes or public laundry and bathing facilities.

The villagers' plans are submitted to the County. The County helps in the design and purchase of materials. The County then submits the plans to the Provincial Government. The Provincial Government, in the past, provided limited financing but now it has set up its own revolving fund for financing rural water projects. The Central Government has only recently become active in offering guidance and in exceptional cases providing financial assistance.

The operations and maintenance costs are covered by water charges levied on members. The part-time village accountant keeps records of receipts, payments and inventories. The villagers are usually willing to pay the bulk of the cost in advance and take pride in maintaining the system. Sometimes, the fees collected are even able to cover some depreciation costs. Hence, the system is to some extent sustainable. If health conditions improve and agricultural productivity increases as a result of the availability of water, then the community may be able to mobilize funds to expand capacity in the long run.

(ii) KENYA

The Buguta/Makwasinyi community water and Sanitation Project is located in the Voi Division of the Taita-Tavette District in the southern part of Kenya. The project covers 12,000 people in 8 villages in an area of approximately 88 square kilometres. The main economic activity is subsistence farming. Most of the families are low income families (Marks, 1994).

As groundwater sources are poor, the women travel 6 to 20 kilometres a day to fetch water from the small springs in Kasigau Hills. The women's daily activities are: water collection, household work, farming and other income generating activities.

A project to improve water supply was initiated by women, who organized themselves into groups. Their main motivation was to improve the supply of water and hence the health of their families and increase the time and energy available for more rewarding income generating activities. They were able to seek financial assistance from the London based organization, Water Aid and technical assistance from the Kenya Water and Health Organization (KWAHO). They were able to establish a gravity water supply system with 35 kilometres of main and distribution water pipe lines, water storage tanks and water kiosks in each village. The initial capital cost was provided by Water Aid (London). Demonstration sanitary facilities were also built around each water kiosk. The water supply system was able to reach 10,000 people.

In each village, a Water Management Committee was set up to register volunteers, collect fees, appoint attendants and manage the system. The monthly membership fees cover the maintenance costs and salaries of kiosk attendants.

The attendants are trained to operate and manage the water supply system. They are also responsible for providing water to only those who show their membership card as proof of payment of membership fees.

The effect of the water supply project has been that the majority of the population has easy access to water and the women use the extra time available in more productive activities. The project is sustainable because user charges help cover operations and maintenance costs. Over time as incomes increase user charges may be able to cover the cost of capacity expansion and distribution pipes.

XIII PRICING IRRIGATION WATER

Irrigation is the largest user of water in many developing and developed countries. It is estimated that irrigation uses 80% of freshwater (Falkenmark, 1987). However, irrigation water is not priced in many countries. For example, farmers in Tamil Nadu, Punjab and Haryana do not pay anything for irrigation water although the value of water to them is high.

If irrigation water is not priced then the scarcity value of water is not known to the farmers and hence they will tend to overuse water. Water will also be wasted if more water is delivered per unit area than is required and if deliveries do not correspond in time to crop water requirements. it is estimated that the average irrigation system efficiency (ratio of water delivered to water used) is only 50%. (Falkenmark, 1987). In the long run, this will lead to a situation where the construction of new capital intensive dams will be necessary to manage increasing demands for wasteful consumption. However, the limits of capital intensive dam investments have been reached because of the fiscal crisis faced by many countries and even donors.

When water is not priced not only will farmers tend to overuse it but the overuse will lead to environmental degradation. There will be excessive drawdowns on the underground aquifers. The construction of unnecessary storage facilities will lead to flooding, which will have an adverse impact on aquatic development. Excessive irrigation will also tend to increasing nitrate, phosphate and pesticide contamination of aquifers. This will lead to increasing soil degradation through compaction and salinization (OECD, 1987).

It therefore appears that there are financial and environmental constraints to managing demand by building new dams. If new dams are not built and water is wasted and there are competing demands for water then the water available for irrigation will not be as plentiful as it used to be. At the same time, if there are increasing demands to increase agricultural productivity and output to feed the world, whose population is increasing, there will be pressure to use water more efficiently.

It appears then, that the world dilemma today is how to increase and sustain the productivity of irrigated agriculture while at the same time reducing the sector's water consumption. Producing more food with less water and at a lower financial and environmental cost is thus a major challenge for the twenty-first century (Lenton, 1994).

If the demand for water cannot be managed by building new dams, then the only alternative is to provide a financial incentive to farmers to use water efficiently by pricing it to reflect its scarcity value to society. If the true cost of supplying irrigation water can be recovered then future capacity can be expanded to promote sustainable irrigation and agricultural development.

However, most governments have had little success in fully recovering the cost of supplying irrigation water. For example, the Indian National Water Policy of 1987 was designed to levy user charges to recover the annual operating and maintenance costs and part of the capital costs of supplying irrigation water. The user charges levied by the Government were only able to recover 7.5% of the operating and maintenance costs in the 1988-1989 crop season (Swaroop, 1994, p.1915). In fact, before the 1987 policy, that is, during the 1980-81 crop season, the Government was able to recover 22% of the operating and maintenance costs.
The cost recovery rate fell because operating and maintenance costs went up but water rates were not revised upwards. The collection rate was also poor because the staff were inefficient. At the same time, the wage bill went up because of overstaffing. There was no excuse for keeping rates constant because, as Bhatia observed, even if irrigation charges are raised to cover 25% of capital costs and 100% of operating and maintenance costs, the value of water delivered to farmers would still far exceed what they must pay for it (Bhatia, 1989).

India is not the only country that has failed to recover the full costs of supply by irrigation pricing. In Pakistan, on average, only about 40-50% of the operating and maintenance costs of supplying irrigation water are recovered (Swaroop, 1994). It is estimated that to obtain full recovery of operating and maintenance costs, the water rates need to be doubled. The doubling of water rates would not be a burden to farmers because it would only account for less than 10% of farm income (Mulk and Mohadullah, 1992).

Besides India and Pakistan, the cost recovery rates in other countries are also disappointing. In Bangladesh, Mexico and Philippines, for example, the capital cost of supply is not recovered (Swaroop, 1994, p.1915). The cost recovery rate in Bangladesh is only 10-15% of operating and maintenance costs, whereas the cost recovery rate in Mexico and the Philippines is approximately 80% of the operating and maintenance costs of supply. In a survey of 17 World Bank financed projects it was found that on average, only about 30% of the total project costs were recovered and these exceeded operating and maintenance costs but fell far short of total costs. Water charges comprised only 17% of incremental farm income and hence a far smaller proportion of total farm income (Paul, 1975).

It appears that irrigation water is highly subsidized and no irrigation scheme has been designed to cover capital costs.

This is because farmers are a powerful political lobby and the subsidies have been justified on equity grounds and the need to attain self-sufficiency in food production. However, it appears that the equity argument is very weak because irrigation water subsidies go disproportionately to better off farmers (Repetto). There is also no economic justification for emphasizing 100% food self-sufficiency, if the country has no comparative advantage in producing a particular crop. Malaysia, for example, which for years had a policy of 100% rice self-sufficiency has recently reduced the ratio to 65% because it realizes it has no comparative advantage in producing rice and also because it wants its scarce resources to flow to their most valued uses (Sivalingam, 1993).

The total cost of supplying irrigation water is difficult to recover if the Long Run Marginal Cost Pricing (LRMC) rule or optimal departures from it are not used to price irrigation water. There are several reasons why the LRMC rule is not used to price irrigation water. These are: (i) there are millions of indirect beneficiaries of irrigation water. For example in the case of rice the indirect beneficiaries are consumers. Sometimes the price of rice is kept artificially low and hence consumers may benefit more than producers. In this case, it may be unfair for farmers to bear the full burden of the LRMC pricing of water; (ii) farmers may not be willing to be farmers if water is not free or if it is not heavily subsidized. In these circumstances society may have to suffer a famine if imports are not forthcoming; (iii) the value of water varies considerably across seasons, crops, regions and climates. If this is valid then we need a complex pricing system to reflect the true cost of water by seasons, crops, regions and climates. This complex pricing system may not be understood by farmers and administrators, who may conspire to not make it work. This will lead to wasteful use of water; (iv) volumetric pricing and complex pricing systems may involve large administrative costs and offset the gains from optimal pricing; (v) in some countries, farmers may genuinely believe that water is a gift of God and that man has no business making money out of it. They may resent and resist pricing systems on religious grounds; and (vi) low water prices have already been capitalised into land prices and so some farmers would stand to lose a lot as a result of water price increases, which are desirable on efficiency grounds (OECD, 1987).

It appears that prices are determined by economic, social and political forces. Some countries charge a low flat rate per acre or per season or per year. These are administrative or political prices that do not reflect the scarcity value of water and do not lead to the recovery of, at least, most of the operating and maintenance costs of supplying irrigation water.

If a country is unable to use LRMC to set prices then at least it can recover most of its operating and maintenance costs by encouraging community based irrigation systems that rely on Water Users' Organisations to collect user charges from members.

XIV COMMUNITY BASED IRRIGATION PRICING

The experience of several countries has shown that with community based irrigation systems, the potential for cost recovery is enhanced. Below we discuss two cases of community based irrigation pricing schemes, one in the Philippines and the other in Mexico, which have been able to recover most of their operating and maintenance costs.

(i) The Philippines

The farmers are members of Irrigation Associations. As part of the Irrigation Association, they are responsible for maintaining water systems and collecting irrigation service fees. The leaders of the Irrigation Association are also responsible for coordinating the activities of the government irrigation bureaucracy with that of the farmers. The close cooperation between the farmers and the bureaucracy will help to improve the accountability of irrigation managers to farmers. Water will also be conserved because farmers realise that they have to pay for the operating and maintenance costs of the water system. They will work to ensure that the overall performance of the irrigation system is improved because they are in a sense also stakeholders.

With their effective participation in controlling the irrigation distribution system, the farmers' willingness to pay also increases because: (i) the farmers can control water distribution to other farms and their own farms. When the system was under the government bureaucracy those farms closer to the source were overusing the water and than those far away from the source who had to dig for groundwater; (ii) the risk of supply shortages at critical growing periods is reduced. When the system was operated by the government bureaucracy there was no concern for the timely delivery of water and very little effort was made to plan for shortages. According to the Asian Development Bank (ADB) and the International Irrigation Management Institute (IIMI), farmers are able and willing to pay if water supply is dependable, timely and adequate (ADB and IIMI, 1986).

As noted earlier the cost recovery rate in communal systems in the Philippines is about 80% of the operating and maintenance costs of supply.

(ii) Mexico

With decentralization and the reduced role of the government, the operating and maintenance functions of irrigation systems were transferred to Water Users' Organizations. As a result the water fees collected from farmers as a percentage of operating and maintenance costs increased from 18% in 1988 to 83% in 1993. (Swaroop, 1992,p.1915).

It should be noted that community based irrigation pricing is gaining popularity. In Indonesia, for example, farmers are required to pay the Water Association user fees. The objective of the irrigation service fee is to recover at least 50% of operating and maintenance costs of the irrigation system. As a result of increased farmer participation cost recovery is much higher than it used to be (Varley,R., 1989).

South Korea has also successfully implemented an innovative farmers' participatory program to operate and maintain new irrigation projects. The objective of the participatory program is to increase recovery of operating and maintenance costs (Easter and Welch, 1983; ADB and IIMI, 1986).

It therefore appears that a community based organization, for example, a Water Users Association, may be more effective than a government bureaucracy in recovering the costs of irrigation water. Therefore, if farmers are involved in the decisionmaking process on how to allocate costs, the probability they will pay user charges may be higher. In paying user charges, they will realise the scarcity value of water and conserve water more than those farmers who receive the water free.

Another way of bringing home the point that water has a scarcity value is to develop markets in water. If a farmer is able to sell the excess water he gets free to another farmer or another household or to industry, he will gain because his income will increase. By fetching a price for his water he will come to realise its scarcity value and the opportunity cost of water to him. He will thus tend not to waste it. He will in fact save it to increase his income. However, before he can sell it there must be a well functioning competitive market for trading water. We now turn to consider how water markets can be established.

XV WATER MARKETS

Water markets have the potential of improving the efficiency of water allocation, equity and sustainability of water use. This is because once water can be bought and sold it will go to those who are willing to pay the most for it, or to those who value it the most. In this way the marginal cost and marginal benefit of water use will be equated. Equity will be improved if a small farmer sells to a large farmer or a farmer sells to industries because there will be some income redistribution. The water resource will be sustainable because it will be conserved because it has a monetary value.

It is not, however, easy to set up markets in water where they do not exist or in countries where water is perceived as a gift of God. However, in several developing countries, for example, Chile, India, Pakistan, Bangladesh and Nepal there are well functioning competitive water markets.

One of the oldest markets in water can be found in Spain where markets in irrigation water have functioned more or less continuously for the past 700 years. Irrigation shares are traded among farmers and all indications are that the system of trading water works more efficiently than those of other allocation systems, both in normal and draught conditions (Maas, 1986). In Nepal water shares are assigned in proportion to the financial participation of farmers in the construction and maintenance of the systems. In India, Pakistan and Bangladesh, tubewell water is widely sold by tubewell owners to neighbouring farmers (Repetto,1986, p.32).

Before irrigation water can be bought or sold, well defined private property rights in water must exist. The rights must be spelt out clearly. For example, a farmer has a certain percentage of the flow or can buy shares, which entitle him to a certain amount or percentage of available water.

The private property right must be for a continuous period of time so that it provides the owner with some security of tenure. The right must also be exclusive. In other words no two persons can own the private property right to the same water. The property right must be recorded in the official register so that it is formal and legal. The private property right must also be enforceable and trans-ferable. The law must also protect the private property right and the owner must be able to defend his property right for water in a court of law if it is challenged. The law and the courts must be seen to be fair and must be able to enforce property rights that have been obtained in a lawful manner.

For a competitive market to exist there must be many willing buyers and sellers and the real transaction costs of doing business must be zero or negligible. The cost of buying water is, however, seldom zero because the cost of information and conveying water is usually greater than zero. If transaction costs are too high, trading may be discouraged.

If there are well defined and non-attenuated property rights in water and there exist many willing buyers and sellers, and transaction, costs are low, then a market in property rights will exist. The buying and selling of water will, under such conditions, ensure that water will flow to those who value it most. (Coase, 1960). The market will, therefore, allocate water efficiently and wastage will be minimized. The buyers and sellers will also realise the opportunity cost of water because it has alternative uses and they can easily sell the water to increase their income.

The implementation of tradeable private property rights will also be more acceptable than volumetric pricing especially to farmers, who perceive that the water they receive is their traditional right. Volumetric pricing would be seen by farmers as expropriation of traditional water rights and may be violently resisted by some farmers. On the other hand, if the system assigns private property rights to water to them, they may perceive the system as being fair and just.

However, there may be some third party effects when water is bought and sold. Although the buyer and seller may benefit, others may suffer losses. For example, third parties might be affected by a change in water quality or a change in the return flow or a change in the ground water level as a result of the sale of water. Sometimes third parties may lose from the reduced return flow from the seller and other may gain from the increased return flow from the buyers. If there is some mechanism whereby losers may be compensated by gainers, then private property rights in water and water markets may be more politically and socially acceptable to society at large.

XVI CONCLUSION

Water is a scarce commodity and it should be priced so that it flows to its most valued users. If water is not priced then it will be wasted. If water is wasted and if population increases then more water will be demanded by households, industries and agriculture. To satisfy increasing demands in an environment where water is wasted, governments will have to build new capital intensive dams at costs they can ill afford. If the dams are built they may cause environmental degradation. The alternative to free water and environmental degradation is to give water a value by pricing so that water will be conserved and used efficiently.

However, it is not easy to design a pricing scheme that is both equitable and efficient. An increasing block tariff based on modifications to the long run marginal cost pricing rule may achieve both objectives of pricing, that is, the equity and efficiency objectives. However, an increasing block tariff based on the long run marginal cost of supply may be resisted by rural dwellers and farmers on equity grounds.

A more appropriate system of pricing rural household water supply and irrigation water is through community based water users, associations. This type of pricing has resulted in higher rates of recovery of operating and maintenance costs but the amounts recovered are not sufficient to cover capital costs. A community based pricing system is, however, better than a pricing system that is not even able to recover 1% of the operating and maintenance costs of the water system.

To enhance the value of water it may also be useful to develop competitive and fair markets in water. If a well functioning water market is established then water can be allocated more efficiently between households, industries and farms and the prices paid will more accurately reflect the scarcity value of water. If this happens then water will be conserved and the construction of capital intensive dams can be postponed. If prices are able to reflect the true cost of water then is more probable that water resources development will be selffinancing and environmentally sustainable.

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Additional Market and Economic Instruments to Achieve Freshwater Management Objectives

by

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Water is far from a simple commodity
Water's a sociological oddity
Water's a pasture for science to forage in.
Water's a link with a distant futurity
Water's a symbol of ritual purity
Water is politics, water's religion
Water is just about anyone's pigeon.
Water is frightening, water's endearing
Water is tragical, water is comical,
Water is far from the Pure Economical.
So studies of water, though free from aridity,
Are apt to produce a good deal of turbidity.
(Kenneth Boulding, 1964).

1.0 Introduction

The poem of Boulding is today more true than ever. It is realised more and more that water is 'far from a simple commodity'. One the one hand water is somewhat unique in that it simultaneously involves dimensions of public and private goods. On the other hand however, water is also an economic resource, albeit often taken for granted under conditions of abundance. The close association of water with religious practices, the enormous impacts of droughts on the socio-economic fabric of society, and the disastrous consequences of floods, have often led to a widespread public belief that water should be subject to a unique set of rules (ie. cannot be treated as purely an economic resource). Water was considered a necessity to life and this led to allocations of the water resources which reflected little of the true scarcity value of water to society.

The demands for water (in both the quantity and quality dimensions) and the services it provides will continue to grow. At the same time sources of new and alternative supplies are decreasing. In the developing areas of the world, population growth and economic development efforts suggest that domestic, industrial, and agricultural water demands will grow rapidly. In the developed countries, demands for environmental services provided by clean streams and lakes may grow more rapidly than the demand for withdrawal uses. In most areas, allocating water for one use - whether it is for irrigating crops or preserving instream

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flows - will involve tradeoffs. There is no free water. Water resources have become of increasing value, water management and water allocation of greater importance.

Management and allocation (or re-allocation) of water raises many questions. Or as stated in the World Development Report (1992):

> The allocation of water in all countries is a complex issue and is governed by legal and cultural traditions. Users typically have well-established rights. Reallocation is a contentious and ponderous process that generally responds to changes in demand only with long lags. Even though agricultural use of water has the lowest value per cubic meter, there is strong political opposition to diverting water from agriculture to other sectors. The result is that in many countries, industrial and developing alike, large volumes of water are used in irrigated agriculture, adding little economic value, while cities and industries, which would gladly pay more, cannot get enough." (WDR, 1992; p. 101).

It is however, not only the optimal allocation of water that is difficult to achieve when water scarcity increases, but also the management of water quality. Efficient and sustainable development and use must take into account the limits of and the ecological processes underlying natural water systems. Any use of water changes its quality (usually down), and all subsequent users are affected. A strong development bias combined with policies that foster an illusion of unlimited supplies of inexpensive fresh water can erode the productive, recreational, and aesthetic values of a nation's water resources by ignoring the water quality interdependencies that exist between different water uses (Howe, 1982). The consequences can be very large in terms of clean up costs, lost production, health effects etc, or as Feder and Le Moigne (1994) write:

> "Countries have generally paid too little attention to water quality and pollution control. Besides contributing to severe public health problems, poor water resource management causes widespread degradation of land and water. Many countries do not have standards to control water pollution adequately or the capacity to enforce existing legislation. Furthermore, new types of pollution - often stemming from public investment projects - have arisen involving small quantities of non-degradable chemicals that are invisible, toxic, persistent, and costly to treat." (Feder and Le Moigne, 1994: p. 26).

Water management therefore, can no longer ignore the need to limit use and to reallocate supplies over time in response to changing supply and demand conditions. In many countries, the underpricing of water for uses such as irrigation or waste disposal reduces the quantity and quality available to other uses. Also, locking water into particular uses regardless of the underlying supply and demand conditions becomes increasingly costly over time. Further, water use interdependencies are often not recognised by market processes or not adequately dealt with by management agencies. Water markets and efficient pricing policies deserve greater consideration in future water planning and management.

In this overview paper the role of economic approaches in the management of fresh water will be discussed.

2.0 Economic instruments

2.1 Introduction

Economic approaches to water management have as a goal the establishment of an economic interest in efficient environmental protection and rational use of resources. This goal involves, therefore, economic incentives in the use of water, to reduce quantity of use and degradation of quality. The theoretical advantages of economic approaches can be summarised as:

- they are more **cost-effective**. Effluent charges, at a suitable rate, or emissions trading, can minimise the total cost of pollution control.
- they can contribute to greater **efficiency** in the allocation of resources (eg. transferable resource rights) or pollution control (transferable permits).
- they offer a **permanent incentive** to reduce pollution for the period of time that a payment is made. They also lead to further encouragement for technical change through research and the development of non-polluting products or better and more effective processes of pollution control.
- they increase **flexibility**. For the authorities, it is easier to modify or adjust a charge than to modify legislation; for polluters, freedom of choice and adjustment is preserved.
- they provide a **source of finance**. In most cases, economic approaches play an important role in the collection of funds, which may or may not be used to fund pollution facilities or other environmental projects.

Economic approaches can come in the form of a financial transfer (tax, charge or subsidy), a modification of relative prices (taxation on certain products), or a clear specification of rights (transferable emission permits, or resource rights)[2]. All these instrument create financial incentives for user of water who, given these incentives, select the most advantageous solution such as for example, paying or reducing use or pollution, using water more efficiently or installing pollution control facilities. In other words, economic instruments (or approaches) are intended to modify behaviour through financial incentives and market forces.

With regard to water management we will distinguish two objectives, water quality management and water allocation.

When dealing with water quality management the aim is to reduce pollution and to internalise externalities. Taxes, penalties and defined liability make actions that pollute water less attractive than other alternatives. Alternatively tradeable permits have an implied opportunity cost. The right to use water remains with the individual, but the consequences change. Examples are:

- a specific tax on polluting action, such as in input tax. The general idea is to force those who may pollute to pay part of the environmental cost up front. Effect on input use is often unclear.
- a tax based on pollution reduction necessary to achieve a predefined standard.
- a market for tradeable discharge permits.

[2] There is a wide variety of terms used to discribe economic incentives. In Appendix 1, a summary of the types of tools is presented.

When dealing with water allocation, the aim is to ensure that water is guided to its highest value in use. In many countries, allocation is achieved by means of a regulatory regime. An alternative is to establish water markets using transferable water permits (rights). This is also done in some developed countries, and others are looking at it. The questions of applicability and relevance to the developed world will be discussed in this overview paper.

Before moving to a discussion of the tools, it is important to look at the specific situation most developed countries are in and think about conditions that are necessary when considering the implementation of market approaches.

2.2 Necessary conditions for the use of economic instruments in developing countries

Because developing countries are at a critical point in the management of natural resources, they have the opportunity to avoid costly mistakes often made in industrialised countries. They are however faced with specific problems in achieving this. The possibility of introducing economic instruments for environmental management is dependent on some necessary conditions (OECD, 1993a: p. 94; Hufschmidt, 1983:7), these are presented in the table below.

Condition	Key Characteristics	Specific Problems
Knowledge	Of how economic activity affects the environment Of how changes in the environment affect economic activity Of how to formulate and implement incentive programmes (regulatory agencies) Of how to respond appropriately to regulations (regulated communities)	Scarcity of financial resources Inadequacies of technical, economic and administrative expertise Inadequacies in environmental, economic and social data, including difficulties in data collection and processing.
Legal Structure	Ensure clear and enforceable property rights in resources Provide legal authority to use economic instruments	Inadequacies in monitoring and enforcement of existing environmental protection laws and regulations
Competitive Markets	Reasonable number of buyers and sellers Prices are responsive to changing conditions of resource scarcity	Widespread market failure Extensive poverty
Administrative capacity	Capacity to design and initiate incentive programmes Capacity to monitor compliance with programmes Capacity to enforce compliance	
Political feasibility	Capacity to overcome potential resistance to economic incentive programmes Responsiveness of stakeholders.	Wide diversity of cultural values Often perverse distributional effects of policies Minimal participation by general public, which reduces effectiveness of implementation

All of these conditions highlight problems that make successful implementation difficult. Many of these problems are shared by industrialised nations. The major difference, however, is the degree to which these problems occur in developing countries.

When considering the use of economic instruments or incentives, it needs to be remembered that such approaches cannot alone solve water quality issues. In most cases, incentive programmes should be seen as a complement to direct regulation for environmental quality improvement rather than substitutes for it. The cases to be mentioned below all demonstrate this. Direct regulation provides more control over pollution with less regard to costs, whereas economic incentives provide more predicability in terms of pollution control costs but less control over pollution levels (this mainly refers to taxation instruments).

3.0 Water Quality Management: Taxes and other Monetary Incentives

Emissions charges are fees imposed on the discharge of pollutants in the environment. These charges are designed to reduce the quantity or improve the quality of pollution by making polluters pay at least part of the costs of the harm to the environment (polluter-pays principle). Ideally, the charges are established to reflect the damages caused to humans or to the environment. This is difficult to do. The alternative is to impose a charge for every unit of pollution released into the environment. Reductions in pollution bring with them a reduction in tax or charge that a polluter must pay, hence a financial incentive. On the other hand, financial incentives can also be created by using subsidies (grants or tax incentives) for installing pollution control equipment. Primary options are charges (taxes or fees) on polluting inputs, fees on outputs, cross-compliance, and abatement subsidies. In what follows below taxes on polluting inputs and effluent charges will be discussed. Included in this discussion will also be the concept of abatement subsidies (although as a complement to an effluent charge programme). Finally this section will conclude with a brief comment about 'green taxes'.

It is important to distinguish between two situations, those of non-point source pollution and of point-source pollution. In the former, pollution occurs but it is very difficult (or sometimes impossible) to track down the specific sources from where the pollutants derive. In the latter, the sources can clearly be identified and monitored.

3.1 Taxes on polluting inputs (product charges). Non-point pollution situation.

Taxes on inputs and outputs that can cause pollution are called product charges. Examples are taxes on fertilisers, pesticides, lead in gasoline, batteries, plastic bags, beverage containers etc. In this discussion we will deal with applications that have relevance to water quality management.

Water quality is clearly affected by non-point source pollutants. For example agricultural inputs are, in several countries, a significant source of water quality problems. The non-point source nature of the pollution problem makes it very difficult to charge for example agricultural or forestry operators directly for the pollution they cause. Hence an alternative way is to charge them by levying the inputs that cause the pollution. The principle established here is, that the right to use fertilisers entails an obligation to help cope with the full consequences of the use. Economic theory specifies that the levy charged should bear some reflection of the social cost of fertiliser use, and if the levy is high enough, that the increased cost of that input will reduce application rates and hence pollution.

Examples of applications of this nature can be found in a variety of countries. For example Iowa has imposed a tax of 75 cents per ton on fertiliser, with proceeds used to fund quality monitoring and research on sustainable agriculture (Lawrence and Boggess, 1990). Sweden (and other Nordic countries) uses a fertiliser tax for a similar purpose (Kumm, 1990; Meister and Sharp, 1993).

Practical experience has been that:

a) the tax amounts are arbitrary and not defensible measures of the social cost of fertiliser use;
b) that the impact on use has been minimal and that the tax has been mainly a revenue raising instrument.

Examples.
In Sweden, incentive policies are used to reduce water pollution from agriculture. The policies are:
- Charges and taxes on fertilisers (charge is approximately 30% of the fertiliser prices)
- Extension service assistance to improve the handling of manure and to reduce the use of fertilisers.
- Subsidies for afforestation of arable land.

The tax is levied at the fertiliser production level and is collected every second month. Revenues from the tax are used, among other things, for research and extension services on environmental measures in agriculture. The tax has been in place since 1982 and has steadily increased. The fees have had only marginal importance in reducing water pollution, but they are important in financing the cost of exporting surplus grain and paying for research and extension services (Kumm, 1990).

The Swedish experience is identical to the ones in Norway, Finland, and Denmark. The fact that the impact on water quality has only been marginal has now caused a major change in approach in countries such as Denmark and the Netherlands. In these two countries a mineral bookkeeping system and a tax on surplus minerals has been introduced. Research in both countries has shown that mineral accounting at the farm (even paddock) level is feasible and that it also serves as an extension tool. Farmers are now required to keep track of applications of minerals to their land and taking into consideration the uptake by plants, need to calculate on an annual basis the surplus applied. Any surplus will be taxed (Meister and Sharp, 1993)

This experience with input charges doesn't imply that this policy tool is of little use. The fact that farmers are not willing (or able) to change their ways does not show that such a tax is pointless - indeed, it could be a way of making sure that polluters pay the costs of cleaning polluted water. The main disadvantage of a input tax is that the tax is not linked to environmental damage in specific locations, and may also add unnecessarily to the cost burden of efficient and non-polluting producers.

Implementation has been at the input production level, not the farmer level. The reason for doing this is that targeting the tax at the end use level could entail significant administrative and enforcement costs. In contrast a blunt instruments - such as a tax on all production of the fertiliser - is easier, thus less costly, to administer. However, such blunt intervention would reduce use of fertilisers in those applications for which there are more substitutes rather than in those applications for which risks of human or environmental exposure are greatest (Macauley and Palmer, 1992).

To use input charges (taxes) as the only policy to achieve a decrease in non-point source pollution is difficult for the following reasons:

a. the charge has the be very high (100% or more of the base price) to achieve a significant reduction in fertiliser use (this is base on a price elasticity of -0.3);
b. the linkage between use and pollution is not a direct and clear one;
c. the charge also affects those farmers who don't overfertilise.

3.2. Relevance to developing countries

There is no doubt that inputs such as fertilisers and pesticides, especially in agriculture, do cause major water quality problems in the developing world. The continued increase in the use of fertiliser and pesticides points to a greater possibility of water quality decreases. A tax on the polluting inputs would therefore give the right signal to the users of these inputs. However, in many developing countries these inputs are often subsidised, and so the first step in implementing a pricing policy (which a charge is) would be to remove subsidies. Subsidies do not in most cases benefit the poorer farmers who are thought to need them the most.

While implementation of an input charge would be simple, it only requires tax gathering at say the production of wholesale level and no monitoring of use is required, most governments however, are reluctant to impose taxes/charges which might undermine the competitiveness of industries and agriculture.

3.2 Effluent Charge on Polluting Inputs. Point-source Pollution Case

Most of the West European countries have in place a water effluent emissions charge. One of the most successful of these is the Dutch program. The Dutch effluent charge implementation, and its success, hold several lessons for anyone considering a similar approach.

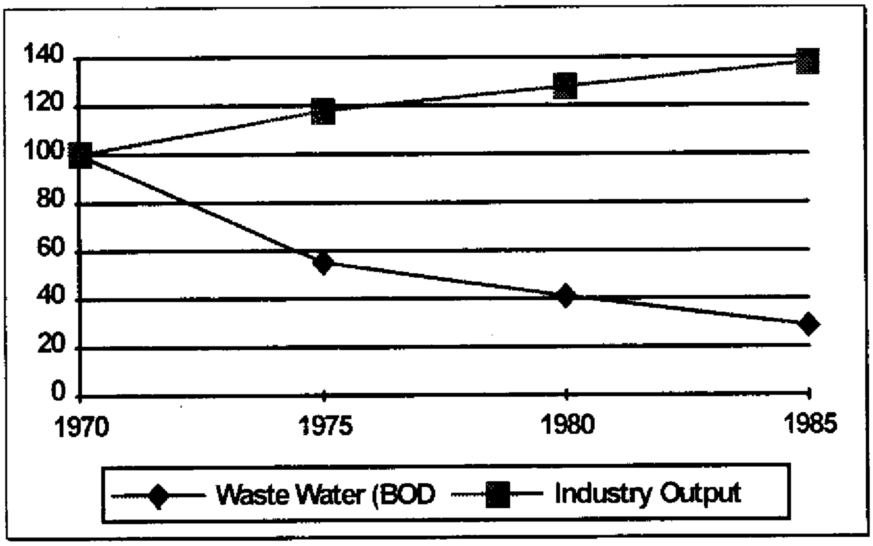
When water quality in Dutch waterways dropped to disastrously low level, it was realised that water quality management required more than a regulatory regime and an effluent charge was introduced. The charge was sold as a financing charge to raise revenue for the construction of sewers and treatment facilities (Meister, 1991).

The implementation of the charge clearly reflects the polluter pays principle, as adopted by the Dutch government. Not only is industry charged for its effect on water quality, but so are all others who directly or indirectly affect water quality, including households.

The charge is based on a formula which takes into consideration the Biological Oxygen Demand (BOD) imposed by the effluent, and the quantities of nitrogen (N), phosphate (P), and heavy metals in the effluent. A formula translates this into a population equivalent (p.e.) measure and firms are charged so much per p.e. per year. In 1993, the charge was approximately $US 50/year, and every household in Holland had to pay for 3 p.e's.

The revenue obtained from the charge is, as discussed above, used for the financing of pollution facilities which clean up the waterways. However, in the early days of the programme some of this money was also available as a subsidy for firms to improve their own effluent treatment facilities. This demonstrates the options under the polluter pays principle to either have the Government clean up the water or to subsidise the polluters to clean up effluent themselves. These subsidies are not in conflict with the polluter pays principle as they are paid out of the effluent charge. From the start, firms were made aware that these subsidies would only be available for a short period of time (approximately 15 years) after which it would be removed.

The results of the implementation of the subsidies were quite spectacular. The graph below shows the decoupling of waster production per unit of output (Meister and Sharp, 1993).



This effluent charge has been thoroughly analysed as to the reasons for its success. Very similar schemes had been put in place at the same time in countries such as France, Germany, and Denmark. None, however, achieved the success of the Dutch scheme (Meister, 1991).

Some of the major reasons for the success of the charge scheme are:

1. The Dutch had in place an institutional structure of regional water boards which were respected local agencies with a long tradition of effective water basin management. These board were neither traditional public utilities, nor private entities; they were a hybrid and included local representation.

2. The equitable implementation of the charge and the fact that it was not sold as a tax to pay for a resource, but rather as a device to finance water quality improvement, enhanced its general acceptance. There was a strict adherence to the polluter pays principle and all revenues were used to improve water quality; none were transferred to the Government's consolidated funds.

3. The package of charges and subsidies helped to gain the acceptance of industry.

4. Implementation was practical in that households and small enterprises were charged on the basis of a fixed charge (3 p.e's for households) based on a table of enterprise representative pollution units.

5. Monitoring was relatively straightforward. The majority of water pollution came from industry and could therefore be identified and monitored.

6. The relationship between taxed effluent on the one hand, and environmental harm on the other, was relatively clear and simple, and could be captured by measures such as BOD, N, P, and heavy metals. Also from the general public's point of view there was a relationship between charges and visible effects.

When some of the above factors are missing (as they were in other countries or with applications of effluent charges to different emissions), the outcome of the policy was often much less successful, and in many cases failed to achieve the environmental goals.

3.3 Evaluation of the Tax instrument

Effectiveness. Taxes (fees, or charges) are a specific price for emissions but usually leave considerable uncertainty about the amount of emission reduction that will be achieved. However, in many cases emission charges are not set sufficiently high to motivate polluters to reduce their emissions. Consequently, polluters simply pay the charge and do not reduce emissions. Under such circumstances the amount of emission reduction is quite predicably zero.

If the tax is high enough (the Dutch example) significant reductions can be achieved. Also in the Dutch situation, the governing authorities didn't have a firm idea of how firm's would react to the charge. The initial response to the charge was greater than expected. In the early years of the scheme more money was collected than was necessary for the State to build pollution control facilities, for the simple reason that the amount of effluent discharge had reduced at a rate faster than expected.

The uncertainty aspect of this policy approach becomes very important when dealing with health effects or hazardous wastes. Here uncertainty may be too costly and alternative policy approaches (such as marketable permits) would be the preferable approach.

Efficiency. Efficiency is desirable in that it implies that objectives are achieved at the lowest possible cost. Taxation does require monitoring and enforcement. An ideal situation would be where there is self-monitoring and peer pressure. Depending on the characteristics and source of the pollution, the efficiency of taxes versus marketable permits and command and control policies, can vary significantly. However, few situations exist where environmental taxes have replaced other tools (they have been implemented as complements to other tools) and therefore a comparison of cost efficiency cannot be made.

Equity. Economic incentives have implications for equity, which involves the distribution of economic and environmental costs and benefits among members of society. The difference is very clear between taxes and subsidies, but also between marketable permits (depending on how the permits have been allocated) and taxes. Equity requires that cost burdens imposed by economic instruments be considered carefully. The direct burden on the polluting community is often associated with changes in profits and with industry-wide competitiveness, both domestically and internationally (OECD,1993a). Equity considerations (and especially also international competitiveness) have stopped many countries from introducing taxes.

The **trade effect** was analysed for the Dutch water charge by Verbruggen (1993) and these were the conclusions:
"...no substantial effects on economic performance and competitiveness resulted from the charge. Several reasons might explain this.
First, charges have been introduced and were raised gradually, leaving industry enough time to anticipate.
Second, the charge burden on firms is, on average, less than 2 per cent and most often less than 1 per cent of their production value.
Third, the burden on industry is diminishing: increases in the charges are offset by reductions in the discharges of pollution equivalents. Apparently there have been sufficient economically viable options available to reduce polluting discharge, either by changing production processes or by installing purification equipment.
Finally, similar charge systems have been introduced by neighbouring countries, e.g. Netherland's major trading partners - Germany and France." (Verbruggen, 1993:59)

Flexibility. Economic instruments should be adaptable to changes in markets, technology, knowledge and social, political, and environmental conditions (OECD, 1993a)

3.5 The move to "green taxes'

In a number of countries environmental and tax policies and practices are becoming more and more integrated. New environmental taxes should, as far as possible be in accordance with other taxation objectives and the basic principles (eg. equity, neutrality, administrative efficiency) underlying modern tax systems. The idea behind 'green taxes' is that all forms of taxation imply excess burden on some kind and in an economy which needs to finance a state, optimal taxes on pollution are an excellent way of helping finance the state at a lower allocative cost than other forms of taxation. Or as Sterner (1993) writes "This would seem to be particularly relevant for many Third World countries where people are not likely to fill in detailed forms about their income and where most finance ministers are desperate to find anything to tax." (Sterner, 1993: 55). Other have written about this but in practice not much has been achieved in practice where environmental taxes have started to replace other forms of taxation. (OECD, 1993c; Weizsächer and Jesinghaus, 1992).

3.6. Conclusion

In most developing countries pollution is caused by a sizeable number of small and medium-sized firms (and many farms), which collectively contribute significantly to the water quality problem. Monitoring such a large number of often widely dispersed firms is a difficult task for regulators. In many cases regulators have to rely on ambient water quality checks, followed by tracking of pollution to source when critical levels are exceeded. Since, however the pollution is the cumulative effect of many firms' effluent, enforcement against a few firms may not be sufficient to address the problem unless penalties are so severe as to have a strong negative demonstration effect.

The introduction of an effluent charge would encounter the same monitoring problem as regulatory enforcement. In this case a tax on polluting inputs might serve as second-best policy, though the efficiency of such a tax would depend on whether the quantity of the input purchased is closely correlated with the volume of waste generated. Moreover, as seen in the example of the Nordic countries, the effectiveness of the tax clearly depends on the elasticity of the input demand response to higher prices and the level of the tax. The tax would provide an incentive and a signal. If the revenues could partly be used to encourage alternative practices, install pollution abatement facilities, and education, the income and cost effect could be small while still providing the right price signals.

In cases where industries are concentrated the possibility of common waste treatment facilities could be considered (such as industrial zones). The polluter-pays principle could be adhered to be charging contributors to the common facility a user-charge (trade waste charge) which would finance the facility. Where, however, we have a large number of widely dispersed firms the cost of achieving the above would be too high and an effluent charge approach, such as the Dutch example, may be feasible.

In all this it is important that pollution can clearly be measured and monitored. Ultimately we need to know what causes the decrease in water quality and therefore what needs to be charged. Further, different regions and different water bodies have varying capacities to deal with wastes and hence charges will vary between regions, or even zones along a river.

In conclusion, taxes for environmental policy still only play a small role in the developed world and are rare in the developing world. There is however, increased awareness of the importance to get incentives and signals right. As indicated earlier this may require, in the first instance, that subsidies (which are often perverse incentives) are removed. Beyond that, it is possible that in certain situations, environmental taxes can be usefully employed, as a complement to regulatory institutions, to enhance the effectiveness of those institutions.

4.0 Marketable Emission Permits

Tradeable emissions permits could be used for the disposal of effluent into waterways. A permit system would involve steps (OECD, 1993a: p. 93):

- the overall level of emissions is determined for an area (or part of a water body);
- permits to pollute are allocated to polluting firms in the area;
- firms that keep their emissions below their permitted level may sell or lease their surplus allocation;
- offsets: all new emission sources in the area are offset by a reduction of emissions from existing sources;
- bubbles: allow routine shifts in emission limits among existing plants if total emissions under the bubble do not increase;
- netting: allows changes in emissions from different sources within a plant or firm so long as there is no net change in emissions.

Trading in permits allows those producers who can reduce pollution at least cost to do so. Producers with relatively high costs of treating their effluent will gain by buying permits rather than treating their waste. Producers with relatively low abatement costs will treat their own waste and sell permits to those whose treatment costs are higher. The result is that the cost of meeting the standard is lower than if non-tradeable discharge limits are set for each producer.

The main issues involved in tradeable emissions permits are: the total number of permits to be issued, how the permits are issued, the monitoring of discharges and the establishment of rules for trading.

Referring back to the discussing about taxes, similar results could be achieved in principle (using a effluent tax rather than tradeable emissions permits) if a pollution tax was imposed at the rate which is equivalent to the price at which permits would trade. However, tradeable emission permits give certainty with regard to pollution control outcome while emission taxes don't.

Tradeable emissions permits and corrective taxes are most feasible where industries on a river are discharging similar pollutants, or where there is concern to control only one type of pollutant. However, most industries discharge a complex mix of pollutants. Defining permits which allow effective trading may therefore be difficult - discharges of any single pollutant may be insufficient to support a market in permits. One option is to attempt to define all pollutants in terms of a common standard (e.g. effects on biological oxygen demand).

A successful regime also requires adequate monitoring of discharges (although this is true of any system whereby discharges are controlled and charged for). Problems may arise where the points of discharge is not concentrated (e.g. in the case of run-off from farms). In that situation it can be difficult to identify the polluters and will require them to obtain a permit or pay a tax (as discussed above).

In comparison with charges, marketable permits have not received widespread use. Most of the experience with tradeable permits has been with the trading of emissions rights of various pollutants regulated under the Clean Air Act in the USA. However, there are also two examples in the water pollution area. The following analysis of the scheme is taken from Hahn, 1989.

Wisconsin Fox River Water Permits

> In 1981, the state of Wisconsin implemented an innovative program aimed at controlling biological oxygen demand (BOD) on a part of the Fox River (Novotny, 1986, p.11). The program was designed to allow for the limited trading of marketable discharge permits. The primary objective was to allow firms greater flexibility in abatement options while still maintaining environmental quality. The program is administered by the state of Wisconsin in accord with the Federal Water Pollution Control Act. Firms are issued five-year permits which define their wasteload allocation. This allocation defines the initial distribution of permits for each firm.
>
> Early studies estimated that substantial savings, on the order of $7 million per year, could result after implementing this trading system (O'Neil, 1983, p.22). However, actual cost savings have been minimal. In the six years that the program has been in existence, there has been only one trade. Given the initial fanfare about this system, its performance to date has been disappointing.
>
> A close look at the nature of the market and the rules for trading reveals that the result should not have been totally unexpected. The regulations are aimed at two types of dischargers: pulp and paper plants and municipal waste treatment plants. David and Joeres (1983) note that the pulp and paper plants have an oligopolistic structure, and thus may not behave as competitive firms in the permit market. Moreover, it is difficult to know how the municipal utilities will perform under this set of rules, since they are subject to public utility regulation (Hahn and Noll, 1983). Trading is also limited by location. There are two points on the river where pollution tends to peak, and firms are divided into "clusters" so that trading will

not increase BOD at either of these points. There are only about 6 or 7 firms in each cluster (Patterson, 1987). Consequently, markets for wasteload allocations may be quite thin.
In addition, Novotny (1986) has argued that several restrictions on transfers may have had a negative impact on potential trading. Any transaction between firms requires modifying or reissiuning permits. Transfers must be for at least a year; however, the life of the permit is only five years. Moreover, parties must waive any rights to the permit after it expires, and it is unclear how trading will affect the permit renewal process. These conditions create great uncertainty over the future value of the property right. Added to the problems created by these rules are the restrictions on eligibility for trades. Firms are required to justify the "need" for permits. This effectively limits transfers to new dischargers, plants which are expanding, and treatment plants that cannot meet the requirements, despite their best efforts. Trades that only reduce operating costs are not allowed. With all the uncertainty and high transactions costs, it is not surprising that trading has gotten off to a very slow start.
While the marketable permit system for the Fox River was being hailed as a success by economists, the paper mills did not enthusiastically support the idea (Novotny, 1986, p.15). Nor have the mills chosen to explore this option once it has been implemented. Indeed, by almost any measure, this limited permit trading represents a minor part of the regulatory structure. The mechanism builds on a large regulatory infrastructure where permits specifying treatment and operating rules lie at the center. The new marketable permits approach retains many features of the existing standards-based approach. The initial allocations are based on the status quo, calling for equal percentage reductions from specified limits. This "grandfathering" approach has a great deal of political appeal for existing firms. New firms must continue to meet more stringent requirements than old firms, and firms must meet specified technological standards before trading is allowed. (Hahn, 1989, p. 97-98)

The analysis by Hahn clearly shows some of the major issues associated with tradeable emissions permits. Although the instruments offers various advantages such as clear control of total emissions and least cost abatement, they also have various limitations. These limitations range from practical ones, such as the establishment of markets ("thin" markets, or market controlled by dominant players, or no market formation at all), to philosophical ones regarding how rights should be allocated ('grandfathered' or auctioned). Field (1994), adds to this that in this particular case the pulp mills can act as oligopolist, that the municipalities don't have to make decisions on a strict cost-minimisation basis, and that the original permits were too liberal. The latter led to the situation were the number of permits did not imply a significant reduction in BOD emissions beyond what could be obtained by standard and easily available control techniques (Field, 1994: 287).

A second example in the USA is the Dillon Reservoir trading programme (see below).

Dillon Reservoir (Field, 1994)
In 1984, Colorado implemented a program which would allow limited trading between point and non-point sources for controlling phosphorous loading in the Reservoir. The large impoundment is a major water source for Denver. In the early eighties it was recognised that phosphorous loadings in the reservoir were causing water-quality problems. While some of the phosphorous was of natural origin, about half was from human activity. Somewhat more than half of this was from non-point sources - urban run-off, golf courses, construction sites, septic tanks, etc. The rest was from four municipal waste treatment facilities. Researchers determined that point source control by itself would not be sufficient to avoid water-quality problems; even if municipal phosphorous emissions were reduced to zero, there would still be enough phosphorous to cause eutrophication in the reservoir. Besides the very high direct abatement costs it would require, this would severely constrain future population growth in the county, which in the 1970s was the fastest growing county in the country.

The answer has been to initiate a phosphorous trading program between point and non-point sources of phosphorous. The program allocated baseline phosphorous loads to different polluters and then allowed phosphorous emission permits to be traded. The intention is to allow point sources, especially the municipal treatment plants, to buy phosphorous emission permits from non-point source polluters whose marginal phosphorous abatement cost are lower. Those responsible for non-point-source emissions have a variety of means available to reduce their phosphorous loadings, such as sewering housing developments that are now using septic tanks, routing underground storm sewers through a series of storage tanks, and detention basins. Of course, the trading program requires that administrative authorities be able to monitor the non-point source emissions at reasonable cost. To date (1991) several trades have been made, under the management of the Summit Water Quality Committee, composed of representatives from towns in the region as well as other public agencies. If the full potential of trade is realised, it has been estimated that the trading program will allow the participants to solve the phophorous problem in the reservoir at a cost savings of more than $1 million a year. Similar point/nonpoint-source trading pograms have been initiated in the Cherry Creek reservoir of Colorado and the Tar-Pamlico basin in North Carolina. The idea is being explored in other regions. (Field, 1994:288-289)

In Australia a system of tradeable rights in salinity came in force in 1992 as part of the Murray Darling Basin Salinity and Drainage Strategy. The administering agency is the Murray Darling Basin Commission. The only participants permitted in the scheme are the States of New South Wales, Victoria and South Australia. Trades will be permitted in terms of salt concentrations, measured in EC (electrical conductivity) units. Or to quote James, 1993:

"By investing in capital works to manage salt entering the river system and enhance river flow, 'salt credits" can be generated. Credits are tradeable between States, but are generally applied within each State to offset debits from drainage entering the river system. New South Wales has a credit of 6.15 units; and Victoria a credit of 5.92 units. South Australia and the Commonwealth have also earned credits, but it is not contemplated that they will be used to offset debits. In South Australia salinity has been reduced by 50 EC units.

The salinity and drainage strategy is a limited form of tradeable pollution right. The rights are not freely traded by industries or individuals, but are exchanged between governments within a constrained strategic framework. Greater flexibility is intended to be introduced to the scheme within the next five years.

NSW is about to introduce its own system of tradeable salinity rights for all water users contributing saline drainage to the Murray Darling and for all water users diverting dilution flows from the Darling Basin. The rights will be issued by grandfathering. The total amount of rights initially will be 15 EC units as measured at Morgan on the River Murray at South Australia. The system is separate from the Salinity and Drainage Strategy. Only a small bundle of EC credits will be involved, and market interactions are not expected to be significant. (James, 1993: p. 22-23).

4.1. Summary and Evaluation

Marketable permits consist of quantity and /or quality permits on emissions and/or effluents. The mechanics are relatively simple. In principle, marketable permits should be effective in meeting environmental objectives, since the environmental tolerance is (or should be) built into the design of the system. They should also be economically efficient by leading to an equalisation of abatement costs by all polluters trading in the market.

Various provisions may be made by the control authority for tightening the total constraint, by reducing the allowable quotas when trade takes place, uniform cutbacks on a prescribed time schedule for all owners of rights, or buy-back by government entering the market.

For marketable permits to achieve environmental objectives effectively it is necessary that a market can be established and that sufficient trades will occur. One of the requirement for the establishment of a market is that there is a relatively large number of participants. If this is not possible we have a 'thin' market (or a thin market with a dominant player). Most water pollution problems are local, or a most regional, in nature. Thus the potential number of traders is likely to be too small for effective trading as some of the examples have demonstrated.

To maintain the market for tradeable permits there are transaction costs involved which need to be included in the overall consideration of establishing a tradeable permit market or not.

In some situations it is important to clearly define the boundaries of tradeability to avoid finishing up with environmental 'hot spots' with too many permits being congregated in a limited area. This means that free tradeability will only work when the location of the adverse effect is not important. It would not be appropriate, for instance, to allow a discharge on one stream to be doubled in exchange for eliminating another discharge on another stream in the same river catchment, if the impacts of the two discharges is not physically related.

Some of the more difficult questions associated with marketable permits is how to allocate the original permits. Different allocations have different equity implications. If permits are 'grandfathered', capital assets will be allocated to incumbents, and new entrants to the market will have to pay the price to obtain permits to discharge. If the permits are auctioned, a double investment outlay by dischargers may be required. The reason is that the formerly 'free' use of the assimilative capacity of the environment would have been capitalised in the initial investment value (purchase price) of the activity.

To date, the experience with marketable emissions permits in water management has been very limited. The main reasons being difficulty to define exactly what the permit should contain, thin markets, dominant players and defining conditions.

5.0 Water Allocation. Transferable Rights

The emphasis in this section is on the development of transferable or tradeable resource rights. Tradeable rights in water (and other resources) have been introduced in a number of countries.

The implementation of *transferable rights* in natural resources creates well-defined property rights where they were previously poorly defined or absent. Under the proper circumstances the externalities resulting from market failure can be internalised by assigning transferable rights. In the case of water, the transferable right may be the right to use a certain quantity of water from a specific source. This quantity could be absolute, as in a given quantity per day, or it could be proportional, as in some function of the level of streamflow. The overall level of water abstraction is determined by government (or local authority) through the number of rights it issues and determination of the availability of water each year.

The steps involved in setting up a tradeable rights system are similar to the ones given for marketable emission permits. Further the conditions for success given in section 2.2 are crucial, especially knowledge about the resource and the impact of trading of water.
The prerequisites for the development of an efficient market system in transferable water are (Howe et al. 1986, Simpson 1994):

1. **Clearly specified rights**:
   a. Water must be owned independently of land so that it is freely tradeable.
   b. The volume of water that an individual has available for transfer and any special conditions on its use must be clearly specified in legal stature. This ensures that both buyer and seller know unequivocally the volume of water available for transfer and use by the buyer, and any conditions attached to its use. The actual volume of water that any individual has available for transfer at any time, will of course, depend on the total supply in the water system. Thus, a clear specification of actual volumetric entitlements under a range of supply levels or conditions is needed. The rights must be easily measured in the field using practical methods easily understood by the user and ideally should be expressed in stochastic terms.
   c. Security of tenure is most important, so that the legal right exists to transfer water at a privately negotiated price as if it were a privately owned good.

2. **Greater demand than supply**. Demand is created by the product's desirability as well as its scarcity, which can come about through any limitations on supply (ie. location, timing, drought, or unusable water quality). Most successful water markets have developed in semiarid areas, where scarcity creates competing demands.

3. **Societal acceptance**. Society must accept the concept of the free transfer of water use rights through a market system, or the market will be doomed to excessive regulation and possible extinction. In some societies, where water is considered a gift from God, the idea of its use being traded as an article of commerce has yet to be accepted.

4. **A good administrative and regulatory structure**. A system of administration must be put in place to assure both the buyer and the seller that their respective rights will be honoured and enforced. This involves keeping an accurate registry of the rights and their ownership, as well as an accounting system that ensures that users receive the proportional share to which they are entitled.

5. **Sufficient mobility**. There must be either an adequate infrastructure to transport the water supplies to the buyer or the economic and technical ability to construct one.

6. **A fair and equitable initial allocation system**. Such a system must be implemented, recognising historical uses but not rewarding waste. This requires careful evaluation of the parameters of use. These parameters must include the consideration of societal needs such as environmental concerns, subsistence needs, and historical use, as well as reliability of the annually available water supplies. While the use of a public auction for initial allocation has been advocated by some, its use in actual practice has resulted in large blocks of water going to economically strong entities who have no reasonably foreseeable beneficial use (Simpson, 1994). This can result in monopolistic control over future development and use of the supplies.

7. **A fair reallocation system**. There must be an equitable system of transferring water rights that enables the reallocation of rights to different uses as needs change.

A system of transferable water rights is flexible in that it can adapt to scarcity. The system also has the potential to out-perform alternative allocation mechanisms provided that the tenure of the rights is secure, that owners face the opportunity cost of holding their water rights, and that compensation between willing buyers and willing sellers occurs (Meister and Sharp, 1993).

The **potential benefits** claimed for tradeable water rights are:

- establishment of an opportunity cost for water in different uses and locations and, within limits, getting water to be reallocated from lower valued to higher valued uses (or locations):
  "Water markets provide stakeholders with the ability to control decision making and the opportunity to derive financial benefits. This encourages an efficient use of the resources as owners are faced with the alternative of developing ways to use water more effectively in order to derive financial gain through the sale of the surplus. Owners can also profit from these gains to purchase the technology and assets necessary to improve efficiency. For example, a farmer might sell a part of his inefficiently used flood irrigation supply and, with the proceeds, buy a sprinkler system that allows more timely and complete irrigation with resultant increased in yield (Simpson, 1994: p.30).
- decentralised decision-making to decide how and where water should be used;
- encouragement of conservation or transfer when this is more economic than supply augmentation, thus preventing or deferring uneconomic investment;
- flexibility in terms of ongoing responses to changes in the value of use;
- reduction in the conflicts over allocation of water that are a feature of the current adversarial system (in many western countries). It also removes the possibility of political favouritism. A market system removes the responsibility of water allocation from the politicians and bureaucrats (the political arena) and places it with the owners of the water use rights.

Potential difficulties with transferable water permits are (Howe et al. 1986; Simpson, 1994):

- third-party effects that must be taken into account when deciding upon a transfer. This situation typically occurs when the transfer involves removing the supply from its basin of origin or drying up one area to provide a supply to a different area. Economic efficiency requires this. Moreover, it is not equitable for third-party effects to go uncompensated. The administrative mechanism guiding transfers must be able to identify and incorporate these effects.
- the extent of the market may make identification of willing buyers and willing sellers difficult.
- the allocation mechanism must account for the complete range of values attached to water.
- also, as mentioned by Pigram et al. (1992) there is the problem with the activation of 'sleeper' permits (allocated but unused water).

All these points raised above have played a significant role in the development of water markets in the Western United States and Australia. It is these countries that water market development has progressed most. However, this is not to say that we don't find water markets in other countries. Simpson 1994, mentions several countries which have moved or are contemplating moving in the direction of market based reallocation systems (Chile, Brazil, Mexico, Peru). Also, in some countries, informal water markets have existed for decades, despite the fact that they were not legally sanctioned (Algeria, India, Morocco, Pakistan and Tunisia).

For a fuller understanding of actual implementation of transferable water rights, we will now look at the developments in the USA and Australia.

5.1 Water Markets in the United States[3]

Water rights in the United States (US)[4] are considered to be property rights even though, unlike most property rights, they must be exercised to be maintained. The property possessed in a water right is not the water itself but the use of a certain flow or quantity of water from a particular source with a particular priority. In a study of six western states in the US, all the states allow the permanent transfer of ownership of appropriative water rights to occur without state supervision, in contrast to changes in purpose or place of use. (MacDonnell, 1990).

When considering water markets, one refers to the negotiated transfer of the right to use water, either on a short-term or long-term basis, between the holder of the right and the individual or entity desiring the use of the right. Such a transaction may take a variety of forms. The transfer may be permanent or short-term, and it may or may not involve a change in purpose and place of use.

Water transfers have been viewed favourably in the western US. Shifting economic and demographic forces have increased the power of cities which need the water and reduced the relative value of water used for irrigation. Therefore, over time, the barriers to water transfer have come down. In 1962, Arizona eliminated its strict appurtenancy[5] requirement and explicitly allowed the transfer of water rights. The state of Wyoming enacted legislation in 1973 expressly authorising changes in water rights, and in 1980 the California legislature announced a general policy favouring water transfers. In 1988, the Utah legislature removed the restrictions against transfers of water outside conservancy district boundaries, and in 1989 the Colorado legislature allowed the leasing of water outside conservancy district boundaries. Other western states have also eliminated restrictions against transfer in recent years.

But while these absolute barriers have come down, other rules have come up. Most water right transfers in the western states require approval by some administrative body. These bodies generally require several tests before the transfer is approved, and these tests reflect the concerns raised by Howe et al.(1986), above in that they deal with third-party effects and other values.

For example, the Arizona legislation requires the approval of any irrigation district, agricultural improvement district or water users association affected by a transfer. The Wyoming legislation makes transfers potentially subject to review concerning:

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[3] The material on US water markets taken from a paper by Meister and Alexander (1994).

[4] There is significant variation in the implementation of water rights in the United States. This discussion is based upon property rights as commonly expressed in the western United States.

[5] *Appurtenancy* means that the water right is tied to the land where it is used and can be transferred only if the land itself becomes unusable through natural causes.

1. economic losses to the community and the state related to the transfer;

2. the extent to which these economic losses would be offset by benefits from the new use; and

3. the availability of other sources of water.

The California law requires that transfers not "unreasonably" affect fish, wildlife, other instream beneficial uses, or the economy of the area from which the water is to be transferred. In 1985, the New Mexico legislature subjected water transfers to a requirement that they not be detrimental to the public welfare or the conservation of water. In a similar vein, the Utah Supreme Court ruled that water transfers in that state must pass a public interest review (MacDonnell, 1990).

The overall picture is expressed by MacDonnell (1990) who states, ". . .while there is more general acceptance of water transfer, there also is a trend toward conditioning approval of transfers on protection of an increasingly broad set of interests" (p. 43).

5.2 The Central Valley Project Improvement Act

Although MacDonnell wasn't referring specifically to the Central Valley Project Improvement Act (CVPIA), his point is extremely well-taken and seems to have been somewhat prophetic as to the direction of federal water rights legislation. As one title of a 1992 omnibus water bill affecting 30 water projects in 13 western states, this act provides a new set of rules for allocating water between agricultural, urban and environmental uses in the Central Valley Project (CVP) area of California. Touted by some as a major move toward true water markets, and criticised by others as only a marginal move in the right direction, this act provides a view that is likely to become more common in US water allocation. The three most important provisions of the act provide rules for water transfers, for water pricing, and for redirection of water to environmental uses.

Water Transfers

Perhaps the most promising part of the new act is the provision for transfers of water to its highest valued use. If such transfers were allowed to occur freely[6], the result would be a significant increase in economic efficiency. The act states:

> *All individuals of districts who receive Central Valley Project water under service or repayment contracts, or exchange contracts entered into prior to or after the date of enactment of this title are authorized to transfer all or a portion of the water subject to such contract to any other California water user or water agency, Indian Tribe, or private nonprofit organization for project purposes or any purposes recognized as beneficial under applicable state law. (PL 102-575)*

[6]The principal debate surrounding this act is focussed on whether this is likely to occur.

As pointed out by Gardner and Warner (1994), the potential importance of such transfers may be seen in the current discrepancies in water prices between agricultural and urban uses. Urban water users generally pay between US$450 and $1,000 per acre-foot of water, while farmers pay only $15 per acre-foot from the Central Valley Project. Consider further that agriculture uses about 80 percent of California's developed water yet returns only 8.3 percent of the state's income, and it becomes reasonable to question whether a significant misallocation of water has occurred. This misallocation may well be lessened through rules allowing water transfers. While transfers are not without restrictions, some of which may be significant, it should be noted that individuals are allowed to transfer up to 20 percent of their water allocations *without* approval of their local water agency (Howitt, 1994). This will allow a potential market of 1.4 million acre-feet of water available for sale without local restriction. Compare to this that gross water bank sales totalled 510,000 acre-feet in 1991 (Howitt, 1994). Clearly, the potential exists for a significant change in the use of water resources in the area.

Water Prices

The CVPIA introduces a three-tiered pricing scheme for water users and denies automatic extensions of heavily subsidised prices under existing contracts. The prices are determined as follows:

> *(1) the first rate tier shall apply to a quantity of water up to 80 percent of the contract total and shall not be less than the applicable contract rate; (2) The second rate tier shall apply to that quantity of water over 80 percent and under 90 percent of the contract total and shall be at a level halfway between the rates [of the first and third tiers]. . . (3) The third rate tier shall apply to that quantity of water over 90 percent of the contract total and shall not be less than the full cost rate. (PL 102-575)*

Thus, while the act does not provide for a fully integrated market, it does provide for a full-cost rate on marginal water use, which should have significant effects of the nature of water use in the affected area of California. Among the anticipated results are a substantial reduction in the quantity of water used (especially in the long-run), an increase in the use of water conserving irrigation techniques, the postponement of new water projects, and a decline in the irrigation of poor quality farm lands (Gardner and Warner, 1994). These improvements are not as significant as could be expected under a system of unrestricted transfers and market pricing, but they are a major step from the previous condition.

Environmental Water Use

Two of the most controversial parts of the act involve environmental intervention in the quasi-markets created by the act. The first of these mandates that 800,000 acre-feet of CVP water annually be dedicated to fish, wildlife, and habitat restoration. About 13 percent of the total, this amount could irrigate over 200,000 acres of cropland (Gardner and Warner, 1994). The second provides for a $50 million environmental restoration fund to be created from fees levied on agricultural and hydroelectric power users (Schneider,1992).

While there is some legitimacy to the view that, as a public good, the benefits of the protection of wildlife are diffused among a large group of people, and that the transaction costs may be high of gathering those people together to act in the market, there is some evidence that "market forces can create a setting for private sector innovation and initiative in pursuit of environmental quality" (Project 88, 1988). This is a particularly contentious issue with some arguing that environmental interests should compete in the market like anyone else, while others argue that this reallocation provides some compensation for decades of externalities imposed on fish and wildlife by agricultural and commercial interests.

In addition to the minimum water allocation, environmental interests restrict transfers through a complex set of 13 water transfer conditions. One of these restrictions prohibits transfers in any situation which would "result in a significant reduction in the quantity or decrease in the quality of water supplies currently used for fish and wildlife purposes, unless the Secretary determines pursuant to findings setting forth the basis for such adverse affects would be more than offset by the benefits of a proposed transfer." (PL 102-575) The transaction costs of such restrictions are likely to be large and can be expected to significantly affect the ability of the quasi-market to effect water transfers.

5.3 Other experiences with Transferable water rights

In **Australia** considerable progress has been made by the various States to increase the transferability of water entitlements. Tradeable rights in water use are commonly described in Australia as tradeable water entitlements (TWEs). TWEs are widely accepted in most States of Australia. This reflects a response to pressures for more flexible resource management calculated to improve the efficiency and effectiveness of water use. These pressures arise from limitations on the scope of future water development and the consequent political and economic need to use existing regulated water supply more efficiently. The underlying justification for the introduction of transferability is that it should promote the transfer of water to its most highly valued use (Pigram et al. 1992).

In some States water can only be transferred temporarily, although in others (South Australia, and on regulated rivers in New South Wales) permanent transfers are allowed. Most regimes only permit transfers within the same supply system between irrigators and include restrictions to mitigate negative effects on third parties and the environment. Water transfers in most regions have generally involved only a small proportion of total water allocated - usually less than 5 percent. In the government schemes in New South Wales, more than 20 percent of allocations were transferred in 1987-88. Initial water rights have generally been allocated free of charge, although some new allocations in Victoria and Queensland have been auctioned.
A system of tradeable water rights operates successfully in New South Wales' regulated river valleys (ie. those with storage facilities) and irrigation areas. The introduction of tradeable rights was a response to the increasing scarcity of water relative to demand. Water users used to have virtually unlimited access to water. Now rights are defined according to a set of maximum volume for non-drought period. New users must purchase existing entitlements. For most river systems two types of rights exist - high and normal security. Except in droughts, high security holders receive all of their allocations. Normal security holders receive what water is available after allocations to high security holders and reservoir carry-over for possible future dry periods has been determined. Irrigators can temporarily alter the reliability of their supply by "borrowing" from their water allocation for the following year. Limits are applied to the distance over which transfers occur reflecting both technical and political constraints. The cost to the government of running the river systems are recovered in part through user charges.

In many of the regulated river zones, water has been transferred from hilly upper-valley reaches to more productive downstream areas with a resultant improvement in efficiency of water use James (1993) cites a case study of tradeable water entitlements in Victoria (Australia). In his conclusion he writes " Although the introduction of TWEs in Victoria has the promise of improving the efficiency of water use, this case study has shown that various factors are vital to its future success. Major issues include the limits placed on transfers with other States due to different subsidy regimes, restrictions on trade between regions or between sectors, and the possibility of rural decline in some areas. The removal of some of these impediments is likely to result in greater efficiency gains than have been achieved so far (James, 1993, p.67). This was similar to a conclusion reached by Simmons et al. 1992, who stated that experience since the introduction of limited transferability has not borne out the initial fears that regions in which selling predominate would undergo economic contraction (Simmons et al, 1992: p. 152).

While the potential benefits of greater efficiency may not as yet have been realised because of limitations and restrictions on transfer, this should not be a matter of great concern. As Prigram et all (1992) explain, the introduction of transferability is a radical departure from traditional practices and carries with it the prospect of economic and social instability. The constraints have avoided such instability. The fact that transferability has been introduced and has been accepted by the industry creates an environment where future pressures on water use can only lead to greater flexibility in tradeability.

5.4 Tradeable Rights and Developing countries.

In section 2.2 some of the constraints regarding natural resource management in developing countries that need to be taken into consideration when considering the introduction of additional market and economic instruments were mentioned.

In a recent World Bank report (1993) the reallocation of water to increase aggregate economic benefits was discussed. Basically there are three mechanisms to re-allocate water a) administrative allocation by government, b) trading among users, and c) setting higher prices for water so that low-value users would release water for higher-value users. The report has the following to say about the various options:

"The information requirements are likely to be higher with the administrative reallocation and price setting approaches, than with trading, in which participants have incentives to seek the most beneficial adjustments based on information they already posses. The transfer of water under each of these three mechanisms entails third-party effects, whereby groups that benefit indirectly from the original allocation (for example, service industries catering to agriculture or downstream users benefiting from return flows) suffer economic losses and thus may require compensation and mechanisms for adjustments. This would be of particular concern when the groups adversely affected are the poor. A similar concern arises for farmers when water is transferred by administrative decision or in response to higher charges because farmers lose an economic rent they perceive as an acquired rights. Indeed, the political leverage of farmers often blocks reallocation even in situations of gross misallocations. An approach based on trading may avoid the political debate while improving allocation, but other costs must be considered as well. Environmental concerns (which are not reflected in market transactions) would need to be satisfied with any transfer." (World Bank, 1993:47-48).

Similar sentiments were expressed by the Philippines Water Board Authority in personal conversations with them (February 1995). To them equity consequences of pricing or water transfers represent the most important aspect of any water management policy.

6.0 Conclusion

The idea of implementing pollution control measures through mechanisms such as charges and marketable permits is attracting attention in developing countries. Past neglect is hardly surprising given the limited attention afforded these techniques in the industrial world and the newness of environmental policy itself in many developing countries. Nevertheless, many developing countries have environmental agencies, and others are seeking advice on how to establish them. It is not too early to urge developing countries to begin considering a broad set of policy instruments.

Economic incentives or regulatory approaches alone are not going to solve the urban and rural water quality problem in developing countries. To achieve the latter a more comprehensive water management plan for the region an country is needed which includes public investment in water treatment facilities as well as information programs to acquaint people with safe water use. Within this broader plan however, economic incentives can play as role as complements to regulatory structures. Many countries should perhaps establish their own instruments instead of simply borrowing the institutional structures already in place in the OECD nations. It seem likely, however, that they must gain far more experience before such instruments can be transferred as part of environmental policy in the developing world.

From the discussion in this overview paper it has become obvious that environmental taxes are mainly used in Europe and have had little impact on environmental quality. Their implementation requires careful formulation, monitoring and enforcement. Attempts to adjust the price mechanism through environmental type taxes, in developing countries, may in most cases, be premature. The developing world often lacks the institutional basis for implementing such taxes. They may lack experience in environmental monitoring in general, have an inadequate legal system to back up a regime of fines, have problems collecting taxes, and so on. More important, pricing in developing countries rarely reflects the purely financial costs of production. Considerable environmental gains may be achieved by simply ensuring that prices reflect the financial costs of production. Setting prices below real costs, produces several effects, one of which is an inefficient use of resources. The implied subsidy encourages excessive consumption, results in waste and environmental degradation (Pearce and Warford, 1993)

Nonetheless, in many instances, charges could be implemented in a simple rule-of thumb fashion, and the weapon of charging or taxing should not be overlooked. Externality taxes are not intended to raise revenue. They are designed to offer incentives and work best when the demand for the product in question is fairly responsive to price, that is, when it is elastic. If demand is not responsive to price, taxes must be very large - which is not politically feasible - to have any effect. At the same time, modest environmental taxes on commodities with inelastic demand can be justified as a means of raising revenue in developing countries, whose tax base is often difficult to implement.

While there is much uncertainty about the suitability of economic incentives, a reasonable course of action could be:

- initiate a system of product charges to generate revenues;
- use part of these revenues to increase knowledge and to build an institutional capacity to cope with environmental problems
- return part of these revenues as subsidies to encourage better practices and to put into place pollution abatement measures and facilities;
- use accumulating knowledge and experience to consider more effective systems for controlling pollution such as emission charges and marketable permits and rights.

Taxing products or creating rights, even it this doesn't lead to changes in behaviour in the first instance does, nonetheless, raise revenues that can either be used to supplement other sources of general government revenue or be directed to specific environmental purposes, and create values and signals to which resource owners will ultimately respond.

With regard to tradeable water rights, the examples provided from developed countries give some idea of the requirements in terms of information and administrative capabilities. The evolution of transferability of water rights has been a slow one and much has been learned. However, with regard to the developing world, major concerns would need to be researched before any attempt is made to introduce a transferable scheme. Of major importance would be the equity consequence of trading on the rural poor, the dominance in market by a few, third - party effects and instream flows or environmental concerns. Any consideration of a transferable water right scheme, however limited, can only occur within a much wider integrated strategy for water management and an existing regulatory framework that can monitor and enforce.

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GUIDELINES FOR THE DESIGN OF EFFECTIVE WATER MANAGEMENT INSTITUTIONS UTILIZING ECONOMIC INSTRUMENTS

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I. Introduction to Water Institutions.

The past three decades have seen a growing interest in the institutional framework within which water planning, development, and management take place. This concern has stimulated studies of procedures and institutions as they have evolved in a number of countries, including OECD member countries, Canada, the United States, Mexico, and others (see United Nations references). These studies serve to reinforce the impression that the weaknesses in water planning and management stem from institutional shortcomings much more than from lack of appropriate analytical techniques.

Highly sophisticated planning techniques have been developed; expert specialists have been trained in a variety of disciplines; talented consulting groups have come into being in the private sector and universities; and government agencies have assembled talented teams for planning, systems design, and management. Yet, major shortcomings continue to occur: studies get carried out but appear not to reach the decision-makers; outside consultants come in, perform studies, and depart without facing the problems of implementation; plans are generated by special ad hoc study groups, but they often belong to no one and don't get executed; narrow ranges of structural solutions continue to be developed; agencies fail to attract and keep trained, motivated personnel; innovative thinking is often discouraged or eliminated before being presented to the appropriate decision-makers; etc. According to the United Nations (National Systems..., 1974, p. 4), "It is true that engineering techniques still outpace in their sophistication the managerial applications involved in contemporary water administration."

The Conference on Water Development in Less Developed Areas (Berlin, 1963) long ago found that "the main problems in the field are not technical, but are of an organizational, administrative, political or managerial nature.... Aid-giving nations may be more helpful in solving these problems than in providing either engineering or financial aid." (U. N., National Systems ..., 1974, p. 38). In the United Nations-sponsored study of North American water planning (Howe, 1974, pp. 59-60), it was concluded that:

> The record seems quite clear that the greatest concern is the achievement of coordination in planning and management among the agencies usually found in several ministries and at different levels of government.
>
> Technique has already far outrun the ability of planning and operating agencies to use sophisticated tools. This points up the need for continuity in the functions and responsibilities of the agencies charged with planning.

Irving Fox noted in 1976 that the term "institution" is used in many ways, referring to organizations, rules, laws, regulations or established customs. We adopt Fox's definition of the institutional framework (p. 743):

> "an interrelated set of entities and rules that serve to organize societies' activities so as to achieve social goals."

However, it remains unclear to what extent there exist general principles regarding "optimal" or appropriate institutional design. Fox et al (1970, p. 158) state:

Of foremost importance, the study strongly supports the view that institutional design should be determined by factors that may differ widely from region to region.

The United Nations Integrated River Basin Development study (1970, p. 27) states that:

There is certainly no single correct way to organize and administer a river basin programme. The plan of organization must in each case be fitted into the general governmental structure and into the cultural patterns and political traditions of the countries and regions which are involved.

Chambers, in writing about rural development planning (1974), has noted that what is often lacking are detailed procedures for getting the work done and for providing motivation for successful performance and innovation. These details are often not attractive to the higher official or the outside consultant who may recommend sweeping changes: set up a new organization; realign ministerial responsibilities; reorganize agencies; etc. Chambers' observations should serve as a warning that naive shuffling of agency structures without attention to the details of motivating individuals will get us nowhere.

II. Guidelines for the Design of Water Planning and Management Institutions.

If it is so clear that institutional shortcomings are the major constraint to better water planning and management, what have we learned from this experience that might guide us to the design and use of better institutions? Table 1 below provides a list of institutional characteristics that should be used in designing water institutions.

Table 1- Desirable Institutional Characteristics

1. Capability of coordinating water plans and management procedures with other functional agencies, e.g. agriculture, environment, economic planning, industry.

2. Capability of considering a wide range of alternative solutions to water problems, including non-structural measures and the use of economic instruments (pricing, taxes, tradable permits, subsidies, etc.).

3. Separate planning and evaluation from construction and management functions.

4. Have the multi-disciplinary expertise to carry out "multiple-objective planning and evaluation."

5. Observe the "subsidiarity principle" in assigning responsibilities to agencies at national, provincial and local levels.

6. Have the expertise to involve all "stakeholders" in the planning operation from the beginning.

7. Build in a reward structure that will stimulate creativity and innovation.

8 Build in a reward structure that will stimulate learning through *ex post* analyses.

Coordination of water plans with related sectors seems a very obvious requirement but is typically neglected. In many countries, the subsidization of irrigation water leads to excess agricultural production which is then dumped on world markets. In California (U. S. A.), subsidized irrigation water has led to the destruction of the Kesterson Wildlife Refuge through excessive drainage waters (U. S. National Research Council, 1989). Excessive water diversion for irrigation has dried up many streams and lakes that have been highly valued for fisheries and recreation, including the Aral Sea in central Asia.

Considering a wide range of solutions to water problems with the ability to pick the best is much more important than trying to develop highly refined engineering and economic analyses. Non-structural solutions in areas such as flood control, water conservation, development of dryland crop varieties, etc. are becoming much more important and practical. Frequently, local and foreign special interest groups will apply pressure for the use of particular technologies (see Howe and Dixon, 1993). Consideration of a wide range of alternatives is encouraged by having a multidisciplinary planning team.

The separation into two agencies of planning and project evaluation and construction and operation avoids pressures to plan construction-intensive projects. In Kenya, the Tana River Development Authority (TRDA) was established in 1972 as a planning agency to resolve conflicts on the Tana River: irrigation versus hydro-power; upper basin versus lower basin. TRDA operated very effectively in carrying out this mission for a few years with a small but expert staff. When it came time to build a large dam, the temptation became too great and they became a construction agency. The bureaucratic principle of expanding the budget and staff has resulted in TRDA becoming a huge organization that accomplishes little more than the small original staff.

In Botswana, the Department of Water Affairs has continued to support the large Southern Okavango Integrated Water Development Project when a sequence of smaller-scale localized projects and water management techniques would produce much larger net benefits (IUCN, 1993). The same factors are at work: agencies that control construction opt for capital-intensive, over-sized projects. Justification for such projects often takes the form of biased benefit-cost analyses.

Separating planning and evaluation from construction and operation may not be easy and, in some circumstances, may not be possible. Limited manpower may require that engineering and hydrology staff be used in both. Data and experience from construction and operation areuseful in planning. Some compromise is likely to be necessary.

"Multiple-objective planning" (MOPE) was developed largely by the U. S. Water Resources Council circa 1973 but has been widely adopted by other organizations. The Organization for Economic Cooperation and Development (OECD) has utilized MOPE in advising OECD governments and training water planners (see OECD, 1985). The system is a simple one to assist decision-makers by making available all relevant information regarding a proposed project or plan. Information can consist of monetized benefits and costs, physical and environmental data, and social and demographic data, usually arranged in four categories:

1. a benefit-cost analysis from a national point of view;
2. a benefit-cost analysis from a project region point of view;
3. an analysis of environmental impacts;
4. an analysis of (non-monetizable) social impacts.

The point of MOPE is not only to provide more information but, by doing so, to reduce the temptation to distort the more traditional national benefit-cost analysis. Naturally, the political decision-makers must attach weights to the four categories.

The "subsidiarity principle" has been an important guide for policy formulation in European Union (European Union, 1990). Roughly speaking, it means:

> "assigning decision-making and enforcement to the lowest governmental level consistent with the internalization of all important externalities."

The intent of subsidiarity is both to relieve central authorities of detailed local program responsibilities and to place decision-making closer to local preferences, data and information.

Linked to subsidiarity, the physical structure of a river basin makes it a natural management and development unit. All parts of the basin affect the flows of the main river, and structures built in one part of the basin are likely to affect streamflows, groundwater and water quality in other parts of the basin. The complexity of the basin is obvious. With several structural and non-structural alternatives available at several sites, the number of combinations of development alternatives becomes large very quickly. Fortunately, there exist computerized models that can be adapted to a wide range of river basin conditions (see Viessman and Welty, 1985, esp. Ch. 10).

River basins are often economic regions, too. Patterns of settlement, agriculture and transportation along rivers have tended to integrate the economies, linking basic industries (agriculture, livestock, mining, forestry) with secondary and service industries. Thus, the main economic and demographic effects of water projects and policies are likely to occur right in the same river basin.

With an integrated economy and physical interdependence, the river basin presents many opportunities for the use of economic instruments to motivate appropriate conservation and protection of the riverine environment: the appropriate pricing of water withdrawals (or system of transferable water rights); appropriate pricing of potable water; appropriate motivation towards efficient flood control measures; charges for transportation; taxes on pollution, etc. Since the entire basin is physically and economically connected, the effects of these economic instruments also are interdependent and should be designed from a basin-wide viewpoint.

Problems arise in river basin planning and management when the basin is divided into multiple political jurisdictions like states or countries. There is then a tendency to ignore the interdependencies with resulting inefficiencies and inequities. For example, the Sénégal River is an international river that rises in the Fouta Jalon in Guinea, then flowing through Mali and forming the boundary between Sénégal and Mauritania. The latter three countries have formed the Organization pour le Mise en Valeur du Fleuve Sénégal (OMVS), a river basin commission for the cooperative planning and management of the river. The absence of Guinea means the loss of their input into the planning process and the absence of channels for helping Guinea deal with serious erosion problems that are causing problems throughout the basin. The same type of jurisdictional problem has prevented coordinated development of the major rivers of south Asia.

Fortunately, there are examples of well-managed river basins in which basin-wide interdependence is recognized in planning and management. The French river basin agencies (Agences de Bassin) have responsibility for water quantity, water quality and flood control. They charge water users for water withdrawals and tax pollutants returning to the river. The revenues are used both to support the Basin Agencies and then to subsidize waste water treatment by towns and industry (see Johnson and Brown, 1976).

Returning to the items in Table 1, water planning agencies must involve all groups that have an interest in water in the identification, design and operation of projects and operating programs. Failure to involve local groups from the beginning can lead to later refusal of those groups to maintain or even use the project (Parlin and Lusk, 1991; Moris and Thom, 1990). Valuable technical information may be available only from local groups. In Central Java in the late 1970s, a donor country and its engineers proposed a large supply canal to bring water to a non-irrigated fertile area. When the proposed route of the canal was publicized, local leaders warned that unstable soils made the route infeasible. This warning was ignored, and the canal indeed collapsed six months after it was constructed.

Finally, creative thinking and learning through ex post analysis must be stimulated by the reward structures of water agencies. Ex post analysis of the performance of projects is the most obvious way to learn how to do the job better next time. Yet, agencies and politicians are extremely reluctant to carry out such studies. The reason is obvious: so many bad water projects are built.

III. Major Unresolved Institutional Problems in Water Management.

A. Defining Property Rights in Water

The legal right to the use of water is integrally linked with the potential ways in which water planning and management can be organized. The majority of countries around the world assert that water resources are in public ownership, but the real meaning of that varies many ways. Countries which permit the private ownership of water surround that right with many conditions and restrictions, so that no water-using party has a carte blanche right to water use.

A survey of 18 countries (United Nations, 1976) suggested that there are four basic categories of water ownership: (1) central government ownership and control; (2) central/provincial (or state) government ownership and control; (3) cooperative social ownership and control with qualified private access to supplies; (4) modified private ownership. Many sub-variants could be identified within these categories. Naturally, the basic laws of water ownership create the framework within which economic instruments must be used.

These different legal traditions of water ownership all have their positive and negative points. Well-defined ownership by central government can mean a superior ability to proceed with water development projects without the delay of buying up or otherwise obtaining the necessary water rights. Central state ownership also can mean a more expeditious reallocation of existing supplies among uses as conditions change without being constrained by provincial, state, local, or private claims on such waters. On the other hand, such a system can fail to detect the need for transfers, the existence of physical and economic inefficiencies in use, and can fail to motivate technological changes in water management called for by changing demand and supply conditions. Central ownership may be insensitive to provincial or local problems and priorities, whereas provincial, state, or private ownership can necessitate compromise solutions which recognize these factors. In all systems, sufficient length of tenure must be granted to water users to be compatible with the lifetimes of water related investments.

Defining property rights in water in ways that will lead to efficient use over the time remains a problem. Instream uses for hydro power, recreation, water quality improvement (through dilution of pollutants), and the preservation of natural wetlands and their ecosystems are exhibiting rapidly increasing values in most countries. Non-use values generated by water bodies have come to be recognized as important water-related benefits (see Peterson, et al, 1988; Mitchell and Carson, 1989; Natural Resources Journal, Winter Issue, 1994). The protection of these values has required major changes in the water institutions and laws of numerous countries.[1] (See United Nations, 1972; Getches, 1984). In many countries, water rights do not provide such instream values.

Property rights (including water rights) refer to the set of socially sanctioned uses, attributes and restrictions of an asset (or class of similar assets) that can be vested in an identifiable legal entity (person, corporation, etc.) and that are capable of being monitored and enforced. These are general properties that inhere in the asset (class of similar assets). Even within this framework, however, the use of assets frequently generates unsanctioned impacts that impinge on the property or personal rights of others. Appropriate control of these externalities then requires further regulation of the exercise of the property rights.

In the absence of well-defined property rights, beneficial uses requiring long-term investment become impossible or can be undertaken only with continuous litigation. On the other hand, too fine a definition of property rights reduces the class size of assets to a point where market processes become difficult because of the "thinness" of the market. If the attributes of water needed by a user become very specialized, then it is better to have the user provide these attributes on an individual basis rather than trying to provide them through the market. For example, the need for very pure water for boiler feed is better provided by the user than trying to establish a market.

B. Technical/Institutional Problems Needing Attention.

If we were to poll water managers and experts around the World regarding the major issues that must be resolved, it is likely that the following issues would receive frequent mention:

1. the coordinated management of surface water and groundwater;
2. the coordinated management of water quantity and water quality;
3. motivating greater economic and physical efficiencies in water use;
4. protecting instream flow values and other public values related to water systems.

How might one proceed to design an institutional framework capable of resolving these issues? Regarding (1), property rights in water resources must recognize the physical interdependence of surface and groundwater and define the rights so that the combined system will generate maximum social benefits. An interesting example of the failure to recognize this

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[1] Some countries require that water actually be diverted from the river channel if a legal water right is to be established.

interdependency is found in the history of water use on the South Platte River in Colorado. Early settlers established senior water rights to the surface flows. Lack of technology precluded large-scale use of groundwater from the huge alluvial aquifer surrounding the river, so the water rights system did not include groundwater. In the 1930s, but especially following World War II, greatly improved pumping technology plus cheap energy caused an explosion in pumping from the aquifer. Frequently during the late summer, the river was pumped dry. Senior rights were clearly being infringed. The initial response was to apply the priority system to all pumpers, making all of them the most junior water users. Then, during drought when groundwater was the logical supply, all groundwater use was shut down. Finally, a compromise was reached under which pumpers are required to augment streamflows in the amounts by which their pumping is estimated to reduce streamflows during the irrigation season. They frequently buy some surface rights and leave the water in the stream.

Coordinated management of water quantities and water qualities is clearly desirable. Any water use changes the water quality somewhere in the system, and changes in water quality affect the productivity of water in its various uses (see Howe et al, 1986, pp. 442-43). While a few urban water systems offer a dual supply system providing both potable and non-potable supplies,, urban water users generally must provide for their own special quality needs such as softness for household use or purity for industrial purposes. In the provision of irrigation water, specific water quality cannot be guaranteed. Water quality fluctuates with river flows and use patterns. Certainly there is no way of executing a market for irrigation water rights that would be differentiated by other than very broad classes of water quality, e.g. "TDS" less than 800 mg/1.

Referring to issue (3) above, one of the most important objectives of appropriate pricing and financing of water systems is the improvement of the economic efficiency of water use. This was noted above in connection with water quantity/quality coordination. Most countries heavily subsidize agricultural water use, leading to excessive applications and consumptive use and causing negative environmental effects.

Protecting instream flow values and other water-related public values is a major policy issue that requires both the appropriate use of economic instruments and recognition of non-market values, i.e. values stemming from water systems that have no market prices. For example, suppose it is planned to transfer a large volume of water from one river basin to another. The losses to the basin-of-origin should be fully evaluated and included in the benefit/cost assessment of the project. Among non-market values lost would be recreation and general aesthetics of the river. These losses will result in other indirect losses to commercial businesses. Cultural values may be lost if historic buildings, lands and social practices are affected. Determining which of these values should be protected and how best to protect them must be resolved by each society for itself.

IV. Barriers to the Use of Economic Instruments for Water Management

The use of Economic instruments in water management and environmental management has expanded in the past twenty years. Yet the rate of progress has been slow. Economists have been calling for the expanded use of economic instruments for at least seventy years (e.g. Pigou, 1920; Ciriacy-Wantrup, 1952; Kneese, 1964; Davis, 1968). If the advantages of economic instruments are so clear to economists, why are they not obvious to the government officials and legislators who establish policy and make the rules?

The use of economic instruments, especially taxes and tradable discharge permits (TDPs), varies greatly around the world. Singapore is famous for its central city tax on automobile use. Sweden probably has the most extensive set of "green" environmental taxes on both pollution and polluting inputs, and Germany has the longest history of regionally planned pollution control (the Ruhr Valley) that has been financed by taxes on industrial pollution. The European Union makes fairly extensive use of pollution taxes, while the United States uses TDPs and similar arrangements - but has never used pollution taxes.

What are the major impediments to broader incorporation of economic instruments in national water and environmental programs? Table 2 lists some major factors.

Table 2 - Barriers to the Use of Economic Instruments

1. Philosophical and political barriers:
   a. government-business relations
   b. lack of trust in public agencies
   c. special interest pressures.

2. Equity issues and the state of economic development:
   a. inability of the poor to pay
   b. interregional differences
   c. importance of the informal sector.

3. Lack of understanding of how economic instruments work and their consequences:
   a. officials' look of understanding
   b. the public's lack of understanding.

4. Unresolved problems in the practical application of economic instruments:
   a. setting tax levels
   b. issuing TDPs
   c. multiple interacting pollutants
   d. variations in environmental conditions.

5. Market structure:
   a. conditions for competitive TDP markets
   b. effects of environmental programs on industrial competitiveness.

6. Institutional barriers:
   a. absence of legislative authority and direction
   b. legislative preference for regulatory approach
   c. financial constraints on prices and taxes
   d. interjurisdictional problems.

7. Capabilities of water and environmental agencies.

In addressing these barriers and ways to overcome them, we should first admit that economic instruments will not solve all our problems in all situations. In the best of market-oriented situations, some degree of regulatory oversight will be needed in situations of rapid economic change. Regulations will have to play a larger role since the functioning of prices, taxes, TDPs, etc. depends on the orderliness and stability of market conditions. Naive dependence on markets and economic instruments can lead to greater problems.

A. Philosophical and Political Barriers.

Returning to Table 2, the relationships between the business community and government agencies are very important to the evolution of policy and the use of economic instruments. In Europe and Japan, there is a close relationship of communication and bargaining between government and business - a "no surprise," non-confrontational environment. This closer relationship is due in part to the oligopolistic structure of industry in those countries. In that environment, the business community may be more successful in influencing policy, in providing useful information and in shaping price changes and taxes.

In other countries, there exists a more confrontational environment and even lack of trust in the intentions of government agencies. Such an environment makes the success of any kind of resource management program problematic and increases the probability of resistance to economic instruments.

Special interests always try to influence water policies. Those who have not paid do not want to start paying. Industries whose profit margins would be impacted by increased prices, taxes and other constraints will resist. Education concerning the functioning of competitive economic systems may be the best way of reducing such resistance.

B. Equity Issues and the State of Economic Development.

The issue of equity and the ability of the poor to pay higher prices or taxes is always raised as an objection to the use of pricing and taxes. Economists frequently have answered that mispricing water or other commodities is not the way to deal with poverty. But this is too easy an answer, especially since access to potable water and sanitation are very important components of human well being among poor populations.

There are ways to price water to the small volume, low income user that retain much of the efficiency advantage of appropriate pricing. If urban metering is in use, an increasing block rate with a low-priced first block (perhaps zero) will work. If stand pipes are used, a benefit-cost comparison may show that the collection of payments may cost more than is collected. Monthly "membership cards" can be sold. It must be remembered that many of the urban poor currently pay very high prices to private water vendors. A modern system requiring payment probably will reduce their costs.

Charging small farmers for irrigation water is problematic, both from the payment and monitoring viewpoints. The trouble is that low or zero irrigation water prices typically get extended, legally or illegally, to the large farms, too. One way around the problem is to allot each small farm sufficient water for good crops if good management is followed. Additional water will then be charged. This practice is widely used in Mexico.

Interregional differences in water prices and water quality measures are generally warranted on efficiency grounds but can become politically troublesome. Such differences must be clearly explained and justified to the public.

C. Lack of Understanding of Economic Instruments.

Both public officials and the water-using public fail to understand the price system generally and the pricing of water and environmental services in particular. A very fine study in the United Kingdom (Hanley, Hallet and Moffatt, 1990) concluded:

> ...many individuals within public agencies have come across the notion of pollution taxes, although few have encountered the idea of marketable permits. However, few of those expressing familiarity with tax schemes could explain their workings in any great detail, or understood the rationale for preferring such schemes over command-and-control systems [regulatory systems] (p. 1424).

It is thus clear that education in economics for the engineers and lawyers who comprise the staffs of most public agencies is badly needed. Pricing, like competition, is something the public approves of as long as it applies to someone else. An aspect of needed education is to inform the public that "economics" or "economic efficiency" do not refer to the narrow, profit maximizing, beggar-thy-neighbor practices of some businesses but to broad assessments of benefits and costs. This misunderstanding underlies the mistrust that some environmental organizations hold towards economics generally.

D. Unresolved Problems in the Practical Application of Economic Instruments.

The setting of appropriate tax levels remains problematic. While theory tells us to equate the marginal costs and marginal benefits of pollution abatement, we know it is not possible to measure all benefits and, probably, not all costs. Trial and error methods would lead to very inefficient adjustments by polluters. Setting the tax close to the cost per ton of abatement by known "end-of-the-pipe" techniques is one approach, but we know polluters nearly always have cheaper ways of cutting pollution than using end-of-the-pipe techniques. Taxes set at that level might be excessively high. For example, the average cost of removing SO_2 from stack gasses of modern thermal-electric plants by wet scrubbers is $300. In the auctions for tradable SO_2 permits in the United States, the average price for 1995 has been $130 per ton. This must approximate the marginal abatement cost of the plants using the most effective means of pollution reduction - which is fuel switching to low sulphur coals.

The <u>issuance</u> of TDPs is problematic from both theoretical and practical viewpoints. If the TDPs are auctioned, all polluters new and old have the same access to permits, but the total dollar amount transferred would be very large. If TDPs are "grandfathered" as they are under the U. S. system, a strong "new source bias" is established, constituting a barrier to entry by new competitors and a bias against new investment by existing firms.

Another problem is the variability of the physical environment. Streamflows and temperatures vary widely, affecting the assimilative capacity of the streams. Average levels of pollutants are not adequate measures of the damages done when pollution occurs in sudden releases. Pollution discharge permits can be made conditional on environmental conditions (e.g. the Fox River permits described in O'Brian, 1983, or the "priority permits" proposed by Howe and Lee

(1983), but they must still be supplemented by regulations on peak pollutant discharges.

E. Problems with Market Structure.

When economic instruments are used, the structures of both product markets and markets for water or pollution permits are important to the effectiveness of the instruments. If product markets are oligopolistic, the large firms may gain control of underlying water rights markets or pollution permit markets. These markets may then be used to inhibit entry or reduce competition in the product markets.

O'Neil (1983), in describing the Fox River BOD discharge permit system in the U. S., noted the following necessary conditions for an efficient TSP system: (1) that there be quite a few participating firms; (2) that the production and pollution abatement technologies vary across the firms; (3) that the trading in pollution permits not be influenced by relationships in the product market. None of these conditions was met in the Fox River case and, as a result, almost no transactions have taken place.

Another factor that influences the governmental adaptation of economic instruments is the fear or belief that differential taxes or regulations will cause changes in the location of industry. While this is theoretically possible, empirical evidence to date (e.g. Netherlands Ministry of Housing, 1990) has shown no effect of differential environmental programs. Quite the contrary, the Conservation Foundation study found that some industries are likely to favor clean, enjoyable environments.

F. Institutional Barriers.

The use of economic instruments requires legislative authority at some level - local, regional or national. There is then a "chicken and the egg" problem of what comes first - legislative authorization or experimentation with these instruments. The extreme tax and regulation consciousness in many countries today can be a serious impediment to the introduction of new policy instruments.

The legislatures of many countries have a bias in favor of regulation rather than economic motivation. This stems from the fact that: (1) the majority of legislators are lawyers who are trained in regulation - not markets; (2) these legislators often feel that regulatory systems are more reliable than motivational systems (although there is great evidence to the contrary); (3) environmental groups often back the regulatory approach because they don't understand the functioning of economic instruments; and (4) business firms often prefer a regulatory approach because of the new source biases and (at times) lesser costs to the firm.

Legislated constraints on prices, taxes and profits of water agencies severely constrain the uses of appropriate prices and taxes. Many water agencies are not permitted to make a profit. This may constrain the use of pricing as a demand management tool during droughts when conservation is needed. Many states in the United States now require public votes on any type of tax increase (the distinction between a user fee and a tax is usually not clear).

The major institutional barrier to rational water management is still the problem of multiple jurisdictions. Rivers and lakes shared by different political jurisdictions tend to be poorly managed as noted earlier. Lago de Lerma in Mexico suffers from these problems, with polluting industries on one side and recreational resorts on the other.

The Colorado River Compact (U.S A.), while allocating water quantity among the riparian states, makes no allowance for water quality control. Thus, the State of Colorado permits the irrigation of lands that heavily contaminate the river with salts that damage downstream users. This type of interjurisdictional problem remains a major problem in water and environmental systems.

What solutions are possible? There are two major classes: (1) creation of a "super authority" like a river basin authority that can impose regulations from a system-wide viewpoint; or (2) facilitating more effective "multiple issue" bargaining among the parties, e.g. the downstream party offering trade concessions for cleaner water.

G. Capabilities of Water and Environmental Agencies.

Water and environmental agencies are typically underfunded in relation to their responsibilities. They must compete for personnel with other better-funded agencies and with the private sector. They are typically headed by lawyers or engineers who have little training in economics, and they must carry on with personnel who are not adequately trained or motivated.

Ideally, there could be permanent interdisciplinary planning teams with the skills needed to deal with the physical, legal, environmental and social issues involved in water system design and management. As noted in the introduction to this paper, this seldom happens. Planners usually are burdened with day-to-day operating responsibilities, and social/legal considerations usually are brought into planning only after the physical system has already been designed.

Typical water planning agencies have no skill in identifying and understanding traditional cultures and production systems. In much of the world, "modern" irrigation systems have destroyed traditional crop, livestock, and fisheries systems that, when evaluated as a whole, were more productive than the "modern" systems that replaced them.

Thus, returning to an earlier point, water agencies need to return to planning on a river basin basis, using multi-disciplinary teams who can deal with the economic, social and environmental issues as well as physical design. Operating personnel are equally important, for the best design system will not meet its objections if poorly operated - as many are. Thus, training, motivation and accountability are crucial attributes of an effective water agency.

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WORKSHOP ON THE APPLICATION OF ECONOMIC PRINCIPLES FOR THE INTEGRATED MANAGEMENT OF FRESHWATER RESOURCES 14 - 16 JUNE 1995

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