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Management of Water Resources

Bulk Water Pricing in Brazil

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This paper is sponsored by the Brazil Country Management Unit of the World Bank to address immediate policy concerns identified through dialogue with the Government of Brazil. It was prepared by the Brazil Water Resources Management Team. Questions and concerns may be addressed to the Team Leader, Luiz Gabriel Azevedo, telephone number (55-61) 329-1041, e-mail LAzevedo@worldbank.org, or to Musa Asad, telephone (202) 473-4386, e-mail MAsad@worldbank.org.

Foreword

The pricing of bulk water, or water as a collected resource as distinguished from its "retail" distribution, is becoming an important tool in water allocation for many countries throughout the world. Though bulk water has been historically viewed as a free public good, and as such highly subsidized or distributed without charge, attaching prices to reflect its economic value has become increasingly necessary to ensure its efficient allocation in regions where the economy cannot sustain water waste. At the same time, providing consumers with an increased voice and participation in the management of water systems complements bulk water pricing to encourage the attachment of value to this limited commodity.

Previous examples of bulk water pricing in a wide range of countries have met with varied success. The case of Brazil illustrates new opportunities for capturing the cost of supplying bulk water, because recent regulation has established bulk water as an economic good. This document compares analytical work done on Brazil with the experience of bulk water pricing in other countries to arrive at practical recommendations for determining fair bulk water prices in Brazil.

Since Brazil contains 12 percent of the world's fresh water supply, it may not appear at first glance to be a relevant country from which to draw lessons in distributing scarce water resources. With a vast territory (8,456,510 sq. km) and issues of regional drought, however, Brazil provides a unique environment in which to demonstrate how adequate pricing of bulk water at a regional level can help allocate water efficiently. We hope this paper succeeds in highlighting the importance of bulk water pricing in Brazil, as well as the global need for legislation reflecting the value of water, and the role of consumer participation in managing the distribution of water.

G Nankani

Gobind T. Nankani
Country Director
Brazil

Abstract

Although procedures for pricing "retail" distribution have long been established, methods for pricing bulk ("wholesale") water supply are still emerging. At the same time, adequate pricing of bulk water is critical to ensure efficient allocation of water, and to properly fund the maintenance and operation costs involved with collecting water at its natural source and distributing it to intermediate water users.

Two central issues thus emerge from discussions of bulk water pricing: How to finance the infrastructure and service of bulk water supply, and how pricing can be used to achieve efficient allocation and use of water as a resource. Attaining efficiency will lead to better allocation of water resources, which will reduce water losses caused by poor maintenance of water supply systems and inadequate attention to water contamination. Of the varied methods used to address these issues, it is clear from analyses of relevant international experiences that public water allocation is the least effective and efficient. Yet devising appropriate levels of pricing, market, and user-based allocation approaches is complicated.

Brazil has recognized the need for bulk water pricing, but has not yet established an overall framework of regulations and pricing mechanisms. Without such a framework, the enthusiasm behind establishing appropriate water pricing mechanisms may descend. The recommendations offered in this paper are intended to help mitigate this risk.

Acknowledgments

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Executive Summary

Brazil has recognized the need to introduce bulk water pricing reform, and has already made significant progress in creating the legal and institutional framework to enable its implementation. However, without specific policies and regulations in place to guide would-be reformers, there is a risk that the current momentum behind implementing bulk water pricing may be hindered or lost altogether. Furthermore, without bulk water pricing it is unlikely that the river basin agencies foreseen under the Federal Water Law will be established, since their main source of revenue is expected to come from bulk water tariffs. Therefore, this paper is mainly oriented toward water sector leaders, policy-makers, experts, and related stakeholders in Brazil and seeks to provide them with guidance for consolidating and sustaining the progress already achieved. The secondary audience comprises a similar group outside Brazil who may be interested in the Brazilian experience—an experience generally recognized to be at the cutting edge relative to most developing countries (and even some industrialized countries)—as well as the substantial amount of material regarding international experiences presented in the paper. Finally, Bank water sector staff and managers, and similar experts from the international financial and donor communities, may also find this material useful.

The paper was disseminated to key Government officials and leading experts during the preparation of the study and while the paper was in draft form. This process has also included workshops among Bank staff and Brazilian counterparts at Bank Headquarters and in Brazil. Following publication of the paper, additional workshops, seminars, and presentations will be organized to facilitate wider dissemination within the Bank and Brazil. The final publication will also be made available to interested parties both at Bank Headquarters and the Bank's Brasilia office.

In newly evolving frameworks, as in Brazil, water users are recognized as stakeholders who interact with entities such as the government, who until now have made the rules and had the greatest influence on norms and regulations.

If water users perceive that funds to local water basin agencies are largely diverted to state or federal coffers, or are not released in a timely manner, they will discontinue paying for water supply services.

Bulk water pricing is easier to introduce, then, if water users see that they are receiving something in return for their payments, such as, greater transparency in decision making, more secure access to water through the introduction of appropriate contractual arrangements, and assurance that collected funds will stay in the river basin or be matched by outside funds through investment projects.

Water pricing is viable even in poor regions, where it can play a decisive role in better water management and increased user participation. Likewise, it is argued that poor populations, assumed to receive free water, are unable to pay the tariff that would cover the marginal costs of the water utility. In fact, the poor stand to benefit most from bulk water pricing. Currently, the poor are disproportionately affected by lack of service, and must turn to private sources and vendors, who charge high prices and whose water is not always safe.

Internationally, a country's willingness to undertake water pricing reforms and implement them cannot solely be explained by degree of water scarcity or the size of its budget deficit. Increasingly, however, most countries are recognizing the necessity to establish some form of volumetric pricing and metering, moving away from uniform charges, and abolishing minimum prices. Many are also aware of the need to significantly increase water charges to all users. In addition, several countries recognize the need to protect the environment through measures such as pollution taxes and incentives to water suppliers and consumers to conserve water.

Worldwide, bulk water pricing has largely been oriented toward revenue generation, rather than economic efficiency or the desire to change consumption patterns through incentives for users. Considering this emphasis, the most relevant factor for a system of water resource management is the institutional capacity to enforce realistic charges that are fully monitored and channel those revenues to necessary investments.

Charging bulk water fees is legitimate and necessary to fund activities that sustain management of water resources. Until now, water management agencies have had to rely on government funding allocations, and have therefore been vulnerable to fluctuations in funding. To assure a reliable water supply that meets acceptable quality criteria, water users need to provide direct financial support for bulk water management.

Based on the lessons learned from regional analysis of water systems in Brazil, as well as the experience of bulk water pricing initiatives internationally, several recommendations are provided for the continued implementation of bulk water pricing policies in Brazil: (1) Make national and sub-national regulatory frameworks a priority. (2) Establish clear pricing objectives, primarily cost recovery and economic efficiency. (3) Actively involve all users and stakeholders in the reform process.

With respect to pricing objectives, while full cost recovery may be the ideal objective, research shows that the main objectives for Brazil in the medium term would be to achieve full cost recovery for operation and maintenance, and partial cost recovery for investments. If and when subsidies are necessary, they should be well-justified and transparent. Finally, to send users the right signals about the true scarcity of water, conditions should be created that allow and encourage the development of water markets.

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ABBREVIATIONS AND ACRONYMS

ACT	Australian Capital Territory
A, O&M	Administration, Operation and Maintenance
ANEEL	National Agency of Electrical Energy
BOD	Biochemical Oxygen Demand
CARGECE	Ceará State Sanitation Company
CMR	Average Total Cost of Annual Production
CNA	National Water Commission of Mexico
COAG	Council of Australian Governments
COD	Chemical Oxygen Demand
CODEVASF	Development Company for the São Francisco Valley
COGERH	Ceará State Bulk Water Supply Company
CRH	São Paulo State Water Resource Council
DGA	Chilean General Directorate of Water
DLWC	Department of Land and Water Conservation (New South Wales)
DNOCS	National Department to Combat Drought
EPA	Environmental Protection Agency
INE	National Institute for Ecology (Mexico)
IBAMA	Brazilian Institute of Environment
IPART	Independent Pricing and Regulatory Tribunal (New South Wales)
MDBC	Murray-Darling Basin Commission (Australia)
MDBMC	Murray-Darling Basin Ministerial Council (Australia)
M&I	Municipal and Industrial
O&M	Operations and Maintenance
PUB	Basic Unit Price
PUM	Maximum Unit Price
SCT	Secretariat of Science and Technology
SS	Settleable Solids
WUA	Water User Association

Unless otherwise noted, all figures and graphs are original collaborations of the authors.

1. Introduction

1 The recent approval of the Federal Water Law[1] (Law 9,433,—January1997) puts Brazil on the verge of implementing wide-ranging water sector reforms, including the introduction of bulk water pricing. Although very encouraging, there is a real danger that the current momentum behind implementing bulk water pricing reform may be hindered or lost altogether. This paper seeks to provide water sector leaders, policy-makers, experts, and related stakeholders with guidance for consolidating and sustaining the significant progress already achieved. The paper offers a framework for bulk water pricing reform and assesses and draws lessons from recent analytical work and practice in Brazil, as well as relevant international experience. It then offers recommendations for the development of both water pricing and allocation policies to facilitate continued implementation of bulk water pricing in Brazil.

2 An important distinction exists between the price of water as a resource and the price of providing the resource to users (i.e., the water supply service, at different levels). While procedures for pricing the latter (secondary "retail" distribution) have long been instituted, methods for pricing of the former (bulk or "wholesale" water supply) are still emerging.

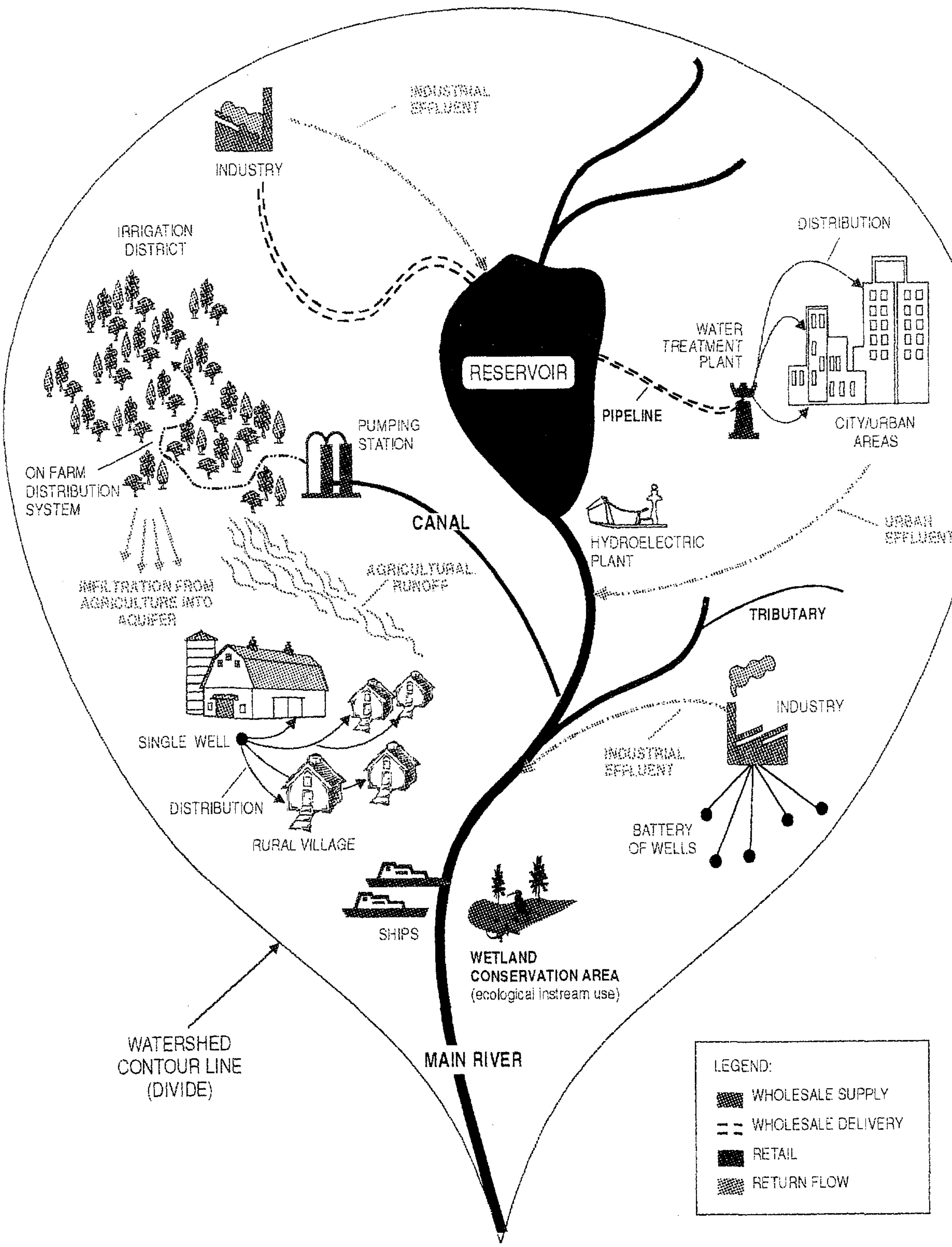
3 An illustration of the water supply chain is presented in Figure 1.1. The diagram illustrates some of the most common sources and uses of water, and the difference between wholesale supply and retail distribution. As indicated, water is initially gathered from natural sources. When it originates as precipitation, it is usually free and is used, for example, in rain-fed agriculture or stored for household use. In most other cases, however, water has to be extracted from a body of water for human use (industrial, irrigation, municipal, domestic, and other uses). In the case of ground water, it must be pumped from aquifers. In the case of surface water, pipes or channels must be built to bring the water to users. Extraction from reservoirs involves a further step, because the reservoir must be built before the water can be diverted to its users.

4 All of the preceding examples relate to bulk (or "wholesale") water supply, which is the focus of this paper. The secondary "retail" distribution of water is usually accomplished by what may be called network service companies. Examples of network service companies include water utilities, which first treat water before supplying it to their customers, or irrigation districts, which receive water at the main intake to the district before it is distributed to their irrigators.

5 As becomes clear from this simplified description, different levels of service are involved in water provision. Most pricing discussions focus on retail water supply and distribution, neglecting significant costs involved at the wholesale level.

6 Regarding bulk water, we therefore face two issues. First, how can investment and maintenance of the required infrastructure be financed? Who should pay for this part of the infrastructure (e.g., reservoirs and canals with multiple uses) and for the service of collecting bulk water from its natural source and transporting it to the intermediate water service company? Are consumers willing and able to pay for the provision of this part of the overall water supply service?

[1] Available in Portuguese (in MS Word format, compacted in .ZIP form) at the following Internet addresses:
www.abrh.org.br/legislacao/federal/index.htm
www.mma.gov.br/port/SRH/legiscompl.html


INDUSTRY
INDUSTRIAL EFFLUENT
IRRIGATION DISTRICT
DISTRIBUTION
WATER TREATMENT PLANT
RESERVOIR
PIPELINE
CITY/URBAN AREAS
PUMPING STATION
ON FARM DISTRIBUTION SYSTEM
CANAL
HYDROELECTRIC PLANT
URBAN EFFLUENT
INFILTRATION FROM AGRICULTURE INTO AQUIFER
AGRICULTURAL RUNOFF
TRIBUTARY
INDUSTRY
SINGLE WELL
INDUSTRIAL EFFLUENT
DISTRIBUTION
BATTERY OF WELLS
RURAL VILLAGE
SHIPS
WETLAND CONSERVATION AREA
(ecological instream use)
WATERSHED CONTOUR LINE (DIVIDE)
MAIN RIVER
LEGEND:
WHOLESALE SUPPLY
WHOLESALE DELIVERY
RETAIL
RETURN FLOW

7 Second, how can pricing be used as a tool to achieve more efficient allocation and use of water as a resource? If, for instance, irrigation districts and municipal water utilities receive bulk water for free, there is no indication of value of alternative uses of the water, and therefore what the most efficient allocation of the water is from an economic point of view. Should it be allocated mainly to agricultural, domestic, or industrial use? Economically efficient allocation means that water is allocated to its highest valued use. Without adequate pricing information, such decisions are difficult to make. Moreover, without adequate pricing, consumers have no incentive to use water efficiently since they receive no signal indicating its value. Many utilities run their own reservoirs and bulk water distribution systems. If the water service companies involved in providing bulk water cannot recover the costs from their final customers, then the systems will deteriorate. This deterioration can be seen worldwide, particularly in many developing countries. Finally, if the cost of maintaining clean water is not incorporated into prices charged to relevant users, then there is little incentive to reduce water pollution. As a result, freshwater supplies become increasingly unsafe. Polluters will not be influenced by pollution charges for downstream water use. Effluent charges must be imposed on the polluters since they may be upstream or have a totally different water source.

8 This paper thus makes the point that adequate pricing of bulk water is essential in a general economic sense to help in the efficient allocation of water, and also in a financial sense in order to guarantee the financial viability of the higher level water supply systems.

9 The following sections present the context and conceptual framework for bulk water pricing reform, the current situation in Brazil, and suggestions for implementing bulk water pricing policies. A summary of relevant international experience is detailed in Annex 1.

2. Conceptual Framework

2.1 Background: Water Availability and Management

10 Precipitation is the primary source of freshwater in the world, with an annual flow about 50 times the normal stock held in lakes, rivers, and reservoirs. Annual precipitation can be highly variable and withdrawal levels fluctuate widely. The same area can experience drought one year and floods the next. Precipitation per capita per year is highest in Latin America and the Caribbean, and lowest in the Middle East and North Africa. Withdrawals are the highest in North America and the lowest in Africa. Today, 22 countries have renewable water resources of less than 1,000 m^3 per capita, a level commonly taken to indicate a severe scarcity of water.[2] An additional 18 countries have less than 2,000 m^3 per capita (near extreme scarcity in years of low rainfall), and these levels are projected to decline further as population expands. Elsewhere (including Brazil), water scarcity is less a problem at the national level, but remains severe in certain regions, at certain times of the year, and during periods of drought. Worldwide,

[2] Dinar and Subramanian 1997.

agriculture is by far the largest user of water, averaging 69 percent compared with 23 percent used by industry and 8percent used by households. In developing countries the share used by agriculture is even higher, reaching 80 percent

11 Because of water's special characteristics, such as its combined public good and economies of scale aspects (see Box 2.1), and because of other good reasons, governments have always played an active role in the ownership and management of the resource. Despite good reasons for this involvement, however, government management leads to serious misallocation and waste of water resources. Several problems relate to government involvement, including fragmented public sector management, neglect of water quality (with serious health and environmental consequences), and inadequate pricing of water resources.

Box 2.1 Special Characteristics of Water

- Large, lumpy capital requirements and economies of scale in water infrastructure tend to create natural monopolies, warranting regulation to prevent over-pricing. Moreover, many water investments produce joint products, such as recreation, electric power, flood control, and irrigation, making pricing and allocation decisions more difficult.
- The large size and extremely long time horizons of some investments, given underdeveloped capital markets and the potential for political interference in many water infrastructure investments, reduce the incentives for private investment in the sector.
- The various uses of water within a river basin or from a common aquifer are interdependent. Withdrawals in one part of the basin reduce the availability of water for other users; ground water pumping by one user may lower the water table and increase pumping costs for all users; and pollution by one user affects others in the basin, especially those located downstream.
- Certain types of water activities, such as the control of floods and water-borne diseases, are (local) public goods, which cannot easily be charged for on the basis of individual use.
- Water resources are often developed because of their strategic importance for national security and regional development. Governments thus typically maintain ownership of water thoroughfares, providing services such as the coast guard and traffic regulation.
- Some regions are subject to periodic droughts. Because water is essential to sustaining life, governments may take control of water.

Source: World Bank Policy Paper on Water Resources Management, p.28.

12 Pricing water well below its economic value is prevalent throughout the world, even in developed countries. Much has to do with public perception. In fact, many countries (including Brazil) have historically considered water as free. In practice, this has focused water resource management on an expanding supply, since that is politically expedient. Pricing and demand management approaches have therefore received much less attention. This preference for supply expansion to meet political objectives leads to infrastructure investments that could be avoided or postponed, thereby increasing pressures on water-dependent ecosystems. Similarly, farmers in both industrial and developing countries often pay little or nothing for publicly-supplied irrigation water. Therefore, they have little incentive to conserve water or refrain from growing water-intensive crops. Likewise, many towns and cities charge fees that provide no incentive to conserve water, while others charge nothing at all. A review of Bank-financed water supply projects indicated that the price charged for water covered only 35 percent of the average cost of supply, and charges for many irrigation systems were much less.[3]

13 The result of this low pricing is a major misallocation of water (at least in economic terms), wasted water resources, serious debt burdens or fiscal deficits for the government agencies charged with water management responsibilities, and poor service delivery to users (especially the poor). As populations increase and the cost of expanding infrastructure continues to grow,[4] governments are increasingly looking toward implementing improved water pricing methods to more effectively and efficiently manage the resource. The importance of pricing as a tool to achieve efficient water allocation and conservation will depend on the relative value of water. When good quality water is plentiful and cheap, it does not pay to invest in costly monitoring devices and pricing systems. However, as water becomes scarce (even in regional or localized contexts, if not on a national scale), it becomes increasingly worthwhile to measure, monitor, and price water appropriately.

2.2 Economic Rationale for Bulk Water Pricing Reform

14 Despite an emerging consensus that effective water resources management includes managing bulk water as an economic good, reaching agreement on what this actually means in theory and in practice continues to be a major challenge. The following offers a useful framework of the economic rationale for implementing bulk water pricing reform.

2.2.1 The Relative Value of Water

15 Like most goods, water has a value users are willing to pay for. They will use water as long as, for each additional unit, the benefits exceed the costs. However, unlike the case for many goods, markets for water in most places either do not exist or are highly imperfect. Determining the relative value of water for different uses or users is quite cumbersome. Numerous, rather imperfect, methods exist to estimate the value of water in different uses. These

[3] Water Resources Management Policy Paper, p.30, The World Bank.

[4] See Dinar and Subramanian 1997. Empirical evidence from around the world indicates that as countries rely increasingly on ground water supplies, because aquifers are excessively depleted, the costs of water service delivery increase exponentially, sometimes as much as 200 percent –300 percent.

include: estimating demand curves and integrating areas under them; examining market-like transactions; estimating production functions and simulating the loss of output that would result from the use of one fewer unit of water; estimating the costs of providing water if an existing source were not available; and using well-structured contingency valuation approaches (Briscoe 1996).

16 Given the lack of precision these estimates offer, they may not be very useful. This is especially true because the value of water varies widely depending on its use, the income and characteristics of the user, and factors affecting availability and reliability of water supply. While such estimates are too imprecise to guide technical allocation and pricing rules, they do provide insight for policy-making purposes. An examination of values[5] yields some fairly consistent findings across both developing and industrialized countries. In general, (a) values are low for hydropower and irrigated agriculture for food grains; (b) values are significantly higher for household uses, industrial purposes, and irrigated agriculture for fruits and vegetables; and (c) values for environmental uses fall somewhere in between[6].

2.2.2 The Cost of Water

17 While the value of water depends on its use, the cost of water is usually associated with the infrastructure of storing and delivering it—"use cost." The use cost can be calculated based on historical cost, on the cost of replacing the infrastructure (replacement cost), or on the cost that would be incurred if infrastructure capacity were expanded to produce another cubic meter of water (marginal cost). Another cost component, often ignored, perhaps because of the difficulty to grasp and measure it, is the "opportunity cost" of having the water in its present use.[7] As water becomes more scarce (both in terms of quantity and quality), the opportunity cost of the water becomes more acute and important to consider.

18 The opportunity cost of water is especially important when dealing with bulk water, since the way water is allocated for use among sectors and regions will carry the opportunity cost component for all calculations of costs and values along the distribution path. At the bulk water level, allocation is considered mainly among sectors. Each sector is usually associated with different "water value" levels that result from its use. Cited values range from less than US$1/m^3 in agricultural uses to nearly 100$US/m^3 in residential and industrial uses.[8]

19 Defining the link between water use and the opportunity cost of water introduces another concept—water allocation—into the framework.[9] Chapter 4 deals with water allocation principles and pricing objectives in detail. Table 2.1 below highlights the advantages and disadvantages among common water allocation mechanisms. At least one message is clear from this table: public water allocation is the least effective and efficient mechanism. Determining the right mix of pricing, market, and user-based allocation approaches is more complicated. The remainder of this chapter offers guidance for making such a determination.

[5] Moore and Willey 1991, Gibbons 1986.
[6] Adapted from Briscoe 1996.
[7] Winpenny 1994, Briscoe 1996.
[8] Gibbons 1986, Young 1996, Briscoe 1996.
[9] Spulber and Sabaghi, 1998.

Table 2.1 Advantages and Disadvantages of Various Water Allocation Mechanisms

	Marginal cost pricing	Public allocation	Water market	User-based allocation
Advantages	• Theoretically efficient, and minimizes overuse. • Easy to combine with taxes to internalize externalities. • Easy to adjust to varying water supply quantities.	• Promotes equity objectives, independent of the charge.	• With appropriate design achieves high allocative efficiency. • Allows internalization of externality costs. • Flexibility in responding to changing market conditions. • Allows compensation.	• Flexibility to adjust to local conditions. • Political acceptability. • Easy to adjust to varying water supply quantities.
Disadvantages	• Time-span sensitive. • Depends heavily on nature of demand. • Neglects equity issues. • Difficult to implement.	• Fails to provide incentives for production and use efficiency. • Subject to political pressure. • Inflexible with regard to inter-sectoral allocation.	• Sensitive to existing physical, legal and institutional frameworks. • Sensitive to level of transaction cost.	• Heavily dependent on local capacity. • Diseconomies of scale to institutional management.

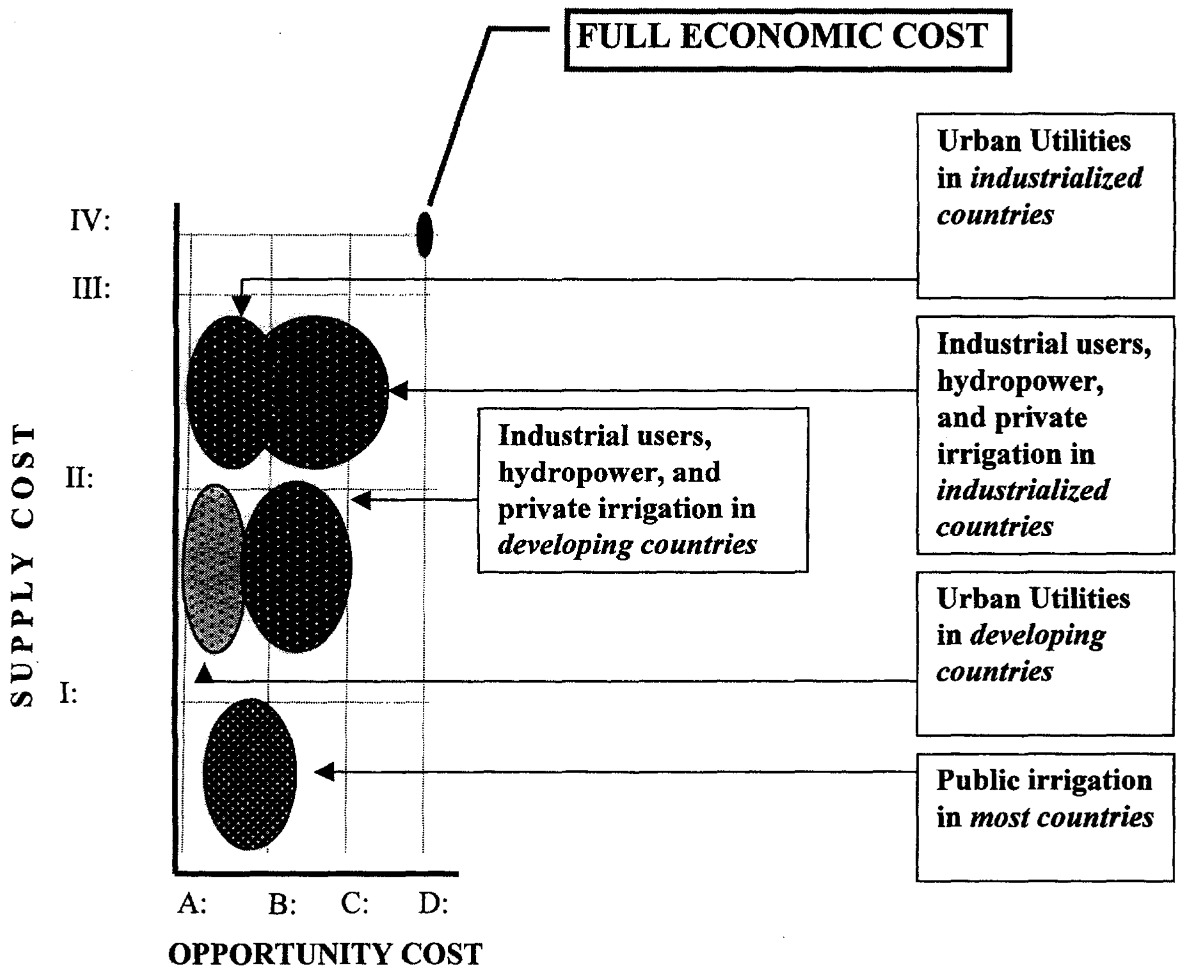
2.2.3 Balancing Water Values and Costs

20 In an ideal world, users should pay the full economic cost of water; that is: (a) the use cost that corresponds to the marginal financial cost of supplying water to the user; and (b) the opportunity cost that reflects the value of water in its best alternative use. The combination of use and opportunity cost is known as the full economic cost, as shown in Figure 2.1 below.[10]

21 In reality, however, even in the best cases, for urban water users in industrialized countries and a few in developing countries, only full average financial costs are recovered (level III in Figure 2.1). Among other reasons, much has to do with the special characteristics of water described above (Section 2.1). Practical considerations also come into play, such as the relative administrative ease of managing simple rather than complex tariff systems and the difficulty in estimating opportunity costs. For the majority of urban water users in developing countries, cost recovery is even lower (level II, Figure 2.1). These utilities face not only the same practical considerations as industrialized country utilities, but also much more rapidly growing costs (as the demand for new supplies increases), and a history of subsidized investments and cost pricing. In the case of irrigation, cost recovery tends to fall into levels II and III for users of private systems (depending on the level of energy subsidies), and level I for users of public systems (where governments tend to subsidize nearly all costs except operations and maintenance).

[10] Adapted from Briscoe 1997, 1996.

Figure 2.1



<u>Legend</u>:

Supply Costs:
I: Operations and maintenance costs only
II: Average financial (capital + O&M) cost, with capital valued in terms of historical costs
III: Average financial (capital + O&M) cost, with capital costs computed in replacement terms
IV: Long run marginal cost of additional supplies

Opportunity Costs
A: Water can be used only by an individual user
B: Water can be leased or sold to neighbors
C: Water can be leased or sold within a limited district
D: Water can be leased or sold to any urban or agricultural user

22 In light of the above, setting the achievement of full economic cost recovery as a bulk water pricing objective seems to be neither appropriate, sensible, nor attainable. In terms of cost recovery for use costs, there is still a long way to go just to achieve marginal cost pricing for average financial costs across all use types. As for charging opportunity costs, as a cash price, it is nearly impossible to make a good argument that reformers should integrate opportunity cost pricing into their systems for two reasons. First, demand for water is only somewhat elastic. Non-agricultural consumers can only use so much water at prices higher than agricultural users pay. Once non-agricultural users get an increased water allocation, the opportunity cost will drop. Second, socioeconomic realities in most countries, particularly developing countries, would render any implementation of opportunity cost pricing highly impractical. In fact, as the 1997 International Commission on Irrigation and Drainage Conference concluded, it would be inappropriate to roll opportunity costs into water tariffs for three main reasons:

- because the information requirements are onerous (opportunity costs vary dramatically by place and season);
- because levying such charges would (usually correctly) be perceived as expropriation by those who currently use the water;
- because it would defy common sense—using the numbers cited earlier in this paragraph it would mean that farmers in, for example, Chile, Australia, and California would be asked to pay more than 10 times the cost of providing the services they receive!

23 More and more international experts[11] conclude that from a conceptual, practical, and political perspective, the appropriate approach for ensuring that the scarcity value (i.e. opportunity costs) of water is transmitted to users is to clarify property rights and to facilitate the leasing and trading of these rights. This means creating the necessary conditions for water markets to emerge.

2.3 Institutional Aspects of Implementing Bulk Water Pricing Reform

24 The economic framework described above provides a strong rationale for introducing bulk water pricing reform. From an economic perspective, marginal cost pricing is the most efficient and effective tool, with the important caveat that opportunity costs are best handled by creating conditions for water markets. However, implementing bulk water pricing reform does not take place in an institutional vacuum. Similarly, timing the implementation of reform(s) is equally important. The following provides a framework for considering the institutional aspects of reform, with examples of application to Brazil, as well as options for the sequencing of reform processes.

2.3.1 Institutional Economics and Water Resources Management—Theoretical Framework

25 Over the past decades, institutional economics has developed as a compliment to mainstream neoclassical economic theory. Its key concepts are bounded rationality, institutions, transactions costs, and path dependence, which will be discussed.

[11] Briscoe 1997, Bromley 1998, OECD 1999.

26 *Bounded Rationality.* This concept is a realistic modification of the neoclassical notion that individuals *always* act rationally to maximize their own utility. Rather, bounded rationality asserts that individuals *try* to be rational and to maximize their utility, but they are not completely able to do so because: in the real world they never have complete information; and even if they had, they would not be intellectually capable of processing it all.[12] Nevertheless, the concept of bounded rationality does recognize the attempt to be rational in an economic sense. This is important because it means that individuals react to incentive structures in a predictable manner. For example, if a good is free, individuals are assumed to use more of it than if they had to pay for it. The implication is that, on the one hand, an analysis of the incentive structures individuals face can explain why they behave in a certain way; on the other hand, it is possible to design a management mechanism that permits the application of economic instruments that induce a certain behavior, such as the efficient use of water.

27 *Institutional Arrangements.* Incentives must have an origin if we assume that individual actors are susceptible to them. Institutional economists maintain that institutional arrangements, such as regulations and laws, are such incentives, but incentives can also be informal such as customs and codes of behavior. Here, institutional arrangements that act as the "underlying rules of the game" are considered distinct from actors, i.e. individuals, agencies, and organizations. Together, institutional arrangements and actors compose the institutional framework.

28 Institutional arrangements affect actors' decision making through formal and informal contracts which are used to exchange goods, to gain access to public goods, and to retain the rights of acquired goods. The institutional framework can facilitate these (trans-)actions, for instance by providing clear rules on contract layout and by helping to enforce them. This is typically the case for property rights, particularly ownership.

29 Regarding water resources, property rights to water can take various forms. For example, a property right can be established in relation to the right to use of water. This is the case in the Northern Colorado Water Conservancy District in the United States. There, permanent ownership of the water right exists: owners of water rights can use the water, are entitled to appropriate its returns, and may transfer the water right to others. However, the ownership of the water resource itself remains with the state government.[13] At the same time, ownership of the water rights is limited in a number of respects, the most important being that the water rights can be transferred freely within the district, but cannot be sold, or given away, outside the district. The reason for this restriction is based on political decisions that the water source was developed for the benefit of this particular area and should remain there. This example demonstrates that property rights are embedded in rules that can be designed, changed, and adapted to different situations and physical conditions. It must be recognized, however, that the constraints imposed on ownership rights change their value in the eyes of the owner, potential acquirer, and other interested parties.

30 *Transaction Costs.* Transaction costs[14] are: the inevitable transaction costs in terms of time and effort of negotiating, monitoring, and enforcing the terms of a contractual agreement; strategic

[12] Simon 1982

[13] Kemper and Simpson 1998.

[14] Following Ostrom, Schroeder□ and Wynne 1993.

costs;[15] and information search costs. Each category consists of ex-ante and ex-post transaction costs. Transaction costs play a major role in the context of water resources management. Considering allocation requires information about the number of water users, how much water they draw and when, what types of uses there are, and so on. As to water use, individual users need to know how much water their systems, clients, or crops usually consume, which crops yield the highest returns, how much water they will receive at a given point in time, how much the water costs, etc. In the absence of this type of information, or if the transaction costs in terms of time and money for obtaining such information are too high, water users do not have incentives to use water efficiently. If they, for instance, do not expect that they will actually have to pay for the water they are using, they will not change their behavior and use less.

31 *Path Dependence.* Path dependence implies that both *historical* and *current* institutional structures condition the potential for change. The notion is taken from the technological realm, where the initial investment in one particular technology frequently leads to further development of that technology rather than a radical switch to new, possibly more efficient solutions, because of the transaction costs of developing and introducing an entirely new alternative. In the case of water resources management, this sort of "lock-in" to a particular institutional approach very much underlies the challenge in many countries to move from treating water as a free good to managing it as an economic resource.

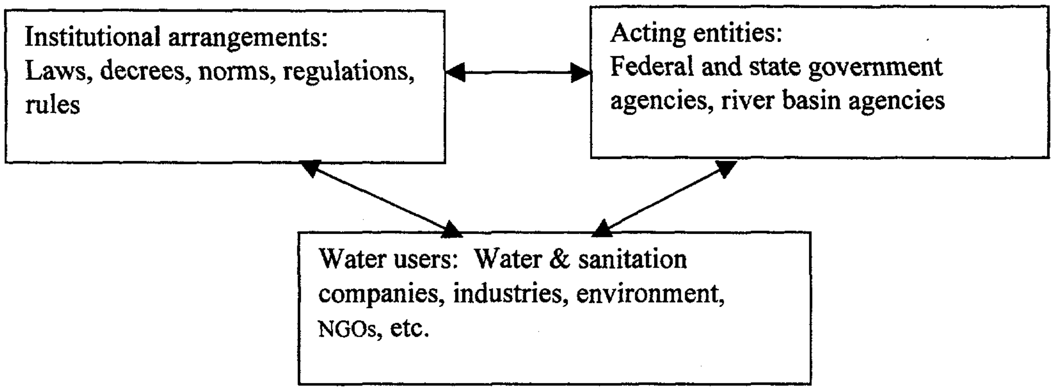
2.3.2 Implications of Institutional Analysis for Bulk Water Pricing Reform in Brazil

32 Reform processes generate winners and losers. Depending on their relative gains or losses and power positions, they will have varying impacts on the reform process. Figure 2.2 roughly depicts the institutional set-up for water resources management in general and water pricing issues in particular.

Typically, an institutional framework for water resources management is characterized by institutional arrangements such as laws, legal norms, and regulations on one hand, and actors such as water users, government agencies, and river basin agencies on the other hand. The arrangements can be regarded as guidance and incentives to the actors. In traditional systems, the water users, who in Figure 2.2 below are depicted as a third category, have had no say in determining the framework. They have been merely dependents. In the new evolving frameworks, as in Brazil, water users are recognized as stakeholders and interact officially with entities such as the government that until now have made the rules and influenced norms and regulations.

[15] Due to space limitations, this type of cost cannot be treated in detail. Literature about these costs and their adverse effect on efficient contracting is extensive, e.g., Stiglitz 1989, Akerlof 1970, Stevens 1993, Repetto 1986, Buchanan, Tollison, and Tullock 1980.

Figure 2.2. Institutional Framework for Water Management



34 *The Water Users*. In most Brazilian states, water users pay nothing for bulk water. What incentives would they have to start paying? Based on institutional theory, they would only pay if their gains outweighed the costs (including transaction costs of setting up monitoring systems, registering, making regular payments, etc.). Furthermore, as indicated below, they would only participate in bulk water pricing reform if they were actively involved in water resources management activities. This involvement may take the form of contractual arrangements, legitimate connections to government intervention, or user-based allocation (i.e., participation in river basin agency activities). In all cases, the underlying driver is that users perceive they will receive tangible benefits from contributing to bulk water pricing reform.

35 Ceará (see chapter 3) illustrates the case for industries. Users are paying for bulk water mainly because they already paid a high price for water; pricing reform merely split their tariff into two parts, one of which is now designated as a bulk water payment. Thus, in terms of costs, they have not been subject to change. Current users probably do not see an immediate gain, either. However, new industrial users might see a gain since Ceará's government intends to improve the bulk water supply system to Fortaleza and its emerging industrial districts. In a semi-arid region, contractual arrangements to guarantee water supply is one of the key factors attracting industries. If the price for this guaranteed water enters in their cost-benefit calculations from the beginning, the willingness to accept a tariff for bulk water can be expected to be very high. Thus, the institutional framework that affects the reliability of water supply can fundamentally shift a long-standing cultural norm that the government is responsible for investments, operation, and maintenance costs of water supply systems.

36 In regions of Brazil where water is more abundant, the situation for introducing water pricing differs from that in the Northeast. Many industrial users do not perceive a water crisis yet, and in many areas there is still a perception that water is plentiful and pollution is not an issue. Obviously, this depends on the type of industry. Typically, industries related to beverages and food are quite susceptible to water quality issues and there is evidence (the experience in the Rio Doce is an example) that such industries are willing to contribute significantly to improve the situation. Their reputation hinges not only on the actual quality of water but also on public perception of it.

37 Other industries, however, may simply feel taxed if they are made to pay for water they had been using without payment. It is in this context that the overall changes in Brazil's water resources management framework come into play. If appropriately implemented, plans to decentralize water resources management to the river basin level will encourage users to actively participate in the water resources planning and allocation process. For the first time, users will have an incentive to contribute because they can benefit from participating. Through this mechanism they will obtain access to information about the water situation in their river basin, be able to influence the allocation of investment resources, and may follow up on sanctioning mechanisms. Again, the proposed institutional framework will play a crucial role in enabling the implementation of bulk water pricing reform.

38 In this regard, the financial aspects of the Federal Water Resources Law of January 1997 are critical. For example, the law stipulates that not more than 7.5 percent of the financial resources collected in a basin can be transferred out of the basin. This is a vital guarantee for water users to retain control over their funds and ensure that the tariffs they pay will be put to their intended use. In this way the costs of the tariffs will return to them as gains in terms of improved water quality, improved infrastructure, and improved information systems. If the institutional framework to enforce this law is not firmly established, users will have little incentive to participate in the reform. As outlined in section 2.3.1, path dependence and bounded rationality, human beings react to what they know according to their perception of reality. If water users perceive that funds are largely diverted to state or federal coffers, or are not released in time, they will continue to act as they always have, in this case not paying for something that they can also get for free. In their view, payment would not procure any benefits. With a weak monitoring system, the fear of sanctions would not work as a deterrent, either.

39 To date, this has been true for bulk water and sanitation utilities, most of which have been exempt from any payments for water. In some states, like São Paulo, they have been legally obliged to pay for pollution loads, yet these payments have not been enforced. These utilities (state-owned or newly privatized) must recognize that they are not excluded from the management framework and that they will also be subject to bulk water tariffs. Change could be expected from the entrance of private sector providers into the market. In this case, however, it will be of utmost importance to connect the resource discussions (tariffs for bulk water) to service delivery discussions. At present a number of contracts are being negotiated without apparent regard to the likely increase in the cost of water in the near future if bulk water tariffs are to be implemented. By not taking this cost into account from the beginning, an important opportunity may be lost to change the prevailing perception that bulk water for the urban service sector is free. It might also create legal and contractual problems between the private companies and the concessioning authorities.

40 *Federal and State Agencies.* When bringing about institutional change, the issue is not only how the "receiving end" will react, but also which incentives the promoting entities have at their disposal. Without doubt, there is strong commitment in Brazil to improve water resources management and to make bulk water pricing an important ingredient in this improvement. At the same time, introducing an additional cost factor into an already strained economic situation is not an easy task for the authorities. This can be seen in the state of Minas Gerais, which preferred to

delay its pricing discussions until the passage of the Federal Water Resources Law in 1997; the law makes bulk water pricing mandatory. Again, it is easier to introduce bulk water pricing if water users receive something in return, such as greater transparency in decision making, more secure access to water through the introduction of appropriate contractual arrangements, or assurance that the collected funds will stay in the river basin or be matched by outside funds through investment projects.

A further issue arising in this context is the build-up of an adequate monitoring and enforcement framework, which is essential to achieve compliance with the new tariff payment obligations. In some cases, river basin councils will have their own agencies; in others, current state or federal authorities will take on the responsibility of charging and collecting tariffs. In the cases where existing authorities are replaced by newly founded agencies, certain resistance toward the proposed changes can be expected. Why should existing agencies contribute to their own dismantlement? This potential resistance should be taken into account when assigning roles to authorities as promoters of change.

2.4 Options for Sequencing Bulk Water Pricing Reform

42 As the situation in Minas Gerais highlights, determining when to introduce reform is as important as establishing the institutional framework that provides the appropriate incentives for reform to be carried out. The following illustrates several examples of sequencing bulk water pricing reforms in India and South Africa. More examples prevail elsewhere, but the differences are not significant.

2.4.1 Suggested Options

43 Experience shows that alternative approaches for introducing water pricing reform policies have had various degrees of success in different countries; therefore, a prescription is out of the question. The following options are based on actual approaches tested in several countries. In Brazil, or any other federated country, a certain approach may be appropriate for some states, while another approach better fits conditions in other states.

44 *Phased Approach: Long-Term Vision, Progressing One Step at a Time.* The phased approach, progressing carefully one step at a time, proved successful in the state of Orissa, India.[16] In this instance the government laid the groundwork by both addressing the issues and involving the stakeholders. The process duration was reasonably lengthy. The risk with this approach is that it may take longer than anticipated, and if the participatory parts are not well structured, it may not materialize.

45 *Phased Approach: Learning By Doing.*[17] The learning by doing phased approach, used in South Africa,[18] has the advantage of being flexible and adjustable as it evolves. However, because the process has "myopic" objectives at each stage, it may be derailed, or take too long.

[16] Analysis of approach from Wood 1998.
[17] Wood 1998
[18] DWAF 1995, 1997

46 *Big bang Bang Approach.*[19] The big bang approach, as applied in Andhra Pradesh state in India,[20] may be appropriate in crisis situations where the financial or physical conditions of the sector are at stake. This approach is based on the idea of implementing changes before the opposing forces can get organized to stop the change, and necessitates both leadership and collaboration.

2.4.2 Pros and Cons Analysis of the Sequencing Options

47 The following comparison highlights the pros and cons of the options indicated above. Table 2.2 can be used as a framework for this comparative analysis. This table merely highlights the experience in each of these examples, but details are provided in Annex 1 of this paper.

48 The usefulness of this framework is, again, not to recommend any particular prescriptive model to be adopted for bulk water pricing reform in Brazil. Rather, the framework serves two purposes: it provides examples of real world experiences which, to a large extent, validate the economic and institutional conceptual framework described above; and it enables the identification of several salient, cross-cutting themes that can help guide the reform effort in Brazil.

49 The two, perhaps most critical, themes are: to undertake reform only when there is a powerful, articulated, and clearly recognized need for reform (these are the "enabling factors" identified in the table below); and to involve all users and other stakeholders in the process. Other themes include: paying attention to general principles, but adapting them to different institutional circumstances; integrating water markets not as a panacea, but as part of an overall institutional framework; starting with the easier problems to build momentum; and acknowledging that there are no perfect solutions.[21]

[19] Wood 1998
[20] Analysis of approach from Wood 1998
[21] Briscoe 1997

Table 2.2. Alternative Approaches for Introducing Water Pricing Reform Policies

	Approach 1 Phased/Long-Term Vision	Approach 2 Phased/Doing by Learning	Approach 3 Big Bang
Country	Orissa, India	South Africa	Andhra Pradesh
Description of the approach	1. Establishing a Water Rates Cost Recovery Committee to annually review and determine charges. 2. Incremental public awareness. Communication via staff and NGOs. 3. Incremental user participation. User group formation. Assess performance and satisfaction. 4. Substantial pilot assessment. 5. Incremental price increase (5 years: 0, 50, 80, 100, 100 percent of cost recovery). 6. Incentives for user groups, which are proportional to collection rate achieved.	1. Identification of components to be covered by the pricing reforms. 2. Modification of legal and institutional aspects such as use rights and government support. 3. Identification of user groups to be affected by the reform. 4. Incremental implementation with considerations to negative effects of user groups. 5. Modification of implementation plan based on user impacts.	1. Preparing a 'white paper' indicating the need for reform, and the methodology and values. 2. Issuance of a new irrigation water sector policy. 3. Tripling of water charges. 4. New legislation for user management. 5. Community outreach. 6. Creation of water user association. 7. Establishment of water pricing institutions. 8. Increasing capacity of administration staff, WUA, and NGOs. 9. Joint user-administration walk through.
Conditions prevailing in the country	1. Cost recovery rates close to zero. 2. Revenue collected not by service provider.	1. Extreme unjust allocation of water resources among social groups. 2. Heavy subsidy of water project by Government. 3. Very limited new water resources for development.	1. Weak water administration. 2. Absence of user involvement.
Enabling factors	1. Service level and system maintenance very poor. Clear that a change is necessary.	1. A new South Africa necessitates new water policy. 2. Strong recognition of a need for change by all parties.	1. Crisis level water problems. 2. Strong political support at highest levels. 3. Highly competent professionals leading the reform program.
Problems encountered	1. Delay in implementation. 2. Reform legally challenged by large industrial customers.	1. Inability of the majority of the new users to pay real water cost. Need to consider personal subsidies.	Not Reported.

Source: Wood 1998; DWAF 1995, 1997

3. Brazil: Background and Recent Developments

3.1 Background

50 Fresh water availability in Brazil has been estimated at approximately 12 percent of the world's total. With such abundant water resources, it is not surprising that water in Brazil has been considered a free good—a gift of God. However, due to the naturally uneven[22] distribution of these resources, combined with rapid population growth and industrialization, conflicts over water use have intensified in recent years.

51 Driven by a population that has tripled since the 1950s (now reaching 160 million), along with rapid industrialization and urbanization, and expanding irrigation, pressures for increased water supply are intense. Annual industrial demand is approximately 4.4 billion m^3 per year. With 3 million ha irrigated (only a fraction of the total potential), agriculture is the largest water user, and there is rapidly growing interest in expanding irrigation. At the same time, most (94 percent) national energy is hydroelectric, with production expected to expand at an annual rate of 15 percent through the year 2000.

52 In general, federal and state government water allocation and management systems have, until recently, been inefficient and ineffective; although some states such as São Paulo, Ceará, and Bahia, have made significant advances in terms of promoting water allocation and monitoring systems and bulk water pricing. Installation of many irrigation intakes, small hydroelectric plants, and wells are neither authorized nor registered. Waste discharges are rarely monitored, and untreated urban and industrial sewage is commonly released directly into rivers and lakes, with little or no charge to the polluting agencies and enterprises. As a result, water resources have been wasted and water quality has deteriorated notably around most major industrial and agricultural centers.

53 The increasing demand for water services and inadequate attention to water quality translate into potentially huge investment costs over the next several years. With public financial resources rapidly declining and limited institutional capacity to absorb the financing that is currently available, many in Brazil are considering more effective water pricing as a fundamental means of allocating water resources more efficiently and generating funds for sustainable operation and maintenance (O&M) of existing infrastructure.

54 The Brazilian legal framework for water resources management is based on the constitutional distinction between federal and state waters. Federal waters are those that flow across state boundaries or along the boundaries between two or more states or a foreign country. State waters are those situated entirely within the territory of a single state. Formal water use rights allocation has been limited to hydroelectric and public irrigation projects. The traditional

[22] Of Brazil's water, 80 percent is in the Amazon Basin, accounting for 63 percent of the territory but only 5 percent of the population. The Northeast, with 13 percent of the area and 35 percent of the population, has only 4 percent of the water resources. In the South and Southeast regions, with 60 percent of the population, water scarcities are due to the deterioration of water quality.

perception of water use rights as a public good, rather than an economic good to be allocated to the private sector, has stymied the development of a manageable water use rights system.

55 However, numerous reforms are under way. At the federal level, new water legislation (Law 9,433 passed in January 1997) recognizes that bulk water is an economic (not free) good, which should be charged for in order: to achieve rational allocation; and to create financial resources for integrated water resource management at the river basin level. Implementing the law still requires the passage of detailed regulations, which are currently under formulation. In the meantime, the use of water tariffs for federal water is supported both by the country's Civil Code, which states that "common use of public goods can be free or charged according to specific legislation at Federal or State level"; and by the Water Act of 1934, which states that "the common use of waters can be charged in accordance with laws and rules of the administrative region where they belong." Several states (São Paulo, Ceará, Bahia, Paraná, and Rio Grande do Norte) have already enacted state water laws provide for the establishment of water tariffs for bulk water supply. These states are now working on studies to develop specific pricing proposals and regulations. So far, Ceará is the only state to introduce bulk water tariffs, which it did by official decree in November 1996 for municipal and industrial water use. Water and environmental laws in several states also include provisions for the establishment of pollution charges that may be estimated in accordance with the amount of waste load contained in effluent discharges.

3.2 Current Practices

3.2.1 Bulk Water Pricing in Brazil

56 In general, no bulk water fees are charged for the use of water for irrigation or for water supply. In the hydroelectric subsector, a royalty fee (based on a percentage of the revenues collected by power companies) is paid to those states and municipalities where hydroelectric infrastructure and facilities are located.[23] Water users in urban centers pay for the treatment and distribution of water and the collection of sewage, whereas farmers in public irrigation projects pay a tariff for the O&M of the projects. Current practices include primarily the use of water user charges to cover O&M costs of water resources projects.

57 The establishment of bulk water tariffs is currently one of the most emphasized pricing mechanisms in Brazil. The actual implementation of bulk water supply tariffs is rapidly taking form in many states. Studies are being carried out around the country and some of the representative cases are presented below.

58 *State of Ceará.* In the state of Ceará, a bulk water tariff system is already in place to enable the state's bulk water supply company (COGERH) to establish an appropriate tariff structure, initial tariff level, and timetable for increased tariffs to gradually achieve cost recovery of O&M and some investments in new water storage and conveyance infrastructure. The key constraint is that the unit price of bulk water cannot surpass many users' willingness to pay.[24]

[23] See, for example, Seroa da Motta 1996.
[24] In economic terms, this refers to the ability or capacity to pay.

59 Water user associations (WUAs)[25] are encouraged by COGERH to discuss and plan water supply and distribution criteria. COGERH provides technical information and finances meetings, guiding users to come to agreement. The State Water Council, with governmental and non-governmental representatives, dictates water policy. COGERH acts as an executive body of this council and as a basin agency for user associations. Although WUAs are part of the water management institutional setting and have a role in the decision-making, state intervention through the State Water Council and COGERH is dominant.

60 This centralized structure based on a state company differs from other institutional settings being adopted in other Brazilian states. A decentralized structure could prove to be inefficient considering Ceará's institutional capacity and the fragility of its water system in terms of severe water scarcity and reliance on integrated management of reservoir and conveyance systems.

61 To implement the COGERH strategic plan, a preliminary study was carried out to obtain a rough projection of the company's financial outlook for the years to come. The study set US$18/1,000 m^3 as the initial unit price of bulk water. This value was chosen so that the increase in expenditure for a poor family living in an urban center would not exceed approximately 1 percent of the family's income, putting aside the effect of subsidies.

62 The other assumptions of the study were: that COGERH would pay US$1/1,000 m^3 for water released from federal reservoirs[26] which is currently free of charge; that water losses would be 30 percent of the water volume yield from the reservoirs; that about 30 percent of the bulk water would be delivered to the very poor, who cannot pay anything; that COGERH would be able to charge those users who are supposed to pay 30 percent in the first year, steadily increasing the rate until the fifth year, when it would reach 70% and remain at this level in the following years; and that for those who pay, the unit price would increase from 60 percent (in the first year) to 100 percent (in the fifth year) of the nominal unit price of US$18 per 1,000 m^3.

63 Under these assumptions, COGERH's revenues would grow from zero in the first year, 1995, to US$17.7 million in the tenth year, while the O&M costs would grow from US$1.8 million in the first year to US$6.5 million in the tenth year.[27] After the tenth year there would be a steady financial flow. Its present value (discount rate of 8 percent) is very close to the present value of the US$110.0 million water resource program launched in 1994, assuming that the investments are uniformly spread over a 10-year period. This attractive result is only possible because COGERH would not pay for past investments made by the federal and state government for water resources infrastructure.

[25] Water user associations are common around the world; in most countries, they typically consist of groups of irrigators who associate because of common interests. In Brazil, however, depending on the region, WUAs may also include industrial, urban, and other users or stakeholders.

[26] According to the constitution, water stored in reservoirs built by federal agencies (e.g., DNOCS) in state rivers remain with the federal government. Therefore, COGERH would have to compensate DNOCS for the use of the reservoirs.

[27] During 1997, total revenues reached US$2.2 million, while O&M costs were US$0.6 million, and total Administration, Operation and Maintenance (A, O&M) costs were US$3.7 million.
Source: Management Report of the Board of Directors, COGERH, 3/11/98.
Note: This reference does not constitute an audited financial statement.

64 In 1997, COGERH collected a revenue of US$2.2 million from the management of 85 reservoirs, mostly dedicated to domestic supply. The company's expansion is now aimed at the rural areas, and its main strategy is to introduce efficient O&M procedures. On the supply side it is targeting several activities, including the construction of channels to integrate reservoirs with the objective of maximizing water supplies, and the construction of new water facilities.

65 COGERH is using pricing measures to adjust demand and gradually introduce water scarcity values to users. In doing so, its water pricing policy takes into account ability-to-pay criteria in which the industrial sector contributes with the major share of revenue, cross-subsidizing households and rural users to reach the revenue goal.[28] Currently, industrial sector revenue is about 65 percent of total revenue, compared to a domestic consumption share of less than 5 percent. In the near future, the revenue share of the industrial sector is likely to remain high, as industrial demand increases with the accelerated industrialization taking place in the region.

66 Currently, only industrial and domestic users (through sanitation companies) are charged, although other users will soon be charged for bulk water use as well (Table 3.1).

Table 3.1. Bulk Water Pricing Structure in Ceará

<table>
<tr><th></th><th>Current Prices (US$/1,000 m^3)</th><th>Estimated Annual Revenue (US$ million)</th><th>Proposed Prices (US$/1,000 m^3)</th><th>Estimated Annual Revenue (US$ million)</th></tr>
<tr><td>Industrial</td><td>**545.50**</td><td>**100**</td><td>**663.60**</td><td>**121.65**</td></tr>
<tr><td>Municipal</td><td>**9.10**</td><td>**250**</td><td>**11.10**</td><td>**304.95**</td></tr>
<tr><td>Irrigation and aquaculture</td><td>----</td><td>**150**</td><td>**1.10**</td><td rowspan="2">**185.78**</td></tr>
<tr><td>Others</td><td>----</td><td></td><td>**11.10**</td></tr>
<tr><td>Total</td><td>**554.60**</td><td>**500**</td><td>**686.9**</td><td>**619.27**</td></tr>
</table>

Note: exchange rate - R$1.10/US$1

67 As can be seen in Table 3.1, prices for industrial users are 60 times higher than those for municipal users, who in turn pay as much as 10 times that paid by rural users. This pricing policy is mainly due to: the very low level of per capita income, and the water pricing system adopted by the state sanitation company.

68 One of the poorest states in Brazil, Ceará's per capita income is less than US$2,500.00 per year.. Therefore, there is not much room to increase water prices for low-income domestic users and farmers. This distributive restriction is a sensitive criterion which makes the COGERH system viable, although the company is willing to allow prices to rise gradually (though they may not reach full cost recovery), as an "educational" indicator of water scarcity to adjust demand in the long term.

[28] Rural users are not yet being charged for water consumption.

69 Prices of treated water delivered by the state sanitation company[29] (CAGECE) already have a price component, referent to the payment of bulk water supply. It is already recognized, however, that COGERH's better management and planning, and the increasing reliability of bulk water supply, will increase the value of the bulk water, although this may only come with an adjustment in the prices of treated water.

70 Direct bulk water supply to the industrial sector (previously under the management of CAGECE) has been placed under the management of COGERH. COGERH expanded this supply with small investments on short links to the distribution systems, and prices have been adjusted in exchange for stability of supply. Industrial water users are COGERH's main source of revenue.

71 The expected expansion into rural areas will impose a heavy financial burden on COGERH, without means of applying any full cost pricing. Irrigation is mainly devoted to low-value crops. Physical water losses are usually high in the agricultural sector. The introduction of increasing water prices (although much lower than full cost) is expected to pave the way for a reduction in losses and a change in the production pattern.

72 Apparently, however, for the near future the company will keep its pricing policy of cross-subsidizing households and rural users from industrial users, primarily in surrounding areas of Fortaleza. According to the company's analysis, this option is fully viable since total water charges in Ceará are lower than in the rest of the country, and prior investments made by federal agencies have been decentralized at no residual cost.

73 The potentially successful case of Ceará is very impressive. However, one should take into account the particular characteristics of this state's water supply and demand before advocating its replication in other regions of Brazil. It is important to first recognize the specific determinants of the Ceará case, and then select the features most appropriate for each state's reality.

74 It is argued that Ceará has been a pioneer for five reasons, namely:

1. Water in this state is very scarce since there are no perennial rivers in the region; therefore, water management is of paramount importance to overcoming the annual dry season and drought periods;

2. Because of this severe water scarcity, Ceará does not have the means to generate hydroelectric power. Consequently, the state does not receive a share of the legal financial payments that are accrued from the energy sector and which provide a "free" fund to water resources management in the regions where hydroelectric plants are located;

3. To cope with this absolute and seasonal scarcity, about 7,500 reservoirs were built in the state.[30] Yet these reservoirs have not been successful in providing a reliable water supply, and

[29] There are a few other municipal companies where such a policy is not applied, but they do not represent more than 5 percent of the total state consumption.

[30] Other states in the Northeast, such as Rio Grande do Norte, have the same water scarcity issues, and they are

dramatic shortages continue to occur during severe drought seasons, as occurred in 1998. Federal government investments had almost disappeared in the public deficit crisis of the 1980s, so the state had to fund this massive investment;

4. Ceará has been promoting an aggressive program of industrialization and coastal tourism, taking advantage of its low salary economy and land prices. Clearly, a reliable water supply is a key factor to the success of this program; and

5. There is no major federal river in Ceará. Consequently, the state government is free to implement its own policies, without waiting for federal regulation.[31]

75 Ceará has not attempted to introduce pollution components into its water pricing structure, thereby avoiding a rather complicated matter. This simplifies the problem, as the implementation of a bulk water pricing structure based on quantity is similar to those of utilities such as energy.

76 The absence of water pollution in the pricing structure may seem reasonable in a drought-prone region, although quality degradation also leads to reduced water supply. Taking into account the state's commitment to industrialization, water pollution pricing could be an important factor in adjusting industrial patterns to water availability.

77 In conclusion, the Ceará case, rather than a generalization, should be seen as a particular solution to a particular situation. However, the main message is general: water pricing is viable even in poor regions and can play a decisive role in better water management and increased user participation.

78 *Water Charges in State Legislation.* Since the early 1990s, several states have enacted new legislation regarding water resources management. In all cases, this legislation incorporates the following principles: water resources management at the river basin level; state water resources management plans to guide policy and investment decision making; individual water use rights; and water pricing for both quantity and quality aspects.

79 Table 3.2 shows that the level of charges set in such legislation is based on environmental quality, water availability and hydrological characteristics, and type of use. In some states (including Minas Gerais, Bahia, and Rio Grande do Norte) other criteria are included, such as change in location, regional priorities, and socioeconomic conditions. In at least seven states, the revenue collected from water charges for a given basin is allocated to a water management fund, from which a portion of the revenue is allocated to other basins.

already developing similar reservoir systems.

[31] Federal water from the Parnaíba River on the border with the state of Piauí has no major role in Ceará's overall water supply system.

80 In general, more specific water pricing calculations are left for the regulatory stage. However, no state law clearly defines the process of determining specific water charges. Rather, most laws only indicate that state water councils will approve specific water charges proposed by committees. It would be more transparent if these charges were defined under detailed regulations. The degree of intervention by councils, the role of the water resource agency in such councils, and the determination of charges should also be defined under these regulations.

81 Rio Grande do Sul's legislation is the first to define a minimum charge which committees decide whether or not to increase, using pre-established criteria. This is similar to the French system (see Annex 1). As described below, a recent proposal from the São Paulo State Water Resource Council (CRH) takes a similar approach, and it seems that other states will follow this trend.[32]

[32] The São Paulo case is a good reflection of the difficulty in reaching consensus on setting criteria for water charges. The state has been discussing this issue since 1991, and only now does it appear that an official proposal has been finalized.

Table 3.2. Criteria for Water Charges in the Texts of State Legislation

States	Application of revenue outside watershed	Revenue allocated to water management fund	Achieve better environmental standard	Change spatial occupation	Environmental quality (suitability)	Water availability and features	Type of use	Users' socio-economic conditions	Regional economic objectives
São Paulo (1991)	x	x			x	x	x		
Ceará (1992)	x	x			x	x	x		
Distrito Federal (1993)					x	x	x		
Minas Gerais (1994)			x	x	x	x	x	x	x
Paraná (1995)					x	x	x		
Santa Catarina (1994)	x	x			x	x	x		
Sergipe (1995)	x	x			x	x	x		
Rio Grande do Sul (1995)					x	x	x		
Bahia (1995)	x		x	x	x	x	x	x	x
Rio Grande do Norte (1996)	x	x			x	x	x	x	
Paraíba (1996)	x	x			x	x	x		
Pernambuco (1997)	x	x			x	x	x		
Rio de Janeiro (being processed)					x	x	x		

82 *São Paulo Proposal.* In October 1997, the State Water Resource Council (CRH) of São Paulo submitted a proposal[33] to define specific water charges for all types of use, including irrigation, recreation, and navigation. The proposal advocates setting charges based on a basic unit price (PUB), a maximum unit price (PUM), and an average total cost of annual production (CMR).

83 The PUB is estimated for: water withdrawal; consumptive use; BOD (biochemical oxygen demand); COD (chemical oxygen demand); SS (settleable solids); and inorganic load.

84 The total amount charged to a user for use j in basin i ($CT_{j,i}$), based on either water intake, consumption, or pollution emission, is calculated by multiplying PUB_j by the quantity of intake, consumption or pollution emission ($Q_{j,i}$), and by specific environmental coefficients specific to each basin ($X_{j,i}$), so that:

$$CT_{j,i} = Q_{j,i}\ PUB_j\ X_{j,i}$$

$CT_{j,i}$ = charge for use j determined by water intake, consumption, or pollution emission
$Q_{j,i}$ = pollution emission
PUB_j = basic unit price
$X_{j,i}$ = ecological factors depending on basin, to be determined by the basin committees

where $X_{j,i}$ values are decided by basin committees, but the $PUB_j\ X_{j,i}$ portion may not exceed the PUM_j.

85 The sum of all of a user's $CT_{j,i}$ may not exceed a specified percentage of the CMR (or an equivalent percentage of the billing). In other words, the water charge is based on the user's willingness to pay. The definition of these thresholds, however, appears arbitrary and not based on any explicit criteria of equity.

86 The French system was used as a reference to set the amounts for the PUB, allocate the costs of providing and expanding the supply of water, and allocate the costs of controlling pollution (by the estimated load, and by type of use and users). For allocation purposes, consumptive use was considered most damaging to the environment, whereas diversion least damaging since it only alters the course of rivers and does not produce pollution. All other forms of water withdrawal, regardless of the level of consumption, generate some type of pollution as they reduce flow and dilution capacity. In the case of sewage, given the limited data available, investments were distributed solely in terms of the charge for the estimated BOD load in effluents. Proposed values are shown in Table 3.3.

87 Table 3.3 shows that proposed prices for São Paulo are similar to those charged in France (as shown in Table A-1). For pollution charges, however, proposed prices for São Paulo are significantly lower than those charged in the French system which, in turn, are lower than in Holland and Germany.

[33] This proposal was prepared by a consultancy of the CNEC/FIPE Consortium.

Table 3.3. Proposed "Basic Unit Prices" for Water Charges in São Paulo

Item	Unit	Basic Unit Price in R$
Water withdrawn	m^3	0.01
Consumptive use	m^3	0.02
Effluent discharge		
- of BOD	kg BOD	0.10
- of COD	kg COD	0.05
- of SS	liter	0.01
- inorganic load	kg	1.00

Source: CRH 1997

$X_{j,i}$ values will be later determined by the basin committees. The proposal suggests that they will gradually introduce various ecological factors according to the following timetable:

<u>Years 1–3</u>: Type of water use (urban, industrial, etc.).[34]

<u>Years 4–6</u>: Class of river (in terms of water availability, environmental quality, recharging zone, etc.).

<u>Years 7–9</u>: Seasonal nature of water source[35] (peak period, flooding, etc.).

<u>Years 10 onward</u>: Any other additional differential factors.

88 The proposed gradual approach is recommended, although it is still difficult to charge for all types of use.

89 Regarding type-of-use charges for water consumption, higher prices are suggested for industry, intermediate prices for urban use, and lower prices for irrigation. For water quality the proposal suggests higher prices for irrigation than for urban use, particularly since there are numerous agri-businesses from which irrigation charges could be collected. Rather than being based on (economically) efficient pricing, this overall approach seems to be based on cost recovery objectives. Furthermore, even the cost recovery objective may be difficult to achieve, since price elasticity in the water sector varies depending on the type of use, implying that actual revenue may be significantly lower than projected.

90 Regarding classes of rivers, the higher the environmental quality, the greater the coefficient value. As in France, a higher price is adopted to induce greater control where the class of rivers is most sensitive.

[34] Recently (on 11/12/97), the State Water Resource Council decided to postpone charging farmers until the year 2004.

[35] Excessive use area in the case of ground water.

91 Using basic unit prices based on the above, annual revenues from the respective water charges have been estimated to be around US$500 million, with approximately 50 percent from urban consumption, 30 percent from irrigation and 20 percent from industry. However, this estimate assumes that price elasticity is zero, which (as noted above) is generally not the case. In reality, it is likely that users will adjust their demand for water once they are faced with paying higher water charges, thereby diminishing the actual amount of revenues collected.

92 *State of Rio Grande do Sul.* Lanna and Pereira's Rio Grande do Sul study (1997) is an unofficial proposal supporting the determination of a minimum price (similar to the PUB in São Paulo) which the state will charge for pollution. This pollution charge would vary by type of user. The study uses the Rio dos Sinos Basin as a model.

The criteria proposed in this study are:

(i) mitigation of pollution
(ii) revenue collection
(iii) cost of treating each source

93 Criterion (i) is somewhat similar to environmental quality and, as in the São Paulo proposal for basin coefficients, higher charges would be set to encourage greater control. Criteria (ii) and (iii) are similar to those used in the São Paulo proposal for calculating basic unit prices.

94 The study is distinct in that it determines basic unit prices using an optimization model. This model seeks to optimize the distribution of billing costs with respect to pollution control costs and the level of contamination in the section where the source is located.

The study produces several simulations and analyzes the impact of charges in relation to the operational cost of the industry, with three cross-subsidy scenarios (as shown in Table 3.4). Scenario 1 has no cross-subsidy and prices of the above model are applied in full. In Scenario 2, the industrial sector pays 40 percent of the costs charged to scattered rural sources. And in Scenario 3, industry pays for all rural costs (i.e., the charges to rural sources are fully subsidized by industry).

Table 3.4. Impact of Water Charges for Pollution in the Industrial Sector of the Rio dos Sinos Watershed, Rio Grande do Sul (percentage of operational cost)

Sectors	Scenario 1	Scenario 2	Scenario 3
hides/skins/similar	0.20	0.20	0.21
beverages/alcohol	0.02	0.02	0.02
textile	1.61	1.63	1.66
food	1.40	1.42	1.45
chemical/petro-chemical	0.00	0.00	0.00
metal/steel	0.0002	0.0002	0.0002
cellulose/paper/ cardboard	0.0003	0.0003	0.0003
public utility	1.40	1.42	1.45

Source: Lanna and Pereira 1997

96 One can see that the impact on the operational cost of industries varies little, from 1.40 percent to 1.45percent, with the different scenarios of rural/agricultural subsidies. Thus, non-inclusion of the rural sector would not jeopardize the objectives of the model and case study for Rio Grande do Sul. Furthermore, the political cost of rural inclusion is very high, as can be observed from the experiences of other countries. As the authors[36] indicate, the study's results suggest avoiding charging rural users during the system's implementation phase.

97 Despite the usefulness of the model and the above results, the calculations do not take into consideration adjustments that users will make when they respond to the new pollution charges. In addition, the prices produced by the model do not reflect optimum price criteria for minimizing costs or maximizing well-being as discussed in the economic literature. There is no assurance that the prices in the model are cost-efficient or that they include social costs.[37]

98 *State of Bahia.* The Bahia case study[38] focuses on two of the state's most important river basins—Alto Paraguaçu and Itapicuru. The study estimates water supply charges for irrigation, urban use, and electricity generation, as well as charges for heavy metal pollution produced from chromium mining.

99 For each basin, the study identifies willingness to pay estimates for water services, which support irrigation, urban use, and electricity generation. The estimates are based on covering all costs of water supply systems, including investments and administration, operation and maintenance. Using a public price optimization model, designed to set prices inversely

[36] Lanna and Pereira 1997

[37] The authors (Lanna and Pereira 1997) refer to this solution as one of "cost-effectiveness" because it is aimed at a more balanced distribution of water charge costs. In this context, they are not using "cost-effectiveness" in the sense of the minimization of social costs.

[38] Fernandez 1996, under the auspices of the State Superintendent for Water Resources.

proportional to price elasticity demands for different water uses,[39] the study then determines specific water charges for all types of water use in each basin.

100 The study focuses primarily on cost recovery, so price setting is analyzed in terms of revenue generation rather than pure economic or social efficiency. For pollution, prices are estimated for financing rather than externalities, and only for one type of pollution and user.[40] The author acknowledges this restriction and presents a sub-section dealing conceptually with this aspect.

Amounts to be charged are calculated under the following five scenarios:

Alto Paraguaçu Watershed:
CE : full cost charges for all uses
SE : full cost charges for all uses except power generation

Itapicuru Watershed:
IT : full cost charges for all uses
IR : full A,O&M cost and 25 percent investment cost charges
AP : full cost charges, with higher charges for pollution

Estimated charges, with the respective scenarios, are presented in Table 3.5 .

Table 3.5 Charge Estimates in Watersheds in the State of Bahia (US$/m³)

Use/Watershed/Scenario	Alto Paraguaçu		Itapicuru		
	CE	SE	IT	IR	AP
Irrigation	8.00×10^{-4}	8.00×10^{-4}	9.91×10^{-3}	2.17×10^{-3}	9.86×10^{-3}
Urban	2.76×10^{-4}	3.13×10^{-1}	1.08×10^{-3}	8.80×10^{-4}	1.08×10^{-3}
Power (1)	8.40×10^{-4}	----	---	---	---
Pollution (2)	---	---	1.52×10^{-2}	2.32×10^{-3}	1.80×10^{-1}

Notes: (1) only in Alto Paraguaçu Watershed; (2) only in Itapicuru Watershed (in US$/ton);
Scenarios- see text above.
Source: Fernandez 1996

101 Despite the emphasis on cost recovery, price variations with respect to demand elasticities can be important. For example, in the SE scenario (Table 3.5), for which users that generate electricity are not charged, the price charged for urban use increases. This is because the elasticity of urban use (0.04) is much lower than that for irrigation (0.39) in the Alto Paraguaçu basin.

[39] In economic literature, this public pricing concept is more commonly known as the Ramsey Rule. See, for example, Baumol and Oates 1995, chapter 4.

[40] The author (Fernandez 1996) acknowledges this restriction and presents a sub-section dealing conceptually with this other aspect.

102 In the Itapicuru basin, the estimated price for irrigation charges was higher than what users were willing to pay, when all investments were considered. Thus, in the IR scenario above, the study considered a 75 percent reduction in these investments and, consequently, the new prices resulting from the charge were also reduced, as indicated in Table 3.5. Nevertheless, the price reduction for irrigation was much lower than that for urban use, since the price elasticity of irrigation (0.58) in this basin, unlike that in the Alto Paraguaçu, is lower than that for urban use (0.99).

103 It is also noteworthy that the price of pollution in the Itapicuru basin represents an increase of only 0.1 percent in the cost of mining and 10 percent in the marginal cost of controlling the current level of production. Using the revenue optimization criteria, pollution prices may not create any significant incentive for mining companies to increase environmental controls since there is no environmental constraint for pollution in the price setting procedure.

104 Similarly, if we compare the IT and AP results, there is little variation in charges for irrigation and urban users, despite the significant increase in pollution prices. This result is surprising considering that the price of pollution is relatively elastic (0.57); i.e., if pollution prices increase, water users producing pollution would be expected to substantially reduce water consumption, resulting in reduced demand for water supply and subsequently lower water charges. The fact that the IT and AP results do not show such a variation in charges can be explained by the small amount of pollution generated in relation to direct water consumption by users in the basin. This observation highlights the need to consider externalities when setting water charges, particularly if cross-subsidies are necessary.

3.2.2 Current Practices for O&M of Projects in Brazil

105 *Irrigation.* No bulk water fees are charged for the use of water for irrigation. An inconsistent system of water tariffs for the O&M in public irrigation projects is presently in use. These tariffs are allocated to the sponsoring agency and distributed to the irrigation districts. In 1997 the cost of irrigation water supply[41] ranged from US$3.05 to $34.60 per 1,000 m^3 depending on whether the project was public or private, and whether water was supplied through gravity or pumping. The net economic benefit derived per 1,000 m^3 of water averaged around US$20.00 for low value crops. For high value crops, this number ranged from US$50.00 to US$400.00 per 1,000 m^3.

106 Water fees in public irrigation projects are regulated by the Irrigation Law (Law 89.496 of 1984). This legislation defines that water tariffs in public irrigation projects are estimated by the sum of two coefficients, K1 and K2. Coefficient K1, calculated annually, corresponds to the payment of public capital investment in a project's infrastructure. It assumes a 50 year repayment period and subsidized interest rates, and its value is a function of the irrigated area. In 1998, the K1 value for public irrigation projects was R$4.41/ha/month. Coefficient K2 is meant to cover the total O&M cost of a project, and is estimated as a function of the volume of water used (R$/1,000 m^3). The K1 tariff is paid to the sponsoring federal agency, while the K2 component is usually paid to the water user district directly.

[41] Volumetric component (K2) only.

Table 3.6 Irrigation Water Tariffs in Public Irrigation Projects (1998) [42]

Project	State	K2 (US$/1,000 m^3)
Pirapora	Minas Gerais	24.58
Lagoa Grande	Minas Gerais	12.63
Gorutuba	Minas Gerais	10.00
Jaíba	Minas Gerais	13.08[1]/13.04[2]
Estreito	Bahia	18.32[1]/14.05[2]
São Desidério	Bahia	3.51
Ceraima	Bahia	5.45
Formoso A	Bahia	13.89[1]/13.75[2]
Piloto Formoso	Bahia	21.58
Nilo Coelho	Pernambuco	15.29[1]/3.05[2]
Bebedouro	Pernambuco	10.73[1]/9.19[2]
Mandacaru	Bahia	16.36
Tourão	Bahia	5.22
Maniçoba	Bahia	16.45
Curaça	Bahia	21.63[1]/21.63[2]
Propriá	Pernambuco	8.95
Itiuba	Alagoas	9.28
Cotinguiba	Sergipe	7.73
Boacica	Alagoas	8.48
Betume	Sergipe	9.02

[1] Pumping systems
[2] Gravity systems

107 While the approach of a rate structure composed of a coefficient proportional to the land area and another proportional to the volume of water may be an effective alternative, the establishment of the value of the K1 coefficient by the federal government leads to many problems. It creates a disincentive for farmers to use all of their land, since those that do not grow crops pay a smaller share (K1) resulting in a failure to cover fixed O&M costs. The law allows irrigation districts to charge a fixed minimum value of 30 percent of the forecasted volumetric bill to cover fixed O&M cost, but in many projects this is not sufficient. In addition, agricultural activities in most projects involve a large variety of products and it becomes quite difficult to forecast how much water each farmer would use under each possible combination of crops. Moreover, the 30 percent amount for fixed O&M expenditures is seldom charged.

108 A more coherent approach currently under analysis is the inclusion of a third factor referent to fixed costs, which would be a subdivision of the K2 coefficient (O&M). Those farmers who decide not to grow crops during a season would still be responsible for their share of the O&M fixed cost. This approach is being proposed and is under study in some projects (e.g. Jaíba), but it has not yet been implemented.

[42] The K1 coefficient is standard and in 1998 its value was US$4.41/ha/month.
Source: CODEVASF

109 The Jaíba irrigation project, currently under implementation in the state of Minas Gerais, is one of Brazil's best managed public irrigation projects. The Jaíba Irrigation District provides an example of income as a function of tariffs estimated following the methodology described above. Since the project started operation, 29,692 water bills have been issued, of which 19,551 have been paid (65.8percent). The total value of these bills was R$1,422,289.20, of which R$742,214.72 (52.2 percent) were paid. From the total value charged, the component referent to the K1 coefficient corresponded to R$367,190.92 (25.8 percent), while the amount referent to K2 was R$1,055,098.28 (74.2 percent). The district is currently implementing a campaign to collect unpaid water bills as well as to promote public awareness about the importance of paying those bills in order to maintain the project in a sustainable condition.

110 Assessing the current pricing system in use (as defined by the Irrigation Law of 1984), it becomes clear that it principally relates to the lower-level distribution system directly related to the irrigation district. The real cost of providing the water resource is not taken into account. The water is therefore underpriced, leading to a potential misallocation of the water resource. In economic analyses of future irrigation projects the full price of water should be taken into account in order to make decisions about the economic viability of such investments. It must also be recognized, however, that the impact of bulk water pricing would be significant in the agriculture sector. This would motivate: consolidation of careful transition and phase-in of water charges; and faster development of water markets (which would allow farmers to reduce their water use while being compensated through voluntary market transactions) or other types of compensation to farmers. If and when subsidies are necessary, they should be well-justified and transparent.

111 *Water Supply and Sanitation.* In most urban areas, potable water supply, sewage collection and treatment services are provided by state companies. A monthly fee is charged for these services. In the past, such fees commonly were not sufficient to cover costs. More recently most states have tried to tackle this problem by reducing personnel expenses and modernizing their systems. With the exception of Ceará, no bulk water fee is currently charged to the state company for the withdrawal of water for potable supply. In 1995, the average water and sewage fee in Brazil was around US$0.67/$m^3$.[43]

112 As of 1995, state water companies in Brazil accounted for approximately 18.1 million water connections and 5.7 million sewage connections. On average, 61 percent of the connections were metered, the number of employees per thousand connections was about 4.5, and water losses averaged 45 percent. The average ratio of operating cost to operating revenues was 100%, personnel cost represented 60 percent of operating cost, and the average bill collection ratio was about 82 percent.[44]

113 Since 1992, the Bank has been supporting the modernization of the urban water supply and sanitation sector. The main project objectives are to help states (primarily in the South and Southeast) operate on a commercial basis, with financial self-sufficiency, corporate autonomy,

[43] Source: National Information System for Sanitation (SNIS), 1995; SNIS reports were released in early 1996, with figures in $R, and the exchange rate during Q4-1995 was about 1US$/1$R.
[44] SNIS.

and accountability for their actions. The projects also support a strong trend toward the privatization of urban water supply and sewage services.

114 An argument frequently made against adequate water pricing relates to the willingness and ability of consumers, especially the poor, to pay for water. It is argued that they cannot even pay the tariff that would cover the marginal costs of the water utility, much less the additional cost for the bulk water supply system. These arguments usually rest on the assumption that the poor get water for free. However, numerous studies have shown that the poor are often not connected to the official water supply network, in which case they have to buy water from private vendors (e.g., *carros pipa* in the Northeast), and these private vendors charge many times the price paid by their wealthier neighbors in well-served neighborhoods. Furthermore, the level of bulk water charges recently put into practice or proposed by several states is a small fraction of the average retail water tariff charged by state water companies.[45] Thus, the willingness to pay for a secure water source is usually underestimated.

115 A recent willingness-to-pay study carried out by the World Bank in Northeast Brazil showed that water users would be willing to pay between 2.4 and 4.6 times the current social water tariff in order to have reliable access to water.[46] This result illustrates that tariffs that are too low to provide adequate services to all because the company's revenue is not sufficient to expand its services cannot be justified by pointing to the poor. In fact, the poor are the ones disproportionately affected by lack of service because they have to turn to private sources and vendors who charge high prices and whose water is not always safe.

116 *Hydropower.* A fee is charged for the use of water for electric power generation when the power plant is national, and a royalty when the power plant is international. These fees and royalties collected from the electrical energy sector are redistributed to the states and municipalities where the projects are located, to the National Agency of Electrical Energy (ANEEL), to the National Secretariat of Water Resources for the operation of its monitoring network and safety programs, to the Secretariat of Science and Technology (SCT) for research, and to the Brazilian Institute of Environment (IBAMA) for studies and water quality improvement.

3.3 International Experiences

117 ***Retail pricing*.** A recent World Bank study[47] compares water pricing experiences across 22 countries, in various sectors and over time. The countries selected are a mix of industrial and developing countries, some with water scarcity problems and others with relatively abundant water supplies. The developing countries are included not simply to compare high and low income countries, but mainly because they have, and/or are in the process of carrying out, water

[45] Based on a review of various 1997 news articles from Folha de São Paulo, articles by *Hiroaki Makibara,* and other daily journals, the authors found that average retail water tariffs range from as little as R$0.65 per cubic meter in Bahia to as much as R$10 and R$11 per cubic meter in Paraíba and Ceará respectively, with Carros-pipas charges as high as R$50.00 per m^3. At the same time, bulk water charges in Ceará are a mere R$0.01, an amount also being considered in Bahia and São Paulo.

[46] PAD of PMSS II, 16771 BR.

[47] Dinar and Subramanian 1997. For lessons learned from study, see pages 155-159.

pricing reforms. While the study makes no explicit distinction between retail and bulk pricing, the data generally refer to the former. Nonetheless, the general tendencies and methodologies in water pricing are worth noting.

118 Countries have different reasons for charging for water, including recovering costs, redistributing income, improving water allocation, and encouraging conservation. Pricing schemes often comprise fixed and variable components. Fixed prices vary widely across countries, reflecting the different objectives countries pursue in charging for water. However, volumetric charges for urban and agricultural water use are relatively similar. Per meter charges for industrial water vary more, reflecting the inclusion of pollution taxes which vary by industry, and the different uses of subsidies (e.g., many countries subsidize water delivery to the "poor" and the agricultural sectors by charging higher tariffs to sectors with more capacity to pay, but the subsidies are often not transparent).

119 For urban and agricultural water use, all developing countries and some developed countries use average cost (rather than marginal cost) pricing approaches. Countries generally do not adjust charges by region, despite the fact that the costs of water supply may vary widely across regions. Agriculture water users generally pay something for O&M costs of irrigation systems, ranging from 20 to 75 percent of total costs. Few countries, however, attempt to recover capital costs from users. Where attempts are made, even in industrial countries, investment costs are almost always subsidized in the form of favorable borrowing arrangements (state guarantees or equity contributions, below market interest rates, extended grace and payment periods, and loan forgiveness for political or natural disaster-related objectives). Countries that have attempted to move away from this practice too quickly or dramatically in favor of "pure" market approaches have not been successful and are now experiencing a backlash.

120 The willingness of countries to undertake water pricing reforms and implementation cannot solely be explained by their water scarcity levels or by the size of their budget deficits. However, high-income countries tend to be relatively more open to reforming water pricing policies. For example, Australia and New Zealand are both carrying out relatively radical reforms, yet they have abundant water resources at the national level. Like Brazil, they also have serious regional water shortages and quality problems; so, regional and local issues may have driven the agenda that led to the introduction of reforms at the national level.

121 The above notwithstanding, most countries increasingly recognize the necessity of establishing some form of volumetric pricing and metering moving away from uniform charges and abolishing prices intentionally set low to address ability-to-pay criteria. Many are also aware of the need to significantly increase water charges to all users. In addition, several countries recognize the need to use measures to protect the environment, such as pollution taxes and incentives to water suppliers and consumers to conserve water.

122 ***Bulk pricing***. Worldwide, the use of bulk water pricing systems (where they exist) is mainly oriented toward revenue generation, rather than economic efficiency or incentives for users to change consumption patterns. The main characteristics of the international experiences

on bulk water charge systems are summarized in Table 3.7 and a more detailed analysis is presented in Annex 1.

Table 3.7. Main Characteristics of International Experiences on Bulk Water Pricing

Country	Type of charge	Revenue application	Regulatory and management setting	Charging criteria	Results
France	QT and QL	to finance sanitation works in the basins	committees/ basin agency	public prices and environmental standards	consolidation of the basin level as the main unit of management and revenue generation/distribution
Holland	QT and QL	to finance sanitation works in municipalities	state and federal government levels	public prices and environmental standards	high and increasing charge levels forced abatement practices and generated substantial revenue sources
Germany	QL	to finance sanitation works in municipalities	state and federal government levels	public prices and environmental standards	charge exemption scheme for additional abatement led to high overall abatement level and reduced revenue collection
Mexico	QL	collected by the National Treasury and partially budgeted for the water management agency	federal government	environmental standards	revenue raising with fragile enforcement capacity
Colombia	QT and QL	to finance the water management agency	state and federal government levels	environmental damage	complexity of the charging criteria and fragile institutional capacity led to enforcement failure
India	QT and QL		state and federal government levels		water user associations created and huge price increases implemented
South Africa	QT	for funding water resource management, development, and use of waterworks; and for achieving equitable and efficient water allocation	federal/ catchment or local/area agencies	infrastructure, catchment management, and economic charge that reflects the relative scarcity of water at a given time and place	
United States of America	QT	to finance the water management agencies	federal and state governments		price subsidies to irrigation uses

Notes: QT = quantity charge and QL = quality charge

123 From the analysis of practices in other countries, one can observe two noteworthy points:

- Revenue generation is tied to a specific sector. This provides a strong incentive for users to pay because they have more confidence that they will directly benefit from their payments in the form of improved water services delivery.

- Revenue is generated mainly to cover costs associated with the delivery of water services and pollution control. Although there is a clear tendency to introduce public prices, the criteria for environmental damage and standards are generally not well articulated, except in the case of the yet untested Colombian legislation. For example, charges are usually applied to any type and/or volume of effluent, even those within legal standards. The emphasis on cost recovery alone, with little relationship to specific environmental considerations, may not provide sufficient incentives to promote efficient water use.

124 Considering the emphasis on revenue generation, possibly the most relevant factor for a system of water resource management is the institutional capacity to enforce realistic charges that are fully monitored, and whose revenues are channeled to necessary investments. The characteristics above suggest that federal and state imposed charges could yield favorable results. Where local institutions (river basin committees or agencies) make sense and can be established, the government role could be delegated, with a charge collection and resource application system guided by federal and local plans over a certain period of years. In this way, the question of whether water basins were in state or federal lands would no longer be important. In the absence of committees, the federal charge would apply and would be administered by public entities.

125 The establishment of local river basin management institutions becomes especially relevant in the context of governmental institutional, economic, or political weakness. Given the difficulty of establishing levels of charges which fulfill economic criteria without harming other diverse interests, any centrally based charge system within this scenario of institutional fragility would naturally face enormous barriers to its implementation.

126 Aside from administrative setting of charges, limited international experience indicates that markets could be created to determine prices, as in Chile and some parts of the United States. However, several conditions must be met and clearly understood by all market participants in order for markets to function well. For example, conditions for competition were not clear in the case of the markets for pollution certificates in the United States. The well-known examples of Fox River in the state of Wisconsin and Lake Dillon in the state of Colorado resulted in very few transactions because of the small number of traders and low pollution cost differentials.

127 Even where key conditions are met (guaranteed water use rights and the existence of water scarcity), the market may not produce significant results. In Chile, for example, where a tradable water rights system has been in place for nearly 20 years, only a small quantity of total water volume has been traded, and most trading has occurred among neighboring farmers using the water for similar purposes.[48] This low rate of transaction may reflect either a failure of the

[48] Transaction records in 1992 showed only 3 percent of total water flow was traded in the Santiago area, with an

system or a close to optimal response to the difficulties encountered in enforcing strict command and contrôl measures. The court system in Chile is heavily backlogged, and enforcement and regulation is constrained by inadequate financial resources.

128 The strength of the legal system is important because if monitoring and sanctions for violations are not effectively carried out, then users would question the effectiveness of the transactions, thereby nullifying the value of the exchange of rights. Similarly, in the case of administratively determined charges, users' non-payment can jeopardize the whole system from a political point of view, notwithstanding the economic validity of this fiscal mechanism.

estimated value of US$366,000. Moreover, 94 percent of total transactions occurred between farmers and, therefore, did not involve changes in beneficial use. In the Limarf valley, however, the water market is active and gains from-trade are substantial. See Hearne and Easter 1995.

4. Water Allocation Principles and Pricing Objectives

129 The charging of bulk water fees is a legitimate and necessary measure required to fund activities for the sustainable management of water resources. Water management agencies must have sufficient financial resources to perform their role effectively. Until now, these agencies have had to rely on funding allocations from the government, and also had to channel their proceeds back to the central budget. They have therefore been vulnerable to fluctuations in funding, as can occur when politicians face an array of demands for financial resources. At times, of course, water users may gain from favorable political funding decisions, but such benefits tend to be piecemeal and unpredictable. To be assured of receiving reliable water supplies that meet acceptable quality criteria, water users need to provide direct financial support for bulk water management.

130 Government water resource management agencies are essentially monopolies, but with responsibilities to act in the public interest (i.e. they must aim to provide cost effective services as a community service obligation). Governments are therefore expected to resist temptations to distort the functions of such agencies, by using them to collect revenues for non-water activities. Given the absence of market forces, governments must also make special arrangements to ensure efficient operations and pricing practices for the provision of bulk water. Several important issues need to be considered, including societal acceptance of the need to raise revenue for bulk water supplies, transparency of cost information, and ability of water users and operators to pay.

131 Community acceptance can be gained largely through effective education programs for public authorities, policy-makers, public and private operators, and users. In many respects, Brazil has already successfully introduced such programs in recent years, culminating in the approval of new legislation, at the federal level and in several states, that promotes the introduction of bulk water pricing.

132 Achieving transparency of cost information is crucial when introducing new pricing policies. This will help bulk water users understand the purpose of these changes. A dual tariff system is a highly effective mechanism for achieving this objective. Fixed costs could be recovered by abstraction fees (commonly used in the western United States and Mexico) which reflect users' access rights to water resources. Variable costs for providing water supplies could be charged according to the volume of water used. This implies the need to monitor consumption. The unit price charged for water can be an effective demand management tool. Where fixed costs are relatively high, however, there may be a concern that using variable cost as a demand management tool may be ineffective. In that event, some may argue a case for recovering all costs on the basis of volumes sold. The price charged for water is not, however, the only demand management tool available, as demand is a function of both price and quantity. Licensing of water allocations can be used to establish supply quotas. Where licenses are tradable, both seasonal and long-term supply fluctuations will result in market price responses from renting or buying water allocations or entitlements. By allowing water entitlements to be traded, the market value of water will be established and provide an incentive for efficient water use.

4.1 Basis of Charges

133 For urban water supply, most countries are replacing flat fees with dual tariff schemes consisting of a fixed and variable charge. The fixed charge gives the service provider a reliable stream of revenue to cover overhead expenses, and the variable charge provides consumers with incentives to use water efficiently. The feasibility of charging for water by volume used depends on the practicality of monitoring meters.

134 The design of block rates varies considerably among countries. Some countries (including most industrial ones) use increasing block rates, some use decreasing block rates, and others use a combination. In a few countries, the lowest price applies to such a large quantity of water that few users ever face higher charges associated with larger consumption levels. This obviously reduces the impact of increasing block rate schemes on consumption patterns.

135 For urban and agricultural water use, most developing countries and some industrial countries set charges on the basis of average rather than marginal costs of supply.[49] For agriculture, given the difficulty in measuring water in terms of unit volume over time for relatively dispersed populations, authorities generally calculate charges by dividing the average cost of service by area irrigated, often adjusting the results by season, type of crop, or type of technology used (e.g., gravity vs. pumping). Charges are not generally adjusted by region, even though regional variations in water may be responsible for differential costs of supplying water and for technology used.

4.2 Pricing Concept and Mechanisms

136 In considering whether or not and how to adopt pricing (or other) reforms to improve water allocation, several criteria should be considered when comparing various approaches including:

- flexibility to allocate supplies among uses according to demands;
- security of water use rights to help ensure efficient resource use;
- coverage of economic costs by users;
- predictability of the outcome of allocation to minimize uncertainty;
- user perception that allocation is equitable;
- political and public acceptability so that societal values are incorporated;
- efficacy to ensure that allocation reforms are aligned with policy goals; and
- administrative feasibility and sustainability to enable implementation of reforms.

137 Pricing water as a tool for allocation must be within an overall framework to meet multiple objectives. These often overlapping or conflicting objectives are:

- economic efficiency so that water is allocated to its highest value uses;

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[49] France is one of the few exceptions, setting urban water prices on the basis of long-term incremental costs to account for future resource development costs; but even there, in practice, refunds or discounts are often given, thereby reducing the impact of marginal cost pricing.

- financial sustainability to enable water management agencies and enterprises to cover development and A,O&M costs and earn a reasonable return;
- income redistribution to sectors less able to pay than others;
- social needs to deliver water services to all regardless of willingness to pay;
- environmental needs to maintain water quality and mitigate third party impacts.

138 Several pricing techniques can be applied to meet these objectives. In practice, however, each technique tends to achieve only one or two objectives, so, many countries employ one or more approach at the same time. A thorough understanding of each approach and technique is then useful in determining how best to mix or homogenize pricing mechanisms.

139 A recent World Bank paper[50] uses these objectives to compare approaches to water allocation most common in the world today. These are: (i) public allocation, (ii) marginal cost pricing, (iii) water markets, and (iv) user-based allocation. Of course, in practice, these approaches are not entirely mutually exclusive and reforms often incorporate aspects of each. However, in determining which approach to emphasize, it is useful to understand the relative value of each and the differences among them.

140 ***i) Public allocation***. Not surprisingly, the Bank study finds that public allocation is the weakest of the approaches. As discussed above, public allocation often leads to waste, misallocation of water, and fragmented investment and management of the existing resource. These results contradict the original policy goals—equity and protection of a public good—often cited as justification for public intervention.

141 However, the relative strengths of marginal cost pricing vs. those of the market approach are more difficult to identify, with markets being favored only very slightly above the marginal cost approach. Some of the primary advantages and disadvantages of each are described below.

142 ***ii) Marginal cost pricing (MCP)***. MCP sets a price for water based on the incremental cost of supplying the last unit of water. This is considered economically efficient (or socially optimal). MCP should be applied to cover all water supply costs, including headworks, environmental and social costs, collection, transport to a treatment plant, water treatment to meet quality standards, and distribution to customers. Typically, however, headwork costs and social and environmental costs (admittedly difficult to calculate) are not included in tariffs. In many cases, particularly in developing countries (including Brazil), tariffs do not even cover all pre-distribution costs. Correcting such inadequate and inappropriate pricing practices is the objective of introducing bulk water pricing. By incorporating all costs into prices, MCP can be applied to all types of water uses and costs, whether or not there is a need to differentiate on the basis of quantity or quality.

143 The main advantage of MCP is efficiency, at least theoretically if not in practice. MCP avoids the tendency to underprice and consequently overuse water, obviously of particular relevance when dealing with national and/or regional water scarcity. Costs associated with

[50] Dinar, Rosegrent, and Meinzen-Dick, "Water Allocation Mechanisms: Principles and Examples." World Bank, Paper #1779, 1997.

externalities (social and environmental) are also incorporated, thereby avoiding inadequate consideration of costs for maintaining water quality, resettlement, etc.

144 But defining MCP itself is not straightforward. There is no one set MCP technique, and much information regarding costs and benefits is required but not easy to access and/or calculate, environmental and social costs being the most obvious. Also, MCP varies depending on: short-run or long-run estimates, the permanency of demand changes, and the predictability of demand changes. Simply put, the high costs of expanding supply in times when existing supply is fully used results in a much higher short-term price, which only stabilizes after the large fixed costs have been recovered. This is likely to negatively affect lower income groups, thereby neglecting equity issues, though this may be resolved by introducing explicit "equalization subsidies." Finally, from a practical perspective, MCP is difficult to implement because it requires time-based volumetric monitoring, which is costly and difficult to administer. As noted above, measuring time-based volumes of water use for irrigators may be especially difficult and expensive.

145 *iii)* ***Water markets***. A full-fledged water market is generally considered to consist of an exchange of water use rights, rather than a temporary exchange of water between neighboring users (a spot market). Water markets only function efficiently when: there are many similar sellers and buyers with similar information and low transaction costs; there is no collusion among buyers and sellers; individual decisions affect outcomes only for the individuals making such decisions; and market participants seek to maximize profits. Under these conditions, the market functions efficiently because supply and demand forces dictate quantities to be traded and unit prices for water rights. Usually, the resource value will move from its lowest to highest point as a result of such market forces. That is considered economically efficient from an individual and social perspective. Because of the special characteristics of water described above, a few additional requirements must be met for the market to function effectively. Generally, these requirements are fulfilled by governments to create the necessary market conditions. They include defining initial water right allocations, creating the institutional and legal framework for trade, and investing in the basic infrastructure which allows water to be transferred.

146 Water markets can provide several benefits. Aside from allowing individual users to profit from water market exchanges, the market offers the potential to secure water supply for high-value uses without necessarily developing new, costly water resource infrastructure. Also, efficient water use is promoted by allowing water with low-value uses to be sold. Finally, water trade between the agricultural and urban sectors may benefit the environment. The market induces improved agricultural management, thereby reducing water waste and pollution related to poor agricultural practices. Also, with the capacity to sell unused water through the market, farmers may be in a better position to afford higher water costs, which internalize environmental costs. However, if urban and industrial water use increases substantially because of the ability to purchase water use rights from farmers, attention must be paid to increased environmental pollution related to untreated sewage disposal by municipalities and industries.

147 Despite all these potential benefits, most countries do not have well-functioning water markets; intra-sectoral spot markets (e.g., where neighboring farmers temporarily "rent" water

from one another) are more common. Even in Chile, where the conditions for water markets have been in place for some 20 years, most water trade is spot market oriented, although in the two valleys where water rights are traded the most, economic gains from trade have been substantial.[51] Experience in the western United States demonstrates similar results. Otherwise, however, virtually no other countries have developed functioning water markets, and even in the United States and Chile, government intervention and involvement remain significant. This is mainly because creating and sustaining the necessary conditions for such markets is complicated, not always well understood, and potentially costly. In addition to the substantial political difficulties associated with introducing radical reforms, some of the special challenges include: measuring water; defining water rights when flows are variable; enforcing withdrawal rules; investing in necessary conveyance systems; selling water-for-cash by poor farmers; potentially high transaction costs associated with organizing initial beneficiaries (typically farmers); third party effects; and environmental degradation. In short, potential pitfalls are numerous and risks significant when trying to develop efficient and equitable water markets . With little or no technical expertise, poor institutional capacity, and scarce empirical evidence of success, many countries often find it difficult to justify investing in the creation of markets. Gradual introduction may be the best alternative.

148 *iv)* ***User-based allocation***. User-based allocation requires collective action institutions with authority to make decisions on water rights. The effect of user-based allocation on water conservation depends on the content of local norms and the strength of local institutions. While empirical studies of common pool resource management (including water) have shown that such institutions can develop spontaneously or through an external catalyst, the institutions are not always in place or strong enough to allocate water efficiently.[52]

149 Farmer-managed irrigation systems provide one of the clearest examples of user-based water allocation. Studies have shown a wide variation of rules for allocation within such systems; by timed rotation, depth of water, area of land, or shares of the flow.[53] In the domestic water supply sector, user-based allocation is seen in community wells and hand pump systems, as well as in a growing number of more complicated systems managed by water and sanitation associations.[54] Inter-sectoral allocation by users is seen in the management of village tanks (ponds) or other local water sources used for domestic water, irrigation, and even animal watering.

150 The four allocation mechanisms reviewed above are the most common. Their relative advantage and disadvantages can be summarized in a table such as Table 2.1. In addition to the above, the following approaches are also frequently used:

151 *v)* ***Cost of service***. Cost of service is typically used by water supply utilities to achieve financial sustainability. Price is based solely on the cost of providing water services, usually

[51] A Bank study by Hearne and Easter (1995) found that in the Elqui Valley, for example, net gains from trade were estimated to be in the range of US$6 to over US$1,600 per share of water traded.

[52] Meinzen-Dick et al 1997

[53] Yoder 1994

[54] Watson et al. 1994

including capital and A,O&M costs associated with water production and delivery. If the utility is investor-owned, a return on investment is included; this is typically regulated by the government (preferably by an independent regulatory commission established by the government), which allows a "fair" rate of return. If not regulated carefully, however, such a return can produce skewed results since the rate of return depends on the asset base, thereby providing utilities with an incentive to earn a better return by spending more on infrastructure (as opposed to improving the efficiency of existing infrastructure). If the utility is state-owned, cost recovery is usually through water tariffs or taxes. This revenue provides the basis for raising capital to invest in new infrastructure and O&M. The water tariff paid by the user typically at most only covers the O&M costs. The combination of taxes and tariffs helps to equalize the water tariff over time, particularly when large capital investments are necessary to construct new infrastructure for which demand takes many years to develop. In addition, in such cases, many utilities use decreasing block rates to encourage more sales, thereby bringing demand up more quickly than might otherwise occur. Again, this tends to produce distorted results, encouraging supply expansion rather than more efficient water resource use.

152 *vi)* ***Willingness to pay***. Willingness-to-pay methods are generally used for social and income distribution objectives. Prices are set at less than the cost of water supply to a class of users or a type of use. The resulting revenue shortfalls facing utilities are covered by other sources of income, such as sales for electricity generation or other uses. Increasingly, privatization proceeds are being allocated for such purposes. Willingness-to-pay prices are usually based on detailed studies, often in the form of household surveys, carried out by the government, and more prevalent at the national government level. Though initial prices may therefore be quite valid, often there is little re-assessment of users' willingness to pay over time, even when users' incomes increase. The result is that, even when subsidies may be justified, there is a tendency to significantly over-subsidize projects over time. Again, this creates distorted incentives, encouraging misallocation and waste of water resources well after social and income distribution objectives have been met. Considering the large investments in water resources often made by governments for social reasons, it would be prudent to re-assess users' willingness to pay for such investments, or introduce incentives for users to pay more over time (e.g., declining subsidies, transfer of O&M to users, carefully targeted subsidies, and subsidies for specific users such as those using only certain levels of water or low-cost water conservation technologies). Regardless of the specific method adopted, subsidies need to be made explicit and transparent in order for users to understand the value of water, and for governments to understand the fiscal impact.

153 *vii)* ***Opportunity cost***. Economists often propose opportunity cost as the theoretically optimal approach. Water charges are set to recover the value of water in its best alternative use. However, opportunity cost pricing is impractical because of the huge resistance and the unnecessarily large redistribution of resources that would occur through such changes.

5. Recommendations

154 Brazil has recognized the need to use pricing to promote system sustainability and efficient use and allocation of water resources and has quickly moved towards the establishment of water tariffs for all major user sectors in the country. However, the development of specific regulations and pricing mechanisms has been slow, sporadic, and not well coordinated. No national comprehensive framework exists to guide the formulation of specific state or municipal pricing designs, so the independent efforts cited above remain isolated. Without an overall framework, there is a significant risk that the current momentum behind the establishment of appropriate water pricing mechanisms may be hindered or lost. The following recommendations, taken with the knowledge of experience presented above, are proposed to help mitigate this risk.

5.1 Make National and Sub-National Regulatory Frameworks a Priority

155 National legislation already promotes bulk water pricing, and specific regulations currently under debate may be approved soon. A recently produced draft regulatory framework to support the Federal Water Law, incorporating many of the main principles described in this paper which have been adopted in the Bank's Water Resources Management Policy Paper,[55] is a tremendous advance. Box 5.1 below summarizes some of the main points in the draft regulatory framework, and highlights a few particularly innovative concepts.

156 The recommendations herein should be considered during the process of debating and approving the regulatory framework. At the same time, to avoid losing momentum, it would be important to approve and initiate implementation of specific regulations as soon as possible. In fact, the river basin agencies forecast in the Federal Water Law are expected to depend on revenue from bulk water tariffs for their income. This approval and implementation will become increasingly critical over time, as individual states produce their own regulations, which may or may not be consistent with final federal regulations. Therefore, states should continue to draft and debate regulations and even begin to test approaches at the state and local levels. This would not only help the individual states themselves to establish long overdue pricing frameworks, but could help bring the rest of the country along as well. To minimize the risk of inconsistency or inadequacy of frameworks, it would be prudent for states in advanced stages of implementation to coordinate with the federal government.

[55] A draft of the proposed regulatory framework has been prepared by SRH and is now available for comment on the Internet.

Box 5.1. Main Features of Draft Regulation for the National Water Law

The Regulatory Framework provides specific regulations regarding the National WRM Policy and Management System including, inter alia, detailed requirements regarding: water rights; (bulk) water pricing; WRM at the national, state, and watershed levels; watershed management committees and agencies; WRM plans; the national WRM Information System; water resource management and rationing in times of water scarcity; water quality management; and water conservation. Some of the more important and (in some cases) innovative features include:

1. The recognition that all water is a public good, but with an economic value which should be adequately priced and paid for;

2. The need to guaranty well-defined water use rights for all legitimate uses, including domestic water supply, hydropower, irrigation, navigation and the environment;

3. The requirement that, in times of scarcity, domestic water supply would be a priority; otherwise, water resources would be allocated to different users based on self-determined prices (with the higher bidders receiving allocations first);

4. The provision of rights to release effluents into bodies of water based on the quantity of water required to dilute the relevant pollution load, in accordance with pollution indicators established by the relevant Watershed Management Plan; and

5. The flexibility to delegate all aspects of water resources management to states and watershed management agencies, including, inter alia, WRM planning, water pricing and revenue collection, and investment decision-making.

5.2 Establish Clear Pricing Objectives

157 ***Cost recovery***. The over-riding objective of water resource management, in general, is to efficiently and effectively deliver safe, reliable water to users. It follows, then, that the primary objective of bulk water pricing should be to ensure that adequate revenues are available to finance investments and sustainable O&M that meet user needs for safe, reliable water. This is particularly true in a country like Brazil, where users are not accustomed to paying the true cost of water resources management and service delivery. Poor funding remains a key challenge that must be addressed if Brazil's water resources management and infrastructure needs are to be met over the coming decades. While full cost recovery may be the ideal objective, research shows that the main objectives for Brazil in the medium term would be to achieve full cost recovery for operations and maintenance, and partial cost recovery for investment. Equally important, revenues raised from bulk water tariffs charged to users in a given watershed should be applied to systems in the same watershed. Otherwise, users will no longer be guaranteed that safe water

will be reliably delivered to them, and consequently they will have little incentive to continue paying adequate tariffs.

158 The emphasis on cost recovery also needs to take into consideration willingness and capacity-to-pay issues. As suggested in section 3.2.2, users are generally willing to pay water charges when they are guaranteed safe, reliable delivery of water services. Moreover, evidence shows that bulk water tariffs will not represent a significant increase over existing charges. In fact, if an appropriate pricing system is implemented that enables improved water resources management, users who are currently forced to pay extremely high prices for water from *carros pipas* or other vendors will be much better off. Nevertheless, some users (either because of income levels or use returns) will always be in a better position than others to pay bulk water charges. Bulk water prices may have to be differentiated according to different users' willingness to pay.

159 The question of what to charge different users becomes especially debatable when considering whether to recover O&M and capital costs or just the former. Ideally, prices should be set to recover all costs. However, from a practical perspective, international and Brazilian experience suggests that the primary objective for now should be to recover 100 percent of O&M costs from all users. To the extent feasible, capital costs should also be recovered, especially for investments primarily oriented towards high-value uses. A separate section on the use of subsidies is provided below. Here, suffice it to say that there are often valid social, economic and financial reasons for seeking to recover only a portion of the capital costs of public water resource development projects, and these should not be ignored in favor of taking a purely neoclassical economic approach to pricing.

160 ***Economic efficiency***. While achieving the cost recovery objective alone would be a significant advance forward for Brazil, there are risks associated with developing a bulk water pricing system based solely on revenue generation. If economic efficiency is not also considered, prices may end up being set too high (e.g., in the case of gold-plated projects) or too low (e.g., if important externalities are not considered). In addition, revenues collected may be poorly invested if appropriate economic considerations are overlooked. Box 5.2 presents several practical strategies which can increase the efficiency and effectiveness of the pricing system.

Box 5.2 Efficiency Related Strategies for Improving Water Pricing

1. Set prices based on long-run marginal costs of bulk water management and delivery.

2. Use subsidies only when well justified for social reasons, and ensure that all subsidies (even for capital costs) are explicit and well targeted.

3. Create a hydrological model, accompanied by an economic optimization model, to evaluate water quality, environmental impact, and changes in use, and to estimate their respective monetary values.

4. Incorporate economic and environmental variables which most influence users' water consumption patterns.

5. Plan the implementation of the system on a gradual basis in accordance with the development of institutional capacity and user education, which can provide efficient management. This is especially true for creating water markets, which require defined water rights and fair competition to be in place ex ante.

6. Use cost-benefit, cost-effectiveness, or cost-utility techniques to make investment decisions related to allocating revenue generated from bulk water charges.

   (See Annex 2 for a detailed description of these techniques).

161 Implementing a bulk water pricing system alone will likely go a long way in improving water consumption patterns, especially in a country where water has traditionally been viewed as a free gift from God. Incorporating the economic efficiency criteria described above into such a system will further improve consumer behaviors. However, considering the scarcity and water quality problems facing some regions of the country, water conservation should not be viewed simply as a beneficiary by-product that results from taking other measures. Rather, both the design and implementation of the pricing system should incorporate specific features to promote the conservation of safe water.

162 In terms of setting prices, the best approach in this regard is to link prices to water use volumes, using meters or other measuring devices as much as possible to measure actual uses. However, this so-called volumetric pricing approach may be difficult to implement in the case of some users, particularly when they are very remote and/or dispersed. Therefore, at a minimum, the volume of water accounted for by water rights should be used as a proxy for actual volumes used. Prices may also be based on the share of a flow that users receive times the amount of time they get the share. Either way, a system of monitoring the volume of water consumed, setting prices based on this volume, and ensuring that consumers are aware of their water consumption behavior and its cost, is a critical component of any effort to improve water allocation and conservation. In addition, public education programs have been proven to be a very cost-

effective means of getting consumers to change behaviors. They should form an integral part of any plan to implement bulk water pricing systems.

5.3 Justify, Target, and Make Transparent Subsidies

163 In general, as recommended in the previous section, the general pricing objectives should be to recover costs. If and when subsidies are necessary, they should be well-justified, targeted, and transparent. For the most part, subsidies may only make sense for public multi-purpose water resource development projects, to help fund a portion of their investment costs. Some single purpose projects may also warrant subsidies, especially to the extent that they benefit multiple, dispersed populations, and to the extent that they are expected to benefit future populations about which detailed demand information remains unknown. Subsidies may be either direct (e.g., reduced tariffs) or indirect (e.g., low-cost financing).

164 Where subsidies are necessary (mainly to cover a portion of the investment costs for multiple purpose water resource development projects), they should be targeted based on income levels. Each user should receive water accounts that show the full cost of providing the bulk water, and the value and source of the subsidy being applied (even if the subsidy is as high as 100 percent).[56] The rationale for this approach to billing is threefold. First, it allows users to see how much water resource management really costs. Second, it provides government with a clear account of the level of contributions it is making to certain sectors of the water industry. This enables more objective assessments of the cost effectiveness of these subsidy programs, compared to alternative funding programs. Third, it provides the water resource manager with a platform to advertise any plans to phase out part of the subsidies over time.

5.4 Create Conditions for Water Markets

165 Creating water markets offers a more practical solution than opportunity cost pricing to achieve fully efficient water resources allocation. However, as discussed above, they do not substitute the role of public institutions. Creating water markets is complicated, and the markets themselves take years, if not decades, to develop fully.

166 Since the concept of water markets is relatively new for Brazil, states and the federal government should continue exploring options by examining experiences in the western United States, Chile, Australia, and Mexico. Another valuable example is from the Cariri region in the state of Ceará, where a system of tradable water rights has existed in Brazil for over a century. While the Cariri experience represents a small isolated system, it provides a number of useful indications concerning the value of water, the possibilities of allocating and enforcing water rights in rural areas, and the willingness of water users to pay and cooperate in order to assure a secure water supply.[57]

[56] See, for example, Rivera 1996, which describes Chile's system of direct subsidies managed by the central government.

[57] Kemper et al (1995) found that the price paid in 1993 for water rights in the Cariri region was about US$0.14/m^3. This is comparable to Australia (US$0.11/m^3 in 1988-89) but considerably lower than in the United States (US$1.18/m^3 in 1992 in Colorado). However, Colorado's sales include municipal and industrial buyers who generally pay more than farmers, whereas Australia's auctions are

167 The new institutional arrangements now being put in place all over Brazil can in fact be regarded as intermediate steps toward water markets. Clear water allocation mechanisms, water user rights, and strong regulatory agencies are part of an institutional framework that needs to be in place before a market can function. Once these new institutional arrangements are functioning, it will be possible to compare the Brazilian experience to those in other countries and regions, and to evaluate the costs and benefits involved in taking the step to create water markets. Markets develop in situations of scarcity. Therefore regional approaches, for example to deal with problems of water scarcity related to quantity in the Northeast as compared to dealing with problems of water scarcity related to quality in the South and Southeast, could be developed.

5.5 Actively Involve All Users and Stakeholders in the Reform Process

168 As indicated in section 2.3 regarding institutional aspects of implementing bulk water pricing reform, providing incentives for users to participate in the reform is critical. One of the most effective ways to achieve this is to actively involve all users and stakeholders in water resources management activities, such as tariff setting or water allocation planning.

169 The establishment of decentralized entities, such as river basin committees and agencies as called for under Brazil's 1997 Federal Water Law, has proven to be an effective means of organizing users for this purpose. However, this will be impossible if financial resources resulting from the collection of bulk water tariffs are diverted away from the river basin in which they are collected. Implementation of the Water Law therefore depends on establishing bulk water pricing, in which most of the revenues from such tariffs remain within the relevant basin to provide the primary funding used to create and sustain river basin committees and agencies.

170 It will also be ineffective if only some users are included, while others are excluded. Typically, when reform is difficult, the more powerful interest groups (i.e., large, independent state or private enterprises) can minimize, delay, abstain, or otherwise avoid fully participating. Accommodating such groups may be politically expedient in the short term, but over time this will derail the reform effort because not only are these groups excluded, thereby reducing the effect of the reform, but others will have little incentive to participate. It is advisable, then, not to fall into this trap for the sake of short-term gains. Experience shows that the best way to achieve this is to actively involve everyone at all stages of the reform process, including planning, communications, training, and meeting obligations for tariffs, discharges, etc. Furthermore, to minimize resistance from vested groups, it is preferable to adapt existing institutions to new roles and responsibilities rather than to create a slew of new entities.

limited to private irrigators. Therefore, the Cariri region's water seems to be valued comparably to water in a well-developed economy.

5.6 Conclusion

171 In summary, to sustain bulk water pricing reform in Brazil, the most pressing need is finalization and approval of the regulatory framework. Without this, there is little chance that the river basin agencies anticipated in the Federal Water Law will be established, because their principal funding source is expected to come from bulk water tariffs. But keeping the focus simple does not make it easy. Reaching closure on which pricing objectives are most important, at least in the near term, is both technically and politically complicated. In light of the historical, political, and socioeconomic realities in Brazil, and keeping in mind international experience, the recommendation herein is to establish cost recovery as the foremost pricing priority. While full cost recovery may be the ideal objective, research shows that the main objectives for Brazil in the medium term would be to achieve full cost recovery for operation and maintenance, and partial cost recovery for investments.

172 In pursuing these objectives, it is important to keep in mind that not all users will be able or willing to pay for bulk water, and pricing policies should not be blind to this reality. At the same time, if policies are introduced that differentiate prices among users, it is very important to make sure that the inevitably resulting subsidies are well-justified and transparent. In addition, setting prices according to some economic efficiency criteria (i.e., opportunity costs) is often highly impractical. In this case, creating conditions for water markets is more sensible. Finally, notwithstanding the preceding, no bulk water pricing reforms will be implemented successfully if relevant users and stakeholders are not fully involved in the process. In particular, it will be critical to maintain the integrity of the 1997 Federal Water Law regarding the allocation of financial resources collected from bulk water tariffs.

173 As noted, the above recommendations are intended primarily for Brazil's water sector leaders, policy-makers, experts, and related stakeholders currently faced with the challenge of implementing bulk water pricing reforms. This same audience is also charged with the even greater challenge of carrying out far-reaching reforms in Brazil's overall water resources management sector. The Bank has been supporting this effort for several years and the recommendations herein form an integral part of its assistance, which includes numerous federal and state water resources management and water sector modernization loans. In fact, because of the strong Bank–client relations which have developed as a result, many of the findings and recommendations herein have been shared in draft form with several leading Brazilian counterparts. Due to ongoing administrative changes within the federal and state governments, however, the Bank will have to follow through on its dissemination strategy outlined above. At the same time, it is expected that at least some of the recommendations from this paper will be incorporated in the design of future Bank-financed programs in Brazil.

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ANNEXES

Annex 1

International Experiences

A. 1 The Australian Experience

174 Bulk water pricing in Australia tends to focus on cost recovery methods rather than market-oriented approaches, both to set prices and to allocate water resources between sectors. The focus on cost recovery requires more monitoring, data collection, and analysis than market-oriented approaches (although market approaches may have relatively high implicit or explicit transaction costs that inhibit water trading); consequently, the roles of different institutions responsible for these activities are very important.

175 ***The Federal Government.*** Like Brazil, Australia consists of a federation of states and territories. Each state and territory has jurisdiction over water resources within its boundaries. While the federal government has no direct control over water resources, it can exert considerable influence on states to collaborate over water resource management. A particularly successful example of this collaboration is in the management of the water resources of the Murray-Darling Basin. The catchment area of the basin is shared by the states of Queensland, New South Wales, Victoria, South Australia, and the Australian Capital Territory (ACT). The Commonwealth initiated the formation of two organizations: the Murray-Darling Basin Ministerial Council (MDBMC), consisting of relevant resource management ministers from each state, the ACT, and a Commonwealth minister; and the Murray-Darling Basin Commission (MDBC), consisting of representatives from relevant natural resource agencies for the constituent governments. The member governments have ceded certain powers to the MDBMC so that it can manage water resources in the basin in an effective and sustainable manner. These include authority over investment planning, setting priorities among proposed water resource uses, issuing and administering water rights, and bulk water pricing methods. MDBMC operations are jointly funded out of water tariff receipts from member states.

176 ***States and territories.*** Bulk water users must have licenses to extract and use water. These licenses are issued only by states and territories; they do not confer ownership, rather, they specify rights to access and use of the resource. It is important to note that in Australia, as in Brazil, water is considered a public good that cannot be owned by private groups or individuals.

177 Bulk water pricing is also the domain of state and territory governments. Until recently, the approach to determining water allocation and pricing policies among states and territories had been inconsistent. It was almost impossible to compare the value and cost of water services among states. Also, some sectors of the water industry, especially domestic users and irrigators, received subsidies. The extent of these, however, was difficult to determine. In general, industrial users subsidized domestic users, while many agricultural users received subsidies from the government. In an effort to improve the economic efficiency of the water industry, the commonwealth government, in conjunction with the states and territories, through a body known as the Council of Australian Governments (COAG), conducted an investigation to determine the need for reform of water policies.

178 In February 1995, COAG recommended that charges for all water services across the country should reach full economic cost recovery. Two timeframes were targeted, 1998 for urban water, and 2001 for rural water supplies. It was recognized that where special cases for subsidies remained, the full price of water services should still be shown, and the full value of the subsidy should be made explicit.

179 ***New South Wales.*** As its part of the COAG initiative, the New South Wales Government, through its Independent Pricing and Regulatory Tribunal (IPART), conducted a detailed review of bulk water pricing policies within the State. Criticisms of the existing methods of charging for water and recommendations for future pricing policies were published in an interim report.[58]

180 In New South Wales, bulk water services are provided by the Water Administration Ministerial Corporation, which is administered by the Department of Land and Water Conservation (DLWC). The DLWC controls the use of water from its major dams and related infrastructure, through its licensing of water extraction from rivers, streams and ground water sources. The DLWC exercises monopoly power over the management, licensing, and supplying of bulk water services to rural and regional water authorities, towns, industries and irrigators. However, the Environmental Protection Agency (EPA) retains authority over licensing water and wastewater discharges into rivers and streams.

181 From 1989 to 1995, water charges were essentially restricted to users on regulated streams, and were intended to cover the operation costs of the rural water supply systems. The charges were based on the following:

- Capital costs of water storage and major works were regarded as sunk costs and maintenance costs paid for by the government. However, in 1995 a new policy was introduced whereby users of regulated waters pay a water management charge to cover a portion of the costs associated with DLWC management of water resource infrastructure.
- The government paid 30 percent of the operational costs of regulated river supply systems.
- Water users paid the remaining 70 percent of operating costs through an annual delivery charge. This charge was based on the volume of water diverted or the entitlement volume. Minimum annual charges applied, and these varied from region to region.
- Through a separate metering charge based on the volume of water diverted to the entitlement, 100 percent of the DWLC's costs of surveillance (which included reading meters to check water diversions and issuing accounts) was paid by the users.
- In 1995, annual charges were also introduced for users on unregulated streams, and for ground water users.

In summary the charges were:

[58] IPART, 1996.

- For irrigation and municipal water use on regulated rivers, an extra $1.35/ml (based on licensed volume);
- For industrial use on regulated rivers, a total charge of $10/ml (based on licensed volume);
- For users on unregulated streams, an annual flat charge varying from $80 to $265 (where no previous charge applied);
- For the Sydney and Hunter Water Corporations, an annual charge of $1.80/ml of normal water use (where no previous charge applied);
- For ground water users, an annual charge of $75 or $100 plus a fee of $0.40/ml based on entitlements;
- For stock and domestic users, an exemption from these charges.

182 The IPART findings[59] criticized the then current pricing system because it was based on average cross-state costs, which created cross-subsidies between regions. The basis for the charge was not transparent, and the justification for and efficiency of each activity could not be scrutinized. IPART argued that bulk water charges should be region-specific and based on forward looking costs of the DLWC, not backward looking accounting costs recorded by water supply authorities, as well as the efficient costs of each activity.

183 Economic costs differ from accounting costs in three ways. First, by including external costs whereas accounting costs do not. Second, economic costs of using water infrastructure assets include the opportunity cost of capital, whereas accounting costs do not. Third, economic costs calculate depreciation based on the actual deterioration of the service capacity of the asset over time, rather than calculating depreciation as the notional reduction in an asset's value over a prescribed period. If the service capacity of large infrastructure assets lasts almost indefinitely, the value used in economic depreciation may be considerably less than for the accounting measure.

184 The opportunity cost of capital is the return that could be earned by using inputs in their next best use. If there is no alternative use or value, then the past costs are sunk costs.[60] For sunk costs, prices would not be set to recover either the historical cost or the replacement cost through depreciation charges.

185 IPART proposed that bulk water charges should include:

- A water supply component to recover an appropriate share of the efficient costs of the operation, maintenance, administration, and capital costs of bulk water services. This includes costs generated while dealing with any environmental impacts and any threat to sustainable supply presented by current water consumers.

- A resource management component to recover an appropriate share of efficient costs of managing and resolving competing claims to water resources.

[59] See in Bryant, 1998.
[60] BIE, 1995.

- A separate licensing charge to fully recover regulation-related costs, which are all attributable to extractive users.

- Environmental levies on water users and other beneficiaries where appropriate to recover a share of the costs of providing diffuse public benefits.

186 It was further proposed that the water supply component consist of two tariffs, one fixed and the other variable (based on water usage). The usage tariff would include only those costs that vary directly with the volume of water delivered. The fixed tariff would then contribute to the recovery of all other costs. Basing the usage tariff on the short-term marginal cost would provide incentives to use water more efficiently. The fixed tariff would be shared on the basis of entitlement, rather than on a flat fee basis for all users. The advantage of entitlement based sharing is that holders of "sleeper" licenses (water entitlements that are not used or not fully used) are charged, and holders of large entitlements are charged more than those holding small entitlements.

187 *Victoria State*. In the state of Victoria, water pricing is differentiated not only on the basis of end use, but with an additional cost for new customers. New agricultural customers and all urban water authorities are charged for bulk water at a rate, which is set, such that a rate of return on equity of 4 percent is achieved after meeting business costs. Existing rural users, such as irrigators, stock and domestic water users, are levied bulk water charges with 0 percent real rate of return on equity. The effect of Victoria's pricing policies makes its water prices nearly double those of New South Wales for existing users, and nearly five times higher for new agricultural customers.

188 In Victoria, emphasis is on full cost recovery, whereby the rural user is charged full A, O&M costs, financing costs (such as interest on borrowed money), full 'run of river' costs, and renewals on all infrastructure assets and/or depreciation on assets. The Victorian approach to full cost recovery does not include the full cost of externalities such as those associated with resource management costs and external effects of water use such as salinity control. With respect to externalities, the Victorian government's pricing policy differs from the water policy framework suggested by COAG.

189 ***Related issues***. Environmental management, water rights (entitlements), reliability, water quality, and transferability of rights are among the most important factors taken into consideration when setting specific water prices. Arrangements for addressing environmental needs are still under preparation and some solutions are non-price related (e.g., treating a minimum flow as a specific allocation). In terms of water rights, all bulk water users must hold some form of license or water entitlement, which specifies access to a nominal quantity of water. This facilitates pricing and selling water on the basis of the measured quantity consumed. However, due to changing seasonal conditions, actual quantity of water available each year may differ (sometimes substantially) from the quantity specified for a given water right. Water reliability in some river basins is often lower for irrigation than for other uses, so prices are adjusted to reflect this.

190 The transferability of water rights also plays a crucial role in how water pricing is defined. Holders of water rights may, with approval from their water agency, trade their entitlements either permanently or temporarily. Water agencies play no role in the marketing or price determination process but must assess the physical feasibility of each proposed transfer. Significant trade has occurred mainly among irrigators in the same state (since irrigation consumes most of the bulk water supplies). Potential for interstate water transfers exists, but current differences in water entitlement specifications and methods of water pricing have inhibited states from permitting trading.

A.2 The French Experience [61]

191 Because its water reserves were deteriorating with post-war industrial growth and urbanization, the French government decided to restructure its water resource management system. The changes began in 1964 with the Water Law which, among other things, created water basin committees and agencies and charges for the use of water. The new system came into operation in 1968 once the new law had been implemented.

192 Under this new system, the country is divided into six large water basins, each with its own respective committee and agency. Two-fifths of each committee is made up of officials elected by the community, two-fifths are water users, and one-fifth are government representatives. The total number of representatives varies from 80 to 100 members.[62]

193 The presidents of the agencies are nominated by the Environment Ministry, but their directors are appointed to the committee by a council of representatives which tries to reflect the same representative structure as the committees. With this power structure, water basin management in France is totally decentralized. Since the regionalization and representation of these committees and agencies are defined by law, the water basin entity in France is a political entity equivalent to a federal entity. Water policy is defined hierarchically around a large water basin under which sub-basins are linked.

194 The system of bulk water pricing has been implemented gradually and has faced a variety of political obstacles. Volumetric charges, for example, have not to this day been implemented in some sub-basin areas, and the majority of irrigators do not participate in the system.

195 Charges for pollution initially covered only organic and suspended matter; salinity and toxicity were only introduced in 1973 and 1974, respectively, nitrogen and phosphorus in 1982, and hydrocarbons and other inorganic materials in 1992.

196 The revenues generated from charges are invested in the water basins in the form of administrative expenditures, studies and research, investments of common interest, and loans to users. In 1996 a total of US$1.8 billion was generated.[63]

197 With this income the committees are able to cover 40 percent of water basin investment requirements. The other 60 percent is primarily covered by budgetary transfers from the central government. Investments are defined on a five-year basis. In the period 1992–96, this amounted to a total of US$15 billion, an amount equal to the total spent in the 1982–91 period; in other

[61] When not specifically made reference to, this sub-section is based on information obtained from Cadiou and Tien Duc (1995), Kaczmarec (1996) and Chapuy (1996). Please note that the new European Union directives on the environment have already begun to effect national decision making, but it has not been possible to evaluate their effects within this study. It is also worth noting that much of Brazil's currently re-designed water resource management system is based on the French experience.

[62] Kaczmarec, 1996.

[63] Cadiou and Tien Duc, 1996.

words, in the last five years the same was spent and raised as in the previous 10 years.[64]

198 The framework for defining specific charges is established by law as:

$$\text{CHARGE} = Q \times U \times S \times E$$

where:

CHARGE = annual amount to be paid by the user
Q = quantity of water consumed or pollution generated
U = unit charge value
S = sectoral coefficient
E = environmental coefficient

199 CHARGE is calculated separately for quantity and quality, but one combined charge is applied. The CHARGE for pollution can be reduced by a proportion of the expenses incurred by users who try to reduce their pollution load.

200 Q can be derived from a general table which estimates parameters based on type of user.[65] Consumption by quantity can also be measured directly where a water meter is installed. In the case of effluents, the user can request a direct measuring of his pollution load as long as he bears the additional cost.

201 U, S, and E are initially proposed by the water basin agency and then submitted for discussion and approval by the committees.

202 U for quantity is differentiated between surface water and ground water, and by zone within each water basin. This differentiation by zone takes into account the scarcity of water and the need for investment in regulation and other necessary works. The charge for ground water varies between US\$0.014/m^3 and US\$0.044/m^3. The charge for surface water is only made in areas of high scarcity during periods of rationing, and can reach in some cases as much as US\$0.050/m^3.

203 U for quality is standard for the whole basin and differentiated by pollutant principally according to the cost of treatment. Table A-1 shows the average charge for pollutants for the six water basins in 1993.

204 S is a consumption coefficient, which differentiates the user sectors. In consumption by quantity for example, the coefficient for domestic consumption is generally higher than that for industrial consumption. To calculate the charge for domestic pollution, a coefficient (of mass) is used which varies from 0.5 for small communities to 1.4 for large urban areas.

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[64] Kaczmarec, 1996.

[65] For domestic consumption, fixed national factors exist which can translate the number of inhabitants into a quantity of polluting load.

205 E is an environmental coefficient, which differentiates the receiving body's (river, lake, etc.) capacity to absorb pollutants. In the case of pollution, E varies on average from 1.4 for bodies with high environmental standards to 1.0 for bodies with low environmental standards. For quantity consumption U by zone already considers this a zonal factor.

Table A-1. Pollution Charges in France by Water Basin (US$/kg)—1993

Basins	SM	OM	IS	NR	P	SS	AOX	METOX
Adour - Garonne	18,7	56,2	1053,24	28,11	70,05	70,05	163,75	163,75
Artois - Picardie	24,17	47,99	894,57	27,15	128,90	360,07	-	-
Loire - Bretagne	16,58	25,51	1062,17	36,44	118,94	-	-	-
Rhin - Meuse	19,51	39,01	805,25	26,76	44,53	28,06	-	112,52
Rhône - Méditer. - Corse	18,7	56,2	1053,24	28,11	70,05	70,05	163,75	163,75
Seine – Normandie	22,15	49,45	794,57	44,63	-	462,70	-	-

Source: Cadiou and Tien Duc 1996
Notes: SM = suspended matters; OM = oxidizable matter; IS = inhibiting substances; NR = organic and ammoniac reduced nitrogen; P = total phosphorous; SS = soluble salts; AOX = halogenated hydrocarbons; METOX = toxic and other metals.

206 It is important to note that the guiding criteria used to calculate the level of charges in the French system are those of cost of provision for consumption in quantity, and cost of treatment in the case of pollution. These criteria hold coherently to the criteria of public prices and cost-efficiency.

207 The values of S for quantity are lower for industry and higher for domestic consumers, and can be associated with the differences in size of elasticity of these sectors, according to the rule of public prices. The S coefficients for quality, on the other hand, seem to be based on ability-to-pay criteria, which benefit those consumers with the lowest incomes. In other words, a cross-subsidy is spread among domestic consumers.

208 The values of E for quality, meanwhile, seem in principal to also follow criteria of cost-efficiency, imposing higher payments for areas of higher environmental standards: if the standards for one area are higher than those of another, then the level of charges should also be higher to enforce a higher level of control. For such a rule to be generalized, however, cost functions, absorption capacity, and similar pollution profiles between zones would have to be assumed. Furthermore, the unit charge value is not set so that users as a whole can reach a certain level of load to be ejected into the receiving body, as cost-effective pricing would suggest.

209 The revenue from charges for pollution has represented about three times that raised from charges for quantity consumed, thus treatment works received six times the resources in the period 1991–96, as shown in Table A-2. The improvement in quality has been considered the source of increased consumption.

Table A-2. Charge Revenue Application in France (US$ billions), 1991–96

Source of Application	Total Cost of Investments	Subsidies or Soft Loans provided by Agency
Waste water treatment in industry	1.93	1.16
Waste water treatment in local communities	7.99	3.59
Water resources management	1.17	0.33
Securing drinking water	2,65	0.88
Other sectors (ecology, wetlands, agriculture, etc.)	0.77	0.30
TOTAL 1991/96	14.51	6.26

Source: Kaczmarec 1996

210 In summary, the French system adopts the principal of "polluter pays," indirectly using criteria of public prices to finance costs.

211 The results of the French system are considered successful. At present it is estimated that this charge (on quality and quantity) is equivalent to a 15 percent premium on the total price of water. In terms of investments, this has allowed for the rate of domestic effluent treatment to grow from less than 50 percent in 1982 to more than 72 percent in 1992. In the same period, industry reduced residual emissions of organic matter by more than 27 percent and that of suspended matter and toxic materials by more than 38%.[66]

212 The system also looks positive in terms of planning through a political and active involvement process, and in terms of integrating its management instruments (command and control, and pricing), although the agricultural sector has not yet been fully integrated into this process and scope of charges.

213 On the other hand, little is yet known as to efficiency gains in terms of maximizing benefits from water use, the reduction in environmental damage, or even the minimization of cost controls. As will be shown in the following pages, other European experiences with a system of charges also appear to have been successful in the initiation of investments, in guaranteeing water availability, and in pollution control. At the same time, however, they have clearly not addressed the criteria of economic efficiency in their structure of charges, and therefore have not benefited from the expected efficiency gains. This reality results from the technical and political difficulties of adequately implementing the economic criteria of pricing.

[66] Chapuy, 1996.

A.3 The Dutch Experience

214 Water resource management in the Netherlands is unique in the sense that the country is famous for its territorial expansion into the sea and the thousands of kilometers of waterways that crisscross its territory. However, the country has one of the highest population, agricultural, and industrial densities in the world, which significantly affects the quality of its water resources. Therefore, a law on water pollution was passed in 1970 which, apart from numerous regulatory provisions for controlling effluent emission, also introduced a charge for liquid effluent pollution. This is a federal charge for emissions into federal waters, and a regional charge when for emissions into regional waters. From 1983 onward, a charge for quantity was gradually introduced.

215 The Dutch administration system is totally decentralized through a system of regional water boards, although without the participatory and hierarchical structure of basins as in the French system. The regional water board is not obliged to apply charges,[67] but when it does, the rate is imposed by the management.

216 In 1983 the regions also initiated a fixed rate charge (US$0.005/$m^3$) for the extraction of ground water, while in 1995 another federal charge was introduced for surface water at a rate of US$0.17/$m^3$ for domestic use and US$0.085/$m^3$ for industrial use. The revenue generated from charges on quantity reached US$150 million.

217 In the case of charges for pollution, both industrial and domestic users pay a rate proportional to the quantity of pollution contained in their effluent emissions. For this, there is a unit charge value per unit of pollutant (organic load and heavy metals), which is multiplied by the quantity of pollution to calculate a total value of the charge. The quantity of pollution is calculated in terms of pollutant units.[68] The federal unit value is US$30 per unit of pollutant, while the regional values vary from US$30 to US$60 per pollutant unit, depending on the region and reflecting the differences in cost of construction and operation of treatment plants.[69]

218 It is important to note that the calculation of this value is not related to environmental damage or quality, but rather to control costs. This is because this charge was introduced as a source of financing for the construction and operation of sewage treatment plants, which could be used by these regional water boards. Its initial objective was not, therefore, to be an instrument to induce control at a certain level based on a pollution price.

219 However, the high and ever increasing rates adopted imply that use of charges has been considered a successful instrument in the control of pollution and the adoption of cleaner technology. In 1975, the revenue from charges was US$840 million, while in 1980 it was almost US$2 billion, and in 1990 reached more than US$3 billion.[70] That is, even with a GDP

[67] There are very few cases that are for specific pollutants only.

[68] Population equivalent for example, in the case of organic matter.

[69] OECD, 1995, and Mendes and Seroa da Motta, 1997.

[70] According to Bressers and Schuddeboom, 1996.

equivalent to one-fifth of France's GDP, the revenue from the Dutch system of water charges is more than twice that collected by all the French water basins.

220 Compared with the German system, described below, Bressers and Schuddeboom reveal that the Dutch rates are twice as high as the German ones, while Holland's GDP is one-sixth that of Germany's.

221 To simplify the operation of the system of charges for pollution, the small-scale polluters are charged a fixed rate and the medium scale polluters are charged according to a national index of average parameters of emission. Only the large-scale polluters are systematically monitored. The others may demand direct measuring, but must bear the additional costs.

222 As in the French case, the agricultural sector does not participate directly in this system, again due to technical and political problems, nor was applying the system to industry devoid of court actions in the initial years.

223 The results of the system were carefully analyzed by Bressers and Schuddeboom (1996). In the period from 1975 to 1980 alone, the organic load emitted into the country's water systems was reduced by 27 percent and those of heavy metals by 50percent, despite strong economic growth during that period.

224 The above authors estimated a high statistical correlation (approximately 70 percent) between the level of industrial control and the level of charges. In this way it does seem as if the Dutch system has benefited significantly from gains in efficiency, as could be expected from a charge system geared more toward environmental standards.

225 Bressers and Schuddeboom also observed that the charge was set up in such a way as to allow for a certain level of negotiation between environmental entities and polluters, since the system allows for charge deductions against on-going investments in pollution controls. In addition, in regions where charges have not been adopted, the local administrators often use the threat of adoption to persuade users to invest in pollution control.

226 In summary, the Dutch system seems to represent an experience in which charges for pollution to generate income induce a change in pollution standards by means of applying high and increasing rates based on control costs. In the case of charges for quantity, it is still too early to evaluate the results, although lower rates for industrial use show that criteria of public prices are being indirectly adopted .

A.4 The German Experience

227 The German system of water resource management is also decentralized through regional entities, but not by water basins.[71] The federal government defines a national legislation, which can then be made more restrictive by the states, which are responsible for implementing the regulations. The municipalities are responsible for water supply and sewage treatment, and are consequently free to charge the users for these services, although they are obliged to set rates high enough to cover the cost of services. The legal document that provides guidelines for the system is the Federal Law of Water Resources of 1957, revised in 1986.

228 The German system is not hierarchical and participatory in the administration of water basins in the way that the French system is, although in numerous instances, municipal consortia in different basins unit in their efforts to provide water and sanitation while benefiting from economies of scale and increasing their technical capabilities.

229 Some of these consortia have existed since the end of the last century, such as that of the Ruhr River basin, and they tend to adopt a pricing policy in tune with all municipal stakeholders.[72]

230 A charge for water usage exists only in the form of a federal sewage rate set up in 1976 and first applied in 1981. All domestic and industrial users that discharge liquid effluent into water bodies have to pay this rate, which is collected by the states.

231 Rural users do not fall within the bounds of this rate in Germany, as a result of the same problems faced by France and the Netherlands.

232 The total value of the charge is the sum of the quantity of pollutant measured in terms of its toxicity, multiplied by one unit of toxicity. The scale for this unit of toxicity is given in Table A-3. This rate of toxicity was increased from US$6.60 in 1981 to US$33.30 in 1990, and subsequently increased in 1997 to US$38.90. A rate of US$50 is planned for 1999.[73]

233 Polluters who achieve standards of emission in advance of dates stipulated by legislation are rewarded with a 75 percent discount. In addition, investments in pollution control can be deducted from the amount charged. However, emissions below the legal standards still do pay a price for generated pollution. Such discounts, in addition to the high institutional capacity to impose environmental standards on sources of pollution, result in a low collection of this charge, in comparison to France and the Netherlands. For example, 1991 revenue reached a total of only US$200 million. From the collected total, about 20 percent is spent on administration of the system and the remainder is used by the states to finance municipal investments in water and sewage services.[74]

[71] With the exception of one state.

[72] Based on information supplied by the Ruhr River Basin Association, public price criteria are adopted.

[73] Planagua, 1997 and OECD, 1995.

[74] OECD, 1995.

Table A-3. Scale of Units of Toxicity Used for Water Charges in Germany

Substance	One unit of toxicity is equivalent to:
Oxidizable matter	50 kg
Phosphorous[a]	3 kg
Nitrogen[a]	25 kg
Halogenated hydrocarbons	2 kg
Mercury	20 g
Cadmium	100 g
Chrome	500 g
Nickel	500 g
Lead	500 g
Copper	1000 g
Toxicity for fish	3,000 m^3 of discharged water divided by a dilution factor

Source: Planagua 1997
[a] Introduced after 1991

234 The results in terms of coverage of the municipal sewage service were modest, given the high degree of coverage already in place before implementation of the rate. Thus, from an 89 percent coverage in 1979, a 93 percent coverage was achieved in 1991.[75] In contrast, the results in the industrial sector were significant. Private sector spending on water pollution controls in the period 1980–89 grew by 50 percent, from US$2.2 to US$3.3 million.[76] It is estimated that pollution in the main rivers was reduced by more than half, and that certain "dead" stretches are already showing signs of a rich and varied aquatic life.[77]

235 In summary, it is clear that the German system, by giving deductions to users who increase their levels of pollution control, uses the sewage rate as an instrument to provide incentives for pollution control investment. Thus, revenue from charges does not become the main objective, but rather, acts as an inducement. The system is based on simple principles, and is decentralized and effective. It is, nevertheless, worth calculating how much the institutional capacity to make environmental regulations enforceable has contributed—price effects on the rate aside—to the results obtained.

236 The adoption of levels of charges based on toxicity of pollutants seems to indicate some move in the direction of criteria related to damage by Pigouvian taxes.

237 Nothing, however, indicates that the levels of rates are defined ex-ante by some explicit efficiency criteria.

[75] The figures presented here are only relevant to the old West Germany.

[76] OECD, 1993.

[77] Planagua, 1997.

A.5 The Mexican Experience[78]

238 Mexican water legislation allows the National Water Commission (CNA) to apply the "polluter-pays principle" on water discharge from municipalities and industrial plants exceeding determined standards of organic matters and suspended solids. However, lack of enforcement has substantially reduced the revenue raised. Since the introduction of charges revenue has increased from U$5 to US$10 million, though this still represents only a minor percentage of the potential revenue. Poor monitoring and opposition from polluters are the main reasons for enforcement failures.

239 National coverage of the water system has required monitoring resources beyond the current financial capacity of CNA. The lack of private and public participation and the absence of information based on careful analysis of expected impacts of charges has contributed to polluters' opposition on competitive and distributive grounds.

240 The current revision of this water charge legislation is attempting to remove these political barriers by increasing participation and information and by enhancing institutional capacity.

241 A more participatory and realistic approach may create an excellent opportunity for Mexico to have a very effective system of economic incentives for water management, and also to guarantee financial resources to enhance institutional capacity.

242 The wastewater charges, in place since October 1991 and recently revised, enforce effluent standards and provide an incentive for firms to invest in abatement for water quality control. These charges are legally bound by the Mexican Constitution, the General Law for Ecological Equilibrium and Environmental Protection, the Federal Water Act, and the Federal Water Rights Law.

243 At a decentralized level, the municipalities are responsible for water supply and wastewater management. At the national level, the CNA is responsible for the promotion and execution of federal infrastructure and the necessary services for the preservation of water quality. The charge is then applied by CNA, and the resultant revenue goes to the Treasury without returning to either municipalities or polluters as a fund, although it is partially budgeted to finance CNA activities.

244 The 1991 original version was a non-compliance charge since it only applied to pollutant concentration levels exceeding standards. The 1995 revision turned this charge into a type of tax levied on all levels of concentration.

245 In the 1991 version, the charge had to be paid for every cubic meter discharged and the charge level varied according to the four water availability zones, dividing the country following water availability criteria.

[78] The information in this section is based on Belausteguigoitia, Contreras, and Guadarrama, 1996, and Contreras and Saade, 1996.

246 This charge was applied to all polluting sources discharging effluents. For those sources exceeding the monthly discharge limit of 3,000 m^3, the charge level was determined by the product of the concentration level and zone charge. Monthly discharges below 3,000 m^3 were charged a flat fee related solely to volume levels.

247 Only two pollution indicators were considered: the concentration of chemical oxygen demand (COD) and total suspended solids (SST).

248 Revisions of the Federal Water Rights Law in December 1995 introduced the following new procedures to calculate charges:

(i) Charges would no longer be based on water availability zones, but rather on the different assimilative capacities of receiving water bodies, defined according to the current use of the water and the treatment level required for the amount of pollutants found in the water body. Three categories were defined to classify the country's water bodies:

a) water bodies with lower treatment levels;
b) water bodies requiring secondary treatment;
c) water bodies requiring more sophisticated treatment levels;

(ii) Charges would vary according to different levels of pollutant contents as follows:

249 The concentration of the pollutant COD or SST would be charged by milligram per liter. The pollutant to be charged would be the one with the higher concentration in the water discharge.

The law established the following four ranges for the pollutant concentration:

a) equal to or below 30 mg/L;
b) between 31 mg/L and 75 mg/L;
c) between 76 mg/L and 150 mg/L;
d) above 150 mg/L.

250 According to this revised system, charge levels would be determined on the basis of abatement costs and would, therefore, vary according to the control level and pollution concentration in the recipient water body.

251 This new charge system is stricter than the original since it does not allow for reductions in payments in those cases where emissions are below the standards set for COD and SST, as before. Therefore, this charge is no longer a non-compliance charge; rather it can be considered as a kind of water pollution tax levied on all levels of pollutant concentration.

252 This revision is significant in economic and environmental terms. First, because it creates a permanent incentive for users to reduce the volume and degree of pollution discharged; and second, because the water body assimilative capacity is now taken into consideration.

253 However, other forms of charge exemption were created: to alleviate charge collection, payers with monthly discharge volumes less than 3,000 m^3 still have the option to pay a fixed flat charge varying according to the receiving water body; and to reduce fiscal burden in small municipalities, public water supplies to municipalities with fewer than 2,500 inhabitants are exempt.

254 As a result of the economic crisis in Mexico and the large default among users, the government published a set of Presidential Decrees in 1995 canceling debt that arose from the previous charge system, when either abatement investments were undertaken and the following payments were correctly done or debt size was a financial threat to firms.

255 Another important exemption was for those polluters who had not complied with the deadline established by the law for the construction of their abatement facilities, but had demonstrated to the CNA progress of at least 80 percent in the construction work. These polluters were allowed to pay the charge related to the level of abatement achieved after finishing construction. The works, however, were expected to be finished and put into operation before October 1996. Furthermore, agricultural run-off, because of its diffuse aspect, was not subject to water charges.

256 The Federal Law of Charges is revised every year. Since 1997, this law has aimed to create economic incentives for users of water-receiving bodies to adopt processes that improve water quality beyond the required quality standards. Moreover, there have been some changes in the classification of certain water bodies, and additional pollution indicators are now taken into account.

257 To control the pollution level from municipal and industrial sectors, it was considered more effective to formulate two official standards, published in 1997 (one of them still awaits public consultation), establishing the maximum permissible levels of pollutants for wastewater discharges to national waters, and the maximum permissible levels of pollutants for wastewater discharges as sewage (in this case households were exempt). This represented an enormous effort to simplify the system in place, since this new approach allowed for the reformulation of 43 official standards (mostly for specific industry sectors) into only these two standards.

258 The main purpose of this new approach is to provide incentives for polluters to adopt new practices, processes, and technologies to reduce their pollution emissions. One of the driving forces of this new approach was the government's perception of a large default among users, associated with the economic crisis that struck the country. It was therefore considered that a gradual approach or multi-stage approach was the best option to implement. The deadlines established for complying with the maximum permissible levels for discharges to national waters are the years 2000, 2005 and 2010, according to the population size in the case of municipalities, and the range of biochemical oxygen demand for non-municipal discharges.

259 The current legal framework establishes penalties for non-compliance. It is too early, however, to fully evaluate the effectiveness of these new standards. In fact, in the past months there has been a reduction in collection, mainly as a result of the extension given to polluters for

the construction of their abatement facilities. One important feature of these standards is that they allow for the same parameters to be used to control all agents that discharge into a specific water body; in this way it is possible to enjoy economies of scale while encouraging polluters to treat their discharges jointly.

260 This approach also has the advantage of being dynamic. The parameters considered are the same as in the Federal Law of Charges and the Special Conditions of Discharge, thus allowing for the homogenization of policies. There is still a gap, however, in the development of a new regulatory framework for wastes originating from treatment plants, for the establishment of maximum permissible levels of pollutants for artificial aquifers, and for water infiltration to soil and subsoil. The Mexican government is working on a framework to incorporate these factors. A new standard authorizing the use of treated wastewater for public services has recently been released for public consultation.

261 Among the system's greatest problems in recent years is that, in general, water polluters do not pay for their discharges. This has been the case for almost all municipal discharges and a large proportion of industrial discharges. The amount collected from these sectors represents a very low percentage of CNA's total collection level. The objective of environmental authorities with the introduction of these changes is to force users, on a reasonable timeframe, to comply with regulation charges. It is worth noting that the money collected from these users is diverted to the Treasury, and CNA receives a share of it as a budgetary provision of its services.

262 To conclude, the investments in water pollution control that will be required in future years to comply with these new regulations will be huge. The National Institute for Ecology (INE) has estimated that, for the period from 1995 to 2010, the investments required for wastewater treatment activities (for municipal and industrial uses) will be close to US$9.3 billion dollars. The CNA faces the problem of lack of infrastructure to supervise firms regularly, which implies very high costs. With the new legislation in effect, the charge system is now more flexible and comprehensive. However, proper institutional development for improvement in the monitoring and control of discharges is still an important factor for the success of the system's implementation.

A.6 The Colombian Experience[79]

263 In Colombia, charges for effluent discharge and water use have been in place since 1974[80] through the regional environmental agencies (CAR). This charging system was rarely implemented, however. In those cases when it was implemented, a cost-recovery approach was used to attempt to cover the operation costs of monitoring systems.

264 Failure to expand coverage and introduce pollution/use criteria in charge level determination was due to problems similar to those of the Mexican case. The lack of appropriate design of approach, information about impacts, compatibility with the available monitoring system, and planning of its coverage expansion, all resulted in forceful public and political opposition and the undermining of political support.

265 Only US$116,000 was collected from a potential charge revenue of US$90 million. However, in the few cases where these constraints were overcome, it was reported that successful charge applications induced changes in water use patterns, with reductions in consumption and pollution.

266 In 1993, new environmental legislation (Law 99/93) was passed in Colombia requiring that pollution charges be clearly specified, based on the criteria of full environmental costs (i.e., charge levels must be defined according to the full value of environmental services and the full cost of environmental damages involved). In fact, the new criteria attempt to bring charge levels to optimum levels in the Pigouvian sense, measured by economic welfare losses.[81]

267 The Colombian EMS is attempting to create regulations that will complement the current legislation and allow for the gradual determination and implementation of charges. Moreover, a careful analysis of the economic and social impacts of these charges will be performed in preparation for future negotiations with users and polluters. Adjustments of the existing institutional framework are also under consideration.

268 The new charge scheme was implemented by Decree 901 of April 1, 1997. Through this decree, the Ministry of the Environment defines a minimum tax, and determines the mechanism for adjusting the rate levels to reflect the particular conditions of each location.

269 The main mandates of this decree are the following:

- Initially, the tax will be charged only on emissions of DBO and TSS. The minimum tax rate will be US$0.03 and US$0.013/kg respectively.

[79] The information in this section is based on Rudas and Ramírez (1996), and Seroa da Motta, Ruitenbeek and Huber (1996).

[80] The legislation focused on renewable resources, including air, fisheries and forests. Fishery and forest charges were poorly implemented, as were water charges, whereas air pollution charges were never applied.

[81] Although initially implemented for water management, these charges can be applied broadly for any environmental service.

- Each regional EPA will establish an environmental target that will be revised every five years. The target will be determined via a consensus-based regional process, involving the different agents and communities that have an interest in the resource.

- Polluters must present a report of their emissions every six months. The EPAs will organize random emissions tests to verify the accuracy of the information reported.

- Tax rates will be adjusted every six months by region; however, the rates can only be adjusted until the predetermined regional goal is achieved.

- Tax rates will be adjusted by increasing the regional factor by 0.5. This means that for those regions adopting the minimum level set by the ministry, the tax will double the first year and increase by 50 percent, 33 percent, 25 percent, and 20 percent between the second and the fifth year, respectively.

270 This new legislation eliminates the cost-recovery limitations of charges, which may now be fixed on a tax levy basis. However, creating the new charge scheme will require greater institutional capacity than currently exists, since the determination of new charges is a complex process and the charges are bound to vary significantly with type-of-use and spatial factors. Apart from this technical and institutional constraint, the administration of these new charges can be extremely costly. The high uncertainty of the resulting economic and social impacts is generating strong opposition among polluters and users.

271 These charges present an excellent opportunity for Colombia (and similarly Mexico) to establish effective water management and generate the financial resources required to overcome budgetary constraints.

A.7 The Chilean Experience[82]

272 The Chilean experience with tradable water permits dates back to the 1920s, and a general legal basis was established by the 1951 Water Code. This code allowed the state to give water concessions to private parties according to water use priorities. Water transfers were allowed provided that the type of use remained the same. Then in 1969 during the agrarian reform, water become state property and trade concessions were prohibited.

273 The more recent 1981 Water Code reintroduced permanent water rights, completely separate from land rights and freely tradable for both consumptive and non-consumptive uses. Conditional uses were abolished, and simultaneous requests were settled via bidding.[83]

274 Today there are approximately 300,000 water users in Chile; however, only 35 percent to 50 percent of them have legal titles. Users are organized in private associations controlled by the General Directorate of Water (DGA), within the Ministry of Public Works. This directorate is responsible for water rights regulation, approval of hydraulic works, and technical reports on conflict resolution. Irrigation has a specific national commission, composed of public and private institutions, to plan, evaluate and approve public investments in the sector, which are coordinated by the Directorate of Irrigation and executed by private companies via bidding.

275 To address pollution problems and enhance management capacity in planning and monitoring, Congress is discussing revisions and improvements of this tradable water rights system . A system of tradable water emission permits is also under discussion.

276 An analysis of the transactions records of 1992 indicate that trade tends to be more intense near the Santiago area, where water is more scarce. Still, of the transactions with no land transfer involved, only 3 percent of total water flow was traded in the area that year, with an estimated value of US$366,000. Moreover, 94 percent of total transactions occurred among farmers, and therefore did not involve changes in use. Trade between urban users and farmers did not exceed 3 percent of total trade transactions.

277 This low rate of transactions may reflect either a failure of the trading system or a close to optimal allocation of the initial rights. Such an evaluation would require further research. It is reported, however, that trade has both prevented political disputes and reduced investment expenditures. Moreover, the trade policy has created incentives for water rights titles and improved water use efficiency, thereby increasing social benefits and reducing transactions costs of trade.

278 Chile's tradable water rights are believed to be politically acceptable and enforceable because of the country's long tradition in water property rights. Even water rights not legally inscribed are respected and traded.

[82] The information in this section is based on Rios and Quiroz (1995), and Seroa da Motta, Ruitenbeek and Huber (1996).

[83] Alternate rights are also granted. For further information, see Brehm and Quiroz (1995).

279 Chile's example should be carefully reviewed by other countries seeking similar experiences, as is the case for Peru. Property rights assurance is particularly important for water rights since controversial equity issues, and consequently, political barriers, may arise because water is an essential natural resource in terms of welfare changes and economic impairedness. Countries with no similar tradition should first legalize existing property rights titling and define criteria for new assignments. The water permits already in place in many countries may provide an initial endowment.

280 Once more, experience may start in basins where monitoring and uses are well established. Attention to speculation restrictions and trade promotion are also paramount to achieving successful results. Apart from that, the need to set permit-holding fees as financing source to management and monitoring activities must be taken into account. These fees could be set at higher levels to unused permits in order to promote trade.

A.8 The American Experience

281 The American experience is frequently cited in literature on market creation. The United States also has a well-established system of water pricing for all uses. This pricing system is complex and varies from area to area throughout the United States depending on the climate, water scarcity, and manner in which the water supplies have been developed.

282 For example, in many federally sponsored irrigation projects in the west, the Bureau of Reclamation has strongly subsidized farmers with long-term contracts for the supply of water. These contracts include the repayment of capital costs with subsidized interest rates and, in all instances, include the total recovery of O&M costs. In most of these projects, the responsibility for O&M has been turned over to water districts or user associations. All of the capital costs and O&M of any hydroelectric components of these projects have been retained by the federal government, along with lucrative revenues derived from the sale of that energy. O&M costs for the irrigation components are not subsidized within any of these types of projects.

283 More typically, irrigation projects in the United States were built either by private companies owned by the users or by user cooperatives. For more than 150 years, these entities have had to recover capital costs and full O&M costs. Those that did not were gradually absorbed by more business-like companies along with their water rights and infrastructure. These entities have never received subsidies and have survived because of their ability to collect annual costs from their users. Most of these companies have the right to reclaim the shares of the companies from users who do not pay and to then sell those rights to other users who will pay. Shares of stock in these companies represent a right to a portion of the annual delivery of the company and trade in the open market as do any other shares of private companies on a willing buyer-willing seller basis. The annual assessments to cover capital costs, other fixed costs, and variable costs are set in public meetings attended by the Board of Directors, elected by the shareholders or users, and by the users themselves. This very transparent process has maintained the credibility of the management of these organizations, and the willingness of the users to pay their share of the costs of the system that delivers their water.

284 Pricing for municipal and industrial (M&I) water supplies has been based upon full cost recovery for over 100 years. Provision of M&I water has generally been the responsibility of government agencies or public companies. Private M&I companies are prevalent in Southern California and generally utilize a base water supply of underground water supplemented by bulk water delivered by the Metropolitan Water District of Southern California. In the Mountain West of Colorado, rural domestic water supplies are frequently supplied by user districts that are governed by Boards of Directors elected by the users. These quasi-municipal public corporations receive their revenues for sustainable O&M from water tariffs set by their Board of Directors and funds for capital development from tap fees charged for new connections, and from bonds sold on the open market, secured principally by operating revenues derived from water charges. In some instances, bond issues are also secured by a pledge of the taxation of the property of users within the boundaries of the district or association after submitting such a pledge to the users in a referendum. In some of the earlier districts, *ad valorem* property taxes were voted on by the electorate to finance water rights purchases and the funds to repay the bonds used were derived directly from the taxes collected. This is not commonly the case today, and the ad valorem

power is more often used to underwrite the surety of revenue bonds. In the case of major municipalities and cities throughout the United States, a combination of taxes and water tariffs has been used to finance both fixed costs and operating costs. In many instances, however, the water tariffs are sufficient to recover all costs of the utility, and are also used to subsidize other non-revenue generating activities such as parks, recreation, and social costs.

285 The need for major trans-basin diversions of water from surplus watersheds to dryer watersheds has, in many instances, prompted the formation of large bulk water delivery agencies that finance the large infrastructure requirements of such projects. These large agencies generally use the bond market for funds, and use guarantees based upon anticipated revenue backed by ad valorem taxation power. Examples of this type of agency are the Metropolitan Water District of Southern California, the Northern Colorado Water Conservancy District, the Denver Board of Water Commissioners, and the Delaware Basin Authority. Financing by entities such as these generally is also secured by long term delivery contracts by the cities, industries and agricultural companies to be served. With this type of agency, the water tariffs are set by the elected or appointed directors, answerable to the users. In addition, bond financing frequently builds in minimum water tariffs that can be charged as long as the bond financing is outstanding. With the exception of massive governmental projects such as the California Water Project, the Central Arizona Project, the Central California Project, and the large hydroelectric dams on the Colorado River, government subsidies are not used for water supply projects in the United States.

286 The use of market-based transferability for water use rights in order to allow water to seek its highest and best use is very prevalent in the western part of the United States. Market transfers of the shares of stock in irrigation companies have been occurring for over 100 years. Initially these transfers were between agricultural users, but in the last 20 years, the majority of transfers have been to industries and cities whose demands have expanded. In addition, in the Northern Colorado area, transfers of the contractual rights of use for the Colorado–Big Thompson Project and the Windy Gap Project have been the dominant source of new water supplies for the cities and industries of this region. These transfers occur on both an annual rental basis and as permanent transfers. The market determines the value of the rights and the transaction is between the buyer and the seller with the agency involved recovering only a small administrative processing fee of less that US$100 per transaction, regardless of the amount of water being transferred. In the state of California, for many years, if an individual attempted to sell a water use right, the courts deemed this as sufficient evidence that the right was not being put to beneficial use and the right was forfeited. However, in recent years, changes in the law have been made to encourage the development of a very controlled market in water use rights. At present, however, the only legal buyer is the state of California using a predetermined price. This water is then used to accumulate drought reserves to be sold to users at a moderate mark-up from the purchase price. This type of controlled market has done little to create an incentive to conserve water, but has provided a drought contingency.

287 In Southern California, a type of market transfer has developed ad hoc between the Metropolitan Water District (MWD) of Southern California and several irrigation districts. The MWD is providing the funding to improve the irrigation systems and conserve water supplies in exchange for a right to some of the conserved supplies. This innovative win–win solution

appears to be working extremely well. A similar effort is now being undertaken between the City of San Diego and the Palo Verde Irrigation District. This form of barter market holds great promise for the enhancement of efficient water use in the United States.

288 In the case of pollution control, the American experiment with market transferability of pollution rights has been intense since the 1970s, principally in the area of atmospheric pollution.[84]

289 The American Clean Air Act of 1977 allowed polluters to compensate their emissions from new plants or expansions by gaining credits for emission reductions in other existing plants. Some experiments were carried out with relative success, but the system did not result in the expected gains due to a lack of confidence on the part of the polluters in the security of these rights during this experimental phase and also due to the fact that the conditions of competition necessary to induce transactions were not addressed.[85].

290 These experiments have only recently begun to show results under a program initiated in 1995 by the Environmental Protection Agency (EPA). The EPA issued commercial certificates of sulfur dioxide (SO_2) for the control of emissions from electric power plants. In this case, certificates were issued with emissions 50 percent below the norm to 110 plants that had to transact in the market to cover their emission requirements. In this experiment an attempt was made to better attend to the economic conditions necessary to make efficiency gains in this kind of market, and was further boosted by a futures market on the Chicago Stock Exchange. To date the results have been favorable, although some analysts point to certain EPA trade restriction rules, which effect the degree of efficiency of the system.

291 With regard to control of water pollution, the few experiments carried out in the 1980s were not successful. The following section examines some of the more significant examples: Fox River in the state of Wisconsin and Lake Dillon in the state of Colorado.

291a The state of Wisconsin initiated a system of commercial certificates of organic load (DBOs) for the Fox River in 1981 and extended these to the Wisconsin River some time later. On a 50-km stretch of the Fox River there are 26 sources of discharge, and only the same number on an 800-km stretch of the Wisconsin River (including cities). The certificates indicated a level of emission dependent on conditions of flow and temperature of the stretch where the holder of the certificate was located. Earlier studies on implementation of the system had admitted that the marginal cost of pollution control between the sources of discharge would make it possible for commercialization to reduce the total cost of control by more than 40 percent of the total sum of US$6.7 million.

292 Although the sources have adjusted their discharges to the new levels stipulated on the certificates, only one transaction actually took place between polluters. Besides the small number of polluters and the differences in the costs of pollution control having proved to be insignificant, the experiment failed due to the fact that the small companies in the region were

[84] See Tietenberger, 1996, and Howe, 1994.

[85] This could take place through offsets between regions or within an aerial basin or bubble.

dependent on orders from the large companies.

293 The Lake Dillon experience has been no less disappointing. In this case the objective was to reduce the cost of phosphorus emissions controls which helped mitigate eutrophication of the lake, important both as a recreation center and as a source of water to the metropolitan Denver region. A recovery plan for the lake had been drawn up with stricter standards, and the architects of this plan wanted to reduce the cost of implementing these standards.

294 Aware that the marginal costs of control for diffused sources were lower than for point sources, local managers proposed a system of commercial phosphate discharge certificates in which treatment plants could compensate for discharges above the new standard, with pollution control projects for diffused sources. Only a few transactions were carried out, although the polluters increased the efficiency of their treatment plants in line with the recovery plan.

295 The American experience with the creation of markets for water pollution certificates presented the same limitations as those seen in the equivalent atmospheric pollution experiments of the 1980s. In other words, it was not possible to have pre-requisites for a market in rights because it was not possible to guarantee a sufficient number of pollutants with differences in their control costs and limited economic interdependence. In addition, it is necessary to give assurance on rights under transaction, that is to say that the person who sells today can buy tomorrow and that the buyer will not have his right negated by a change in governmental regulation or policy. To quantify such risk in the market place, it might be necessary to create futures markets, as has been well proven in the case of SO_2 control.

296 In summary, the American experience with market creation, although not always a success, has nevertheless offered lessons and recommendations that can be used by similar systems to reap the expected benefits. The most important lessons are the necessities of guarantees for rights and competition. Either way, these experiences have also shown that while the economic aims are not fully achieved, use rights, due to their quantitative nature, are nevertheless effective in achieving environmental objectives.[86]

[86] That is, these markets are subject to the same degree of institutional efficiency as the instruments of command and control.

A.9 The South African Experience (extracted from Schur 1998)

297 South Africa reform of the water sector should be seen as part of the political change that has taken place in the country since 1994. The main objectives of these reforms are the equitable use of water resources.[87] The reforms address three aspects: legal, institutional, and economic (pricing).[88] Here we will address only the process undertaken by the government of South Africa, which is unique by itself, especially with its background.

298 *Proposed Reforms to Existing Water Rights Structures.* Since 1995, the Ministry of Water Affairs and Forestry (DWAF) has coordinated a process of reviewing South Africa's existing water law, with the objective of developing a new law that reflects the values of the new Constitution and the limits to the country's water resources. Crucial to this review has been the concern that water has been mostly available to a dominant group, which has privileged access to land and economic power. The water law review process began with a DWAF publication *You and Your Water Rights* (1995), which was soon followed by a discussion document titled *Water Law Principles (1996).* Later, *The White Paper on a National Water Policy for South Africa* (1997) represented the culmination of two years of work reviewing South Africa water law. The policy outlines the approach to the future management of the country's water resources as a national asset, which the state must ensure is used beneficially and sustainably in the public interest. A National Water Bill has been drafted on the basis of this White Paper, and will be tabled in Parliament in mid-1998. The bill has now become a proposed Water Act, and was put on the Government Gazette in December 1998 before final approval (see A.9 Appendix).

299 *Proposed Reforms In Water Institutions.* Through the water law review process it has become widely accepted that previous "command and control" approaches to water resources management, imposed unilaterally from a central body, are no longer valid in the context of the socio-economic and political changes that have occurred in the country. The role of the DWAF in the new dispensation is the formulation of policy and the enactment of legislation, while it is considered that the day-to-day responsibility for water resource management should be delegated to more appropriate national, catchment or local, area level institutions.

300 DWAF is currently investigating the feasibility of establishing a National Water Utility, which would take responsibility for managing water resource infrastructure of a national strategic nature. The aim of the National Water Utility would be to plan, implement, and operate projects to develop resources in accordance with national water resource strategies, on a self-funding basis.

301 To support further the process of institutional reform, new water legislation allows for the creation of catchment management agencies (CMAs). The CMA is a self-regulatory body corporate with a governing board and executive / administrative structure that has the statutory responsibility, power, and financial autonomy to perform a range of catchment management functions in a declared catchment management area. During the short- to medium-term transition period, there is likely to continue to be a dominant role for the DWAF in catchment

[87] See DWAF, 1995, 1997, and Schur, 1998.

[88] For a through analysis of this reform, see Schur (1998).

management through its regional offices. Ultimately, the logical outcome of the National Water Policy will be that integrated water resources management through CMAs will be the norm, rather than the exception.

302 Institutions such as water boards will interact with the CMA primarily as stakeholders within the catchment. However, given the limited water management expertise available, it may be appropriate in some circumstances to delegate certain functions to them.

303 Water resources management will be further supported through the formation of water user associations (WUA), which are statutory bodies representative of water user institutions in a declared catchment management area, or part thereof, with the power to develop and operate individual water supply schemes. Existing irrigation boards, subterranean water control boards and water boards established for stock watering purposes only will, over time, be restructured as more representative water user associations.

304 As far as new or previously disadvantaged irrigators are concerned, provincial Irrigation Action Committees (IAC) will be established to help facilitate access to water for irrigation farming. Where substantial state financing would be required, or where there is insufficient water for allocation, the provincial IAC will forward the request to the Agricultural Water Liaison Committee (AWLC), which will be responsible for developing decision-making procedures and criteria which provide quick and efficient feedback to requests. The AWLC will be comprised of staff from 3 government departments, namely Water Affairs, Forestry, and Agriculture and Land Affairs.

305 *Proposed Pricing Reforms.* As part of the water law review process, the DWAF appointed a policy implementation task team (PITT) to examine water pricing at the first tier. The PITT's work was integrated into the drafting of the National Water Bill, which deals with water pricing in chapter 5; part 1. In terms of the bill, the minister may, from time to time, by notice in the Gazette, establish a pricing policy for charges for any water use. This pricing policy may contain a policy for setting charges to:

- fund water resource management;
- fund water resource development and use of waterworks; and
- achieve the equitable and efficient allocation of water.

306 These provisions are derived from a draft document, *A Resource Pricing Policy for South African Water* (1997), which was prepared as an input into DWAF's Water Law Policy Process. Once the National Water Bill has been promulgated, the document will be expanded to serve as the basis for consultation on the new pricing policy.

307 The pricing policy document gives content to the provisions of the bill in terms of a conceptual framework that deals with four inter-related issues; namely social objectives, ecological objectives, financial considerations and economic considerations in the pricing of first tier water.

308 *Implementation of the Reform*. The new pricing approach implies that government water scheme tariffs could consist of three components: Infrastructure charge, reflecting the cost of abstraction and delivery via a water scheme; catchment management charge, reflecting the cost of regulating, managing, and maintaining the water resource or catchment; and economic charge that reflects the relative scarcity of water at a given time and place.

309 Water for basic human needs, long-run ecological sustainability and for meeting South Africa's international obligations will enjoy priority use. The water that remains will be classified as economic use of water and subject to pricing. Included in this definition of economic use will be any land-use that has a significant impact on the natural runoff. Thus, land-based activities (in water-stressed catchments) that reduce stream flow and generate an opportunity cost will be charged for the interception of water that these activities cause.

310 The new pricing reforms will be implemented over a period of years to minimize the impact on various user groups. Initially, the objective will be the adoption of full financial cost recovery tariffs, which will have to be implemented bearing in mind standing agreements with specific user groups and affordability constraints (i.e. the impact on the end-user). It may also be necessary to introduce economic charges in water-stressed catchments, which will require that tariffs be set equal or close to the scarcity value or opportunity cost of water. The administrative pricing of water will eventually give way to more market-orientated mechanisms, through the allocation of water use authorizations on the basis of public auction or tender. This may extend to the trading of water use rights and the establishment of water markets, within a regulatory framework.

Appendix to the South Africa Experience: Minister Preface of South Africa 1998 Water Act

311 We all advocate that measures be put in place that ensure long-term water security in South Africa. The challenge is to achieve this in as fair a way as is practicable. The legal foundation for water pricing has already been provided in the National Water Act, 1998. This document provides a strategy for its implementation.

312 Water is a limited resource in South Africa. In using it, we have obligations to meet basic human needs; the requirements for basic ecological functioning; the legitimate needs of our neighbouring countries; and the redressing of the extreme imbalances with which water is now allocated. Furthermore, when we talk of "water" in this way, we have to think in terms of water of an appropriate quality.

313 One of the most difficult aspects of managing these obligations is a water-pricing strategy. There can be no doubting the fact that the pricing of water can make a substantial contribution to the efficiency with which we use water, the equity with which we share water, and the sustainability of our water reserves.

314 This strategy document therefore is an attempt to find a better way to ensure that the pricing of water contributes to long-term water security. Interested parties are urged to study these draft proposals, and respond in a timely fashion, so as to ensure that we understand your perspectives on what is being proposed.

315 The measures that we are advocating here are designed to be in the enlightened self-interests of all South Africans. A finely-tuned management of water will have immense developmental benefits, and will be a major factor in establishing the quality-of-life prospects of all South Africans.

316 Ultimately, too, each of our own quality-of-life prospects is tied up in those of our fellow citizens.

317 Government's role has to be fair and equitable in treating all sectoral interests. It is the responsibility of all of us to be efficient in our use of resources. If together we can find a practicable, manageable way in which to allocate tariffs to these ends, we shall all be richer.

Professor Kader Asmal, M.P.
Minister of water Affairs and Forestry

A.10 The Indian Experience[89]

318 ***The water reform strategy for India.*** The approach the World Bank is taking in India for cost recovery in irrigation in integrally linked to the strategy for improving sector performance. Water price increases must be part of a comprehensive package that breaks the vicious cycle of low sector performance and farmer dissatisfaction, and creates a virtuous cycle of viable and sustainable operations that the farmers are pleased with. The vicious cycle is characterized by "inadequate financial allocations to the sector (particularly for operations and maintenance) and inefficient and bloated service institutions, which have led to poor quality and unreliable services, user dissatisfaction with the services they receive, and an unwillingness of users to pay for the services."[90] A three-pronged strategy is adopted to transform the vicious circle into a virtuous circle "which will enable the sustainability and quality of service delivery at viable costs to the service agencies and affordable prices to the users."[91]

319 The strategy comprises:

- an institutional structure and analytical apparatus, required for assessing service costs and fees, making periodic recommendations on adjustments and reviewing implementation of such recommendations;

- a public information and awareness strategy including publication of disaggregated service costs and fees, sharing of information with the general public and customers (particularly farmers at the command level), and involvement of irrigation commands, farmer councils and other water user groups in decisions on irrigation and other water services management and expenditures; and

- improvements in service quality, cost increases, and management structures, entailing:
  - (a) improvement in irrigation service quality through better management of maintenance and full funding of maintenance works, rehabilitation and modernization of irrigation systems, associated with farmer participation;
  - (b) increased monitoring and sharing of cost information (in addition to the system improvement program) with the irrigation user groups, irrigation staff and local politicians; implementing measures to increase prices and collection rates, and reduce costs through staff reductions as well as through assumption by farmers of responsibility for some tasks. (Increased monitoring and cost information sharing, in addition to increased collection rates, is now being proposed through use of computerized billing and record keeping, which has been found successful in other India contexts, e.g. Hyderabad water supply/sanitation corporation.)[92]
  - (c) participatory management of irrigation commands (commencing with tertiary portions of the system) by irrigation departments and farmers, and the progressive assumption of O&M responsibilities by user groups initially at tertiary levels and increasingly by federated distributory and higher level groupings, as feasible.

[89] Extracted from Wood, 1998.
[90] World Bank 1998.
[91] World Bank 1998.
[92] Saleth and Dinar, 1998.

Farmer user groups would serve as the focal point for reformed irrigated agriculture and technology extension services to enable better farming practices, enhanced water-use efficiency, and ultimately increased crop yields and farmer incomes. Concerns over farmer willingness to pay for appropriate higher water prices (ill-founded particularly when price increases are coupled with system improvements to raise agricultural productivity) would thus be alleviated.

320 ***Andhra Pradesh reform program implementation***. The background leading to the radical reforms, and the reform program itself, have been well documented (see A.10 Appendix below). In contrast to Orissa, and following a modest pilot program of system improvements and farmer responsibility for O&M, Andhra Pradesh (AP) followed a "big bang" approach to implementation of the irrigation performance improvement strategy program. Water user associations were created en masse statewide and irrigation water prices were increase 300percent, following an intensive public awareness campaign waged by the chief minister to win support of the farmers and politicians for the needed reforms. The public buy-in to the reforms was so complete that the huge price increase was implemented with neither an uproar nor a whimper.

321 Initial evidence of the impact of the reforms has been promising and was one of the reasons for the farmer buy-in to the reforms. The Sriramsagar project in AP which was part of the modest pilot prior to the "big bang," demonstrated the dramatic increase in reported irrigated area after the handover to WUAs in June 1997. Water utilization was two-thirds less than was supplied to the scheme prior to the handover. Total gross area irrigated (in both the monsoon kharif and dry rabi seasons) more than doubled from 1996 to 1997, whereas water consumed in the project area fell from 43,000 m^3 to 28,000 m^3 between the same two years. The success of the initial phase of the reforms has been due to the holistic approach adopted, and more to the concerted strong commitment of the AP Chief Minister to the reform program, as the chief minister's speech reproduced in A.10 Appendix clearly demonstrates.

Appendix to the Indian Experience.
Andhra Pradesh Government Commitment to Irrigation Reform[93]

322 The strength of government commitment in Andhra Pradesh to irrigation sector reform is remarkable. It has been centrally important to the bold beginnings of its irrigation sector reform program. The following are excerpts from a speech given by Sri Chandrababu Naidu, Honorable Chief Minister of Andhra Pradesh, on the floor of the AP legislative assembly on April 2, 1998, regarding the strategy of Water User Associations (WUA) in the state.

323 *"Our government have accorded the highest priority to the Irrigation Sector with a view to promote economic prosperity and agricultural development of the State. The strategy adopted is to not only complete the ongoing irrigation projects in the shortest possible time but to do so with the active involvement and participation of the farmers. Though Government have invested substantial public resources for the construction of a large number of irrigation schemes, the people have not derived full benefits thereunder due to inadequate maintenance and management and also due to deficient water regulation. Government has, therefore, taken the bold decision to hand-over the management and maintenance of all the irrigation schemes to the farmers' organisations. For this purpose, we have enacted the AP Farmers Management of Irrigation Systems Act, 1997.*

324 *"In June, 1997, elections were conducted to 10,292 WUAs for all major, medium and minor irrigation schemes. In November, elections to 173 Distributory Committees were also completed. In the near future, Project Level Committees will also be constituted to translate into action a total transfer of management to the farmers' organisations.*

325 *"Our Government have decided to give complete functional and administrative autonomy to these bodies and to make the Irrigation Department accountable to the farmers organisations. To begin with, the laskars working on the irrigation canals will be brought under the administrative control of the WUAs. The Irrigation Department is directed to assist the WUAs in the improvement of the irrigation systems and in the preparation of operational and maintenance plans. The functioning of the WUAs will be transparent with a high degree of social and financial accountability.*

326 *"An Action Plan has now been drawn up by the Government for taking up essential repairs and maintenance works in all irrigation systems in the State in the three months period commencing from April 1998." [Mr. Chandrababu then included a detailed account of the specifics of implementation and the financing arrangements included in the plan].*

327 *"In order to create a movement which is centered around the people and the farmers, District level conferences will be conducted to educate the farmers and particularly the WUAs in the efficient use of irrigation and to improve the agricultural*

[93] Source: Box 2, Wood 1998

production. This will be followed by a State level conference. Through this, our Government proposes to educate and also disseminate information and technology to the farmers and make them aware of their rights and responsibilities.

328 *"Our government is for the first time embarking on creating a democratic, decentralized structure under the irrigation sector which will be totally managed by the farmers themselves. Our Government seeks the cooperation of the august House in making our efforts succeed."*

Annex 2
Criteria for Allocating Water Charge Revenue

329 Literature on economic criteria for investment selection is very useful.[94] Below, we present the main techniques which can be summarized into three topics:

(i) Cost-Benefit Analysis (CBA)
(ii) Cost-Utility (or Feasibility) Analysis (CUA)
(iii) Cost-Effectiveness Analysis (CEA)

330 As will be further summarized in the following sub-sections, CBA and CUA are prioritization methods while CEA is more useful to define actions when priorities are already defined.

331 **Cost-Benefit Analysis**. CBA is the economic technique most used for the setting up of priorities in investment appraisal. Its objective is to compare the costs and benefits of impacts of alternative investments, in terms of their monetary values, and rank them according to their social rate of return.

332 Note that benefits here are those goods and services, including ecological services, generated by investments. Costs, on the other hand are the foregone income, including flows of non-ecological goods and services, due to the diversion of the economy's resources (charge revenues are sacrificed income) to water management rather than to other economic activities. Benefits as well as costs should also be determined by who they effect, that is, identifying beneficiaries and losers to properly address the resulting equity issues.

333 Monetary values mean economic values based on consumer preferences. Using surrogate markets of complementary and substitute private goods for environmental services or even hypothetical markets of these services, one may capture people's willingness to pay for a change in environmental provision.[95]

334 Using CBA procedures, then, it is possible to identify strategies whose priorities make the most of available resources, that is, whose benefits are greatest related to costs. In doing so, policy makers are maximizing society's resources and, consequently, optimizing society's welfare.

335 With CBA, strategies are then ranked according to their present values of net benefit (benefit minus costs discounted with time).[96] This ranking allows policy makers to define

[94] See, for example, Seroa da Motta (1998a)

[95] See, for example, Seroa da Motta (1998a) for a detailed presentation, analysis and case studies.

[96] Another, usually most appropriated, way of ranking is according to strategies' internal rate of return (rate to which benefits and costs have equal present values). See, for example, Seroa da Motta (1998a) for a detailed analysis of these procedures.

priorities taking first the strategies whose net benefits are higher.

336 Estimation of the monetary values of ecological benefits, however, can be very difficult. Apart from our limited knowledge on ecological links to economic activities, which also jeopardizes ecological criteria approaches, there are methodological limitations on economic grounds. These are related to choices on time discounting rates, aggregation of individuals' values, uncertainty internalization, and coverage of general equilibrium changes. These shortcomings tend to undervalue ecological benefits and, therefore, move society away from sustainable options.

337 Despite these problems, CBA is nevertheless an important method to orient investment decisions. Before we discuss how we could integrate CBA with ecological criteria, it is worth mentioning that the valuation of a few benefits of a given investment may be enough to show that these undervalued benefits are already exceeding costs. Although that is not sufficient to ensure that society is making the best alternative use of its economic resources, policy makers can at least guarantee that economic efficiency will not decrease due to this environmental investment.

338 Identifying how the costs and benefits are distributed across society (i.e., who is paying the costs and who is receiving the benefits), policy makers can also find ways to compromise other alternatives and build consensus which facilitates policy implementation. This feature of CBA, always put aside in valuation exercises, is vital in developing countries, where equity issues are usually constraining policy implementation due to their low level and unequal distribution of income. The use of CBA on this basis is a very important act before society can implement a more sophisticated criteria approach.

339 **Cost-Utility (or Feasibility) Analysis**. There have been considerable research efforts on benefit indicator measurements which integrate economic and other criteria.[97] Instead of using a single benefit measure of monetary value, indicators are calculated for economic values as well as for other criteria, such as: water quality, water availability, flood control, and so on. Each indicator has an absolute weight, and benefits (from policy, program or project) are evaluated with scores for each indicator. Final scores are then calculated for each option, which will represent some form of weighted mean of all these criteria.

340 The main methodological shortcoming here is exactly the setting up of coherent and acceptable scales for determining the relative importance of the distinct criteria, that is, the weights. Each scale will define a specific rank. Therefore, stakeholders participation, governmental integration, and political debate are the only way to minimize these constraints.

341 Moreover, there will always be difficulties in quantifying the absolute output of benefits according to criteria for each option. Consequently, database development is paramount for such an approach.

[97] See, for example, seminal texts on economics by Solow et al. (1993) and Weitzman (1992).

342 Taking into account all these methodological procedures, one may say that CUA is a very costly approach, above available institutional capacity in developing countries. Based on that judgement, there have been some suggestions in cost-feasibility analysis, where institutional capacity, political commitment and social acceptance are additional criteria, to score projects along ecological and economic benefit lines.

343 **Cost-Effectiveness Analysis**. When benefit or utility estimations prove to be very difficult or costs are beyond institutional capability, priorities are often solely made on the basis of ecological criteria. Under these circumstances, policy makers can undertake a cost-effectiveness analysis. CEA considers the various options available to meet a pre-defined policy priority and compares their costs and relative effectiveness at meeting their objectives. In doing so, one can identify the option which assures the achievement of the desirable outcome at the lowest cost.

344 Note that CEA does not rank options to set priorities. CEA must be seen as a tool for action definition once a priority is already set. However, even with the possibility of applying CBA or CUA, there will exist lower levels of decision where institutional costs of project evaluation will outweigh gains in managerial efficiency. In those cases, CEA will also have a major role in revenue application procedures.

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