Policy Research Initiative
Projet de recherche sur les politiques

Economic Instruments for Water Demand Management in an Integrated Water Resources Management Framework

Synthesis Report

PRI Project
Sustainable Development

Symposium Partners

The Walter and Duncan Gordon Foundation

Agriculture and Agri-Food Canada

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The Canadian Water Network

Canada

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Acknowledgments

The PRI thanks the following organizations for their generous support – both financial and intellectual – of the symposium behind this report. The ideas expressed in this report do not necessarily represent those of the sponsors nor of the individual participants.

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Walter & Duncan
GORDON FOUNDATION

Environment Canada
Environnement Canada

CANADIAN WATER NETWORK
RÉSEAU CANADIEN DE L'EAU

PH4-18/2005E-PDF
ISBN 0-662-39330-9

Preface

On June 14 and 15, 2004, the Policy Research Initiative, as part of its Sustainable Development Project, held a symposium on the use of economic instruments for water demand management, specifically pricing, taxes, and markets. Over 60 participants – international and Canadian experts, as well as interested policy makers from the federal, provincial, and municipal governments – gathered in Ottawa to examine the situation in the municipal, agricultural, and industrial sectors. Discussions ranged from pricing and taxes for demand management, to the use of water markets to better allocate the resource between competing uses.

Participants were asked to examine the use of these instruments in the context of integrated water resources management (IWRM), since it is now recognized in most water policies that IWRM applied at the watershed level is the relevant geographical scale at which water policies should be developed. It may be telling that most presentations and discussions did not address directly this aspect of the context. A possible explanation is that economic instruments for water demand management, as emphasized repeatedly during the Symposium, have to be nested within the local context, including careful attention to those factors affecting implementation. However, there are limited case studies of the application of economic instruments at that level.

What is known, however, is that since local conditions are so important, it can be hypothesized that economic instruments for water demand management should be studied at the watershed level. Another observation linking IWRM and economic instruments is that public and stakeholder participation and support seem to be necessary for success.

Integrated Water Resource Management

Integrated water resource management has become the new paradigm for freshwater policy development. The Global Water Partnership defines IWRM as "a process that promotes the coordinated development and management of water, land, and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (IRC, 2004). It integrates land use and water management at a watershed level, to optimize economic, social, and environmental outcomes simultaneously.

This report summarizes what is known and what can be learned based on presentations and discussions made at the Symposium, a number of which examined current practices. Other literature (not exhaustive) was also consulted to place the discussions in the appropriate context. This report is thus a synthesis of the main policy issues around the application of some economic instruments for water demand management in the municipal, agricultural, and industrial sectors and for water allocation among those sectors. The views are not necessarily those of individual participants in the Symposium. Where a symposium presentation is used, it is referenced as (Author, Symposium).

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Executive Summary

Although Canadians are the second largest per capita users of water in the world, increasingly, they are realizing that their supply of freshwater cannot be taken for granted. While safe water for human consumption has been a hot topic, there are also increasing signs of regional water shortages, and dire warnings of the growing infrastructure deficit. In short, in spite of being well endowed with water resources, Canada's current use of water may not be sustainable in the long term.

Canada has thus far made relatively little use of economic instruments (EIs) for water management; they are often promoted as least-cost approaches to the efficient allocation of water, to recover water supply costs, internalize environmental costs and as a signal to induce consumers to reduce their water use. The reality, however, may not be so simple, and it might be impossible to achieve all these objectives efficiently with one single instrument.

On June 14 and 15, 2004, the Policy Research Initiative held a symposium on the use of economic instruments for water demand management. This report focuses on some fee-based measures (pricing schemes, taxes, and charges), and property rights/tradable permits-based measures (water markets).

Pricing Schemes, Taxes, and Charges

Water prices in Canada are variable, but generally lower than in other OECD countries. Domestic water supply is subsidized in most municipalities.

Cost recovery and efficient allocation are the main, but distinct objectives that may require different instruments. Pricing at average cost (where utilities break even) allows utilities to recover their costs. Efficient resource allocation, however, is, in theory, achieved when prices (or taxes) are set at the marginal cost by providing users with a signal about the value of the last amount of water used. The goal of efficient allocation can be reached no matter who pays for the fixed costs of water supply, even if they are subsidized.

Ideally, to internalize environmental and social costs, these externalities should be included in the calculation of the full cost, marginal cost, or a tax. However, in practice, accounting for all the externalities can be cumbersome and expensive, since they are numerous, variable in time and space, and often challenging to measure.

In addition, pricing at the marginal cost (even without externalities) may involve significant implementation costs. As a result, local conditions and institutional arrangements may make other methods more efficient.

While it is clear pricing can affect water use, elasticities are low and other factors, such as the price structure, metering, and education may also have a significant impact on water use.

Water Markets

Markets are proposed as instruments that can help find the right price and an efficient allocation without the need for overall planning and management. In a perfectly competitive setting, a market would ensure that water goes to the higher value use. However, numerous externalities impede market operation.

A major challenge in implementing water markets is to define property rights clearly. Other challenges include implementation costs and high transaction costs, which can stifle market activity; and externalities, including the impact of water trades on third parties and the environment.

Water markets have developed in areas of high water scarcity, such as Chile, Australia, the western United States and southern Alberta, where rights to access the resource exceed availability. The importance of market exchanges in overall water allocation is variable. In Chile, they are the main allocation tools, while in California market trades represent only three to six percent of annual water use. Each market is particular to its own local and institutional conditions and, consequently, each experience is different.

While the economic aspects of markets have been examined, and suggest that under the right conditions trade can lead to increased economic efficiency, few empirical studies have assessed the impacts of water markets on society and the environment. Existing evaluations suggest markets seem to work best when accompanied by other instruments (e.g., regulations, education) to ensure equity and environmental goals are met.

Evaluating the Effects of Pricing, Taxes, and Water Markets

A major difficulty in assessing past experiences with EIs is that their intent is often not clearly defined, and many instruments are implemented simultaneously. This makes it difficult to assess the impact of any single instrument; having only one instrument for each objective may help determine the effectiveness of a particular instrument and is important to our ability to learn from experience. A second and perhaps more important reason to further explore the one objective-one instrument paradigm is that in any complex system, unexpected effects, shocks, and other perturbations may be best handled through a system of checks and balances, rather than through a single instrument.

Having adequate information on overall water use patterns, water availability, and issues of water quality is crucial to defining the objectives being sought through the implementation of EIs. Finally, experience shows that education and co-operation can considerably increase the chances of success in implementing EIs.

Conclusions and Policy Research Implications

There is clearly potential to reduce water use through demand side management, and water demand seems to be at least somewhat sensitive to properly implemented EIs. However, the striking lack of data in the water sector is clearly a barrier to policy research and development.

The main recommendations from a policy research perspective identified in this report are the following.

1. Clarity of objectives

There is a need for detailed ex-post evaluations of specific water demand management experiences, including implementation costs, to understand what tools, or suites of tools, were most effective and cost efficient in achieving specified objectives.

2. Multiple instruments as checks and balances

There is a need to better understand how different pricing and market experiments have tackled third-party and environmental effects.

3. Subsidizing infrastructure

There is a need to hold a public debate about the social desirability and financial feasibility of subsidizing water works.

4. **Data for planning the use of EIs at the appropriate geographical scale**

   There is a critical need for better information on water balances and on water use in various sectors.

5. **Uniformity of approach is neither necessary nor necessarily desirable**

   It is crucial that regional and sectoral differences be well understood and considered in policy development.

6. **Making use of all the social sciences**

   A better understanding of the role and effect of EIs needs the contribution of all social sciences to determine the key factors driving water use decision making and behaviours.

7. **Collaboration between levels of government, with stakeholders and the public**

   It is necessary to examine more carefully how federal departments can support the work done in provinces to establish watershed-based planning. There is also a need to better understand what type of stakeholder participation works best and at what stage in the planning process.

8. **Planning for the future**

   It is time to review the 1987 *Federal Water Policy* in light of subsequent experiences, revise it as necessary, and forge ahead with the judicious implementation of its major strategies.

Introduction

Economic instruments (EIs) are often promoted as a cost-effective way of attaining environmental objectives and should thus be evaluated with this criterion in mind. They are also said to promote technological advances while enlisting market forces to ensure the most economically efficient route to a given target. While experiences in air pollution show that this can be true, the application of EIs to water management in general, and to water demand management more particularly, is relatively recent, and it might be too early to determine if they, like any other instrument, provide all these same benefits in all cases.

Economic instruments for water demand management are promoted to attain a number of different objectives. They can be used to provide financial resources to cover all the costs of providing water, and to foster the economically efficient allocation of water – to move water from lower to higher value uses. They are also said to foster conservation and innovation, and provide signals to induce behavioural changes.

This report focuses on the use of the following EIs: pricing, taxes, and water trading. Some but not all of the findings can be applied to other EIs. While there is no doubt that these instruments can affect water use, it is still difficult to know by how much and how they compare to alternative approaches, such as regulation, education, or community-based social marketing. In fact, there have not been systematic ex-post evaluations of the application of EIs for water demand management in Canada that could show whether they meet objectives. In addition, such evaluations are limited internationally, and much remains to be learned.

Relying on economic instruments poses at least four major implementation challenges: clarifying the components of full-cost pricing, clearly defining property rights and their legal context, planning for implementation costs, satisfying equity concerns, and perhaps most important, seeking and obtaining stakeholder buy-in.

Economic Instruments

Economic instruments are defined as the "use of market-based signals to motivate desired types of decision-making. They either provide financial rewards for desired behaviour or impose costs for undesirable behaviour" (Stratos Inc., 2003). Some argue that economic instruments are better described as market-based instruments since they rely on complex legislative and administrative arrangements (Young and McColl, Symposium).

Although many different typologies can be found in the literature four general types have been identified.

- **Property rights:** Ownership rights, use rights, development rights, and transferable development rights all promote responsible resource management.
- **Fee-based measures:** Fees, charges, taxes, deposit refunds, and revenue-neutral "feebates" all impose payments of specified amounts, thereby creating an explicit cost associated with environmentally damaging activities and an easily quantifiable incentive for reducing the activity.
- **Liability and assurance regimes:** Liability rules and various types of bonds can provide strong incentives to avoid environmental impacts and to clean up and restore environmental damage.
- **Tradable permits:** These provide mechanisms for minimizing the social and private costs of meeting a cap on emissions.

In this report, we focus on fee-based measures (fees, taxes, and charges), and property rights/tradable permits-based measures (water markets).

This report finds that the case for EIs for water demand management should be evaluated with caution and with greater rigour than has generally been the case in Canada, including careful examination of real-life experiences. There has been a tendency to promote EIs as being capable of delivering the best of all worlds: environmental protection, economic and technological development, and revenue generation, while maintaining equity, and all in one convenient box. A main conclusion is that the specific objectives for which economic instruments are to be applied should be better clarified to ensure adequate evaluation of policies and programs, and to learn from experience. Furthermore, it is difficult to see how public support can be garnered for policy changes without clarifying the purpose for which economic instruments are to be used.

There is, however, a striking lack of crucial data for understanding water use and availability at the watershed level. Without such data, it is difficult to assess if water demand management strategies are needed in the first place – apart from financing infrastructure – and to determine if they reach environmental objectives.

Perhaps, we first need to debate the reasons for or against what is possibly the most widely used EI for water in Canada: subsidies for water infrastructure, from all levels of government. In theory, subsidizing the fixed costs of providing water services should not affect the economic efficiency of water allocation. (See accompanying definition of economic efficiency.) In practice, it has proven difficult to implement pricing methods that can achieve both the recovery of all costs and efficient water use. Without clear policies on infrastructure subsidies or, more precisely, on appropriate financial mechanisms to fund water infrastructure, it is difficult to determine which pricing strategies should be used, and to make the case for any particular approach.

Related to this is the fact that the 1987 *Federal Water Policy* is not only old, but at least in respect of its support of realistic pricing, it may have been over-enthusiastic. It may be time to review parts if not all of the Policy, and make it “national,” where each jurisdiction could contribute within its sphere of responsibilities to achieving common goals, such as more sustainable water use.

This report is in three main parts: the first section provides the necessary background, describing the main features of water demand across categories of users (residential, industrial, agricultural, and so-called in-stream users) and of water supply. The second section examines the potential roles and limitations of EIs, principally prices, taxes, and water markets. The third section presents some lessons from experience, and briefly explores policy tools that have been proposed to complement and/or support the use of EIs. The conclusion proposes possible research directions to attain a better understanding of the role and effectiveness of EIs for water demand management.

Economic Efficiency

The concept of economic efficiency used in this text is taken from welfare economics. According to theory, when the maximum output is produced for the inputs used and when the price of a resource reflects its marginal cost, there is an increase in overall net value. The total economic welfare is thus maximized.

Valuing Water

This document does not address one of the fundamental issues in water policy, that is, the fact that water can be perceived differently according to different stakeholders, times, and places and thus there are many sources of value. While this report concentrates on understanding economic values such as the concepts of economic efficiency and willingness to pay, it does not discuss directly other sources of value, which can divide stakeholders (e.g., people who view water as a human right and those who view it as a commodity that can be the property of an individual). Other sources of value include environmental values, which consider water as having value apart from its present or future usefulness to humans; social values which consider that water should be universally available at an affordable price; and public health values where clean water is a necessary condition for the health of populations.

Another aspect of the challenge in valuing water is to understand what is being valued: water can be perceived as a substance, as a resource or as a service. For instance, public utilities managers believe they actually provide water services (treating and delivering clean, potable water) whereas customers may believe they are paying for water, the substance.

While this document does not directly address these issues, they are fundamental to the question of understanding how we should use economic instruments. As indicated in the report, one main problem with economic instruments is that the objectives for which they should be used are not clearly spelled out. And this clarity cannot be achieved without also clarifying the underlying beliefs that drive policy positions with respect to the use and allocation of water. A proposition made by Moss et al. (2003), consistent with the underlying principles of IWRM and some of the findings in this report, is to make decision-making processes more inclusive to allow mutual understanding of these values, and try to find common ground for decision making.

1 Water Demands and Supplies

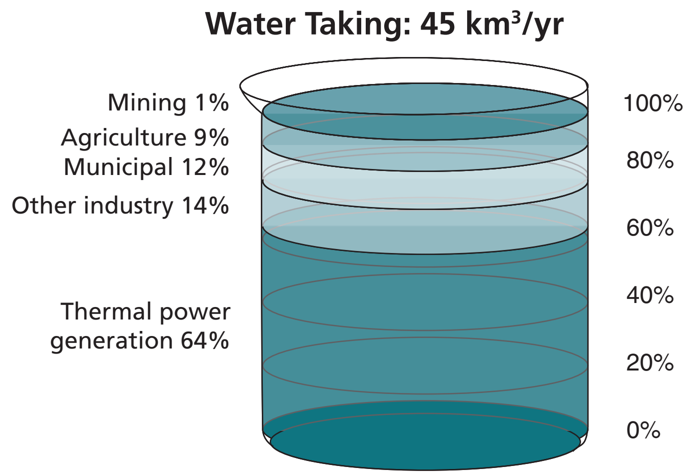
Water is unevenly distributed in Canada, as two thirds of the water flows north while 90 percent of the population lives near the southern border. Moreover, water demand varies greatly both regionally and seasonally. Water quality also varies, with groundwater in some regions being saline, and both surface and groundwater being contaminated in various ways in different settings. Much of the water Canadians rely on is shared with the United States, in the Great Lakes-St. Lawrence basin, or in one of the trans-boundary watersheds in western Canada. Water issues can therefore include highly local issues, as well as national issues.

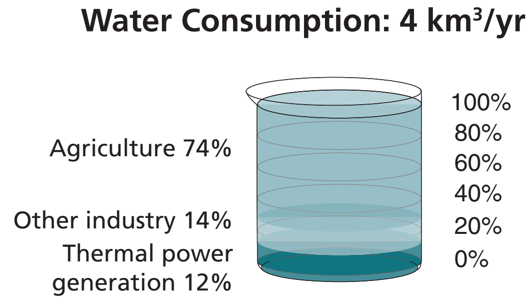
As in many industrialized countries, the industrial sector accounts for 78 percent of water use in Canada. However, thermal power generation, which returns most of the water to the environment relatively unmodified, represents 64 percent and manufacturing only 14 percent. The municipal sector (residential, commercial/institutional, and rural domestic) uses 12 percent, the agricultural sector 9 percent, and mining 1 percent (Environment Canada, 2004a). However, this information is dated as the last survey on water use by sector in Canada was in 1996.

1.1 Residential Water Demand

Canada is the second biggest per capita water user in the world, after the United States. In 1999, on average, Canadians used 343 litres per person per day, compared to 200 litres in Sweden and just 150 litres in France (Environment Canada, 2004b). However, per capita residential water use is highly variable across Canadian cities: for example, 156 litres in Charlottetown, 190 litres in Winnipeg, 259 litres in Ottawa, and 659 litres in St. John's (Brandes and Ferguson, 2003a). At the same time, average Canadian municipal water prices are among the lowest in the OECD (Environment Canada, 2004c), with municipal water infrastructure being heavily subsidized by all levels of government.

Water Use and Consumption by Sector





Water taking in Canada amounts to about 45 km^3/yr, but most is returned after use. Actual consumption amounts to about 4 km^3/yr, mainly for irrigation. Note that the municipal and mining sectors are believed to be net contributors of water rather than net consumers, so have not been included in the consumption graph. Municipal data exclude water supplied to industry, but include estimates for rural residential use.

Data from Environment Canada (2004b).

Residential water demand is not uniform across Canada. It varies greatly according to the location, the climate, and socio-economic variables. Indeed, residential water demand is often found, in the economic literature, to be a positive function of the number of individuals in the family, the size of the house, the number of water-using appliances, and household income (Lyman, 1992; Renwick and Archibald, 1998; Renzetti, 2002). In addition, weather has an impact (mostly on outdoor water use), increasing with temperature and decreasing with rainfall.

Metering is still limited in Canada: about one half of domestic users had water meters in 1991, increasing to 57 percent in 1999 and to 61 percent in 2001 (Environment Canada, 2001, 2004d). Generalized deployment of metering, however, is costly and may require a cost-benefit analysis that is often beyond the capacity of smaller municipalities.

In Canada's big cities, much of the water supply infrastructure is old and in poor repair. In 1996, the National Round Table on the Environment and Economy estimated the cost of repairing and maintaining Canada's water systems at between $38 billion and $49 billion over 15 years (NRTEE, 1996). Using the extant infrastructure in a more efficient way would defer the need to invest in new capacity (Brandes and Ferguson, 2003b). Indeed, new infrastructure is often built to meet peak demand that occurs only seasonally (Robinson, Symposium).

1.2 Industrial Water Demand

Factories use water in a variety of ways. It can be used as an input in the production process, as a cooling or cleaning agent, or even as a source of energy. The main users in the industrial sector (other than electricity generation, where water is generally self-supplied and the use is largely non-consumptive) are the paper, primary metals, and chemical industries (Environment Canada, 2004e).

Ninety percent of industrial water use was self-supplied in the last Industrial Water Use Survey done in 1996 (Renzetti, Symposium). Self-supplied firms take their water directly from water bodies or groundwater; municipal water works supply the remaining 10 percent.

Often, to reduce costs, self-supplied factories return used water directly into a receiving water body without any treatment. This is not a problem if plants are geographically dispersed and relatively non-polluting. However, industries are increasingly concentrated and use new chemicals that are often either toxic or else their environmental chemistry is poorly understood. Introducing a cost to the industry for such use of water and water bodies has been seen as a way of creating incentives for waste treatment and the adoption of innovative technology, and also for reduction of water use.

1.3 Agricultural Water Demand

Agriculture accounts for only nine percent of water use in Canada. However, it is the largest consumer of all sectors. In fact, irrigation, which represents 85 percent of agricultural water demand, consumes 71 percent of the water withdrawn (Environment Canada, 2004d). With climate change, and increasing labour costs and land values, irrigation will probably expand in the semi-arid regions of Canada, such as Alberta, British Columbia, Saskatchewan, and Manitoba, but also in Ontario and the Maritimes where it is used for frost control, as well as supplementing rainfall (Environment Canada, 2004f).

The Canadian context for agricultural water demand is complex. First, as seen above, the distribution of water is uneven across the country, and water supplies are often not located where and when the demand is, requiring reservoir and canal systems to bring the water to the user when and where it is needed. Second, agricultural water demand varies in both space and time. Demand, especially for irrigation, is very sensitive to seasonal weather. Third, different crops require different irrigation regimes. Finally, agriculture demand is poorly known in detail, as metering and monitoring are still infrequent in the Canadian agricultural sector, as in the rest of the world.

Agricultural water use is often subsidized, which some suggest may lead to inefficient water use. Inefficient agricultural water use not only has a quantitative impact, but also alters runoff and possibly groundwater quality, and causes ecological damage. Indeed, the agricultural sector is possibly the main source of diffuse water pollution in many parts of Canada. “In regions with extensive irrigation in particular, the current implicit subsidization has reduced water availability and increased pollution by boosting chemical-intensive agricultural production” (OECD, 2000: 17-18). Reducing excess irrigation could reduce contaminated runoff, and thus pollution.

1.4 Water for In-Stream Uses

In-stream uses do not remove water from a lake or river or from groundwater. Examples include navigation, recreation, and environmental services. The necessity to preserve water (in quantity and quality) for ecosystem functions has increasingly been acknowledged. More specifically, there is general recognition that some amount of water should be left in the environment. "The optimal allocation of water resources requires full recognition of the environment as a water user, and the ability to identify the minimum water requirements to support aquatic eco-systems" (OECD, 1998: 8). It is also worth noting that the ecotourism and recreational value of water is often assumed to be high in Canada, as many activities are centred on waterways (Tate, 1990).

However, in-stream uses have their own complex demands, as ecosystem services may require a "natural" fluctuation in flow regimes, including floods and droughts.

> The former approach of simply defining a "red line" below which lake levels or river flow rates are not allowed to fall is insufficient to protect the ecosystem. The goal is to withdraw water for human use in patterns that emulate, as closely as possible, natural fluctuations in levels and flows (Brooks, Symposium).

In the western United States, persistent drought conditions have added to the urgency of understanding and maintaining in-stream flow needs while pursuing other development goals. The experience with water use efficiency measures so far is that their application at the sectoral level (for example agriculture) does not clearly lead to increases in in-stream flows, suggesting that a better understanding of water balances at the watershed and basin levels is needed to better evaluate the need for and effectiveness of conservation measures (Garrido, 2002; Freeman and Wahlin, 2004; Van Camp, 2004).

Recreational and environmental uses of water are difficult to value since ecosystem services and the benefits of recreation to society cannot be readily measured in dollars. Nonetheless, the development of non-market valuation methods (Young 1996; Frederick et al., 1997) has made it possible to develop at least order-of-magnitude estimates, even if values are not accurate and vary according to the survey and econometric methods used. Non-market valuation includes various techniques that estimate the value of a good by users' willingness to pay. More specifically, these methods can estimate, in general terms, the value water users give to changes in water quantity and quality. These methods have been used to evaluate damage to the environment. However, these techniques do not capture some other sources of value (see description on p. 4). "[S]ome people believe that nature has value apart from its usefulness to humans .... Such groups often oppose market or conventional economic approaches to estimating the environmental value of water resources" (Moss et al., 2003).

Water Use Efficiency and Conservation

The concepts of water conservation and water use efficiency are often used interchangeably to describe the goal of reducing water use.

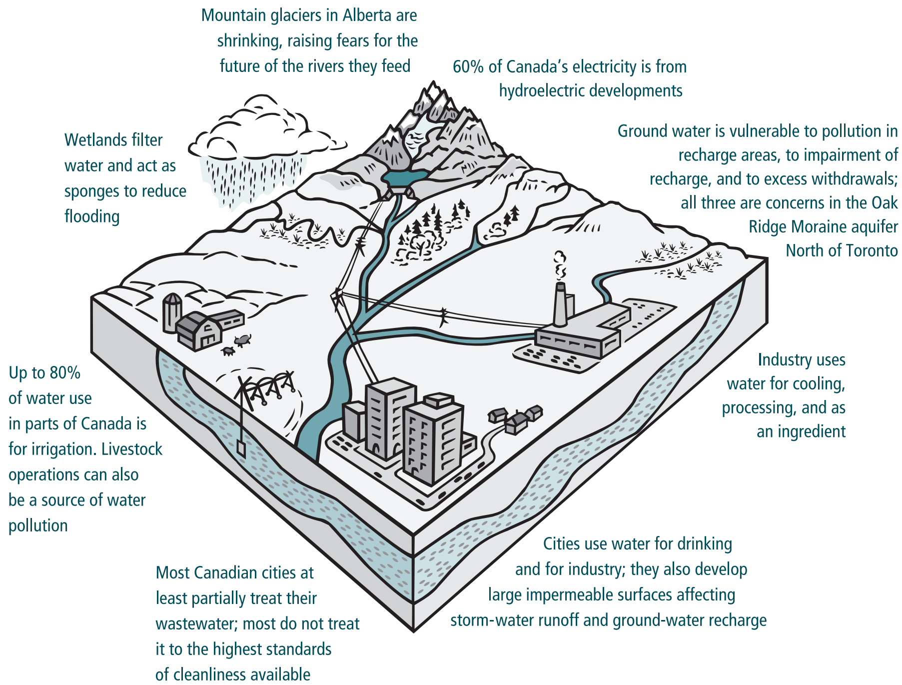
In this text, the two concepts are distinguished to highlight the point that different objectives might actually be sought, and that the suite of appropriate policy tools (including EIs) to reach them can also differ. For our purposes, we found the following distinction, inspired by the work of Brooks (e.g., Symposium), useful.

Water use efficiency refers to technical and economic approaches to reducing the quantity of water used to achieve a given task. In this sense, water use can be analyzed at the individual or firm level, as well as the sectoral level (e.g., municipal, industrial, agricultural). It does not necessarily imply that less water is used overall, as the water "saved" in one application may become available for another use.

Water conservation, in turn, refers to reductions in net water use observed at the watershed or basin level; this water can be made available for other uses, such as ensuring in-stream flows.

While pricing strategies can, in theory, promote both water efficiency and water conservation, it is not a given that greater water use efficiency in some sectors leads to water conservation.

Hydrological Cycle



1.5 Water Supplies

The two principal sources of water supply are surface and groundwater. Surface water is in rivers, lakes, reservoirs, and oceans. Groundwater is the water that accumulates over various periods of time (from years to centuries or even millennia) in underground aquifers. Where groundwater is replenished rapidly, it can be considered a renewable resource; where it is replenished slowly, it may be better thought of as a non-renewable resource. It is estimated that about 29 percent of the world's freshwater is stored as groundwater and about 18 percent of it is in North America (Shiklomanov, 2000).

Thirty percent of Canadians depend on groundwater for residential use, principally in rural areas and in smaller municipalities. For example, 100 percent of Prince Edward Island's population and over 60 percent of the population of New Brunswick are groundwater-dependent. The use of groundwater varies by province.

> In Ontario, Prince Edward Island, New Brunswick, and the Yukon, the largest users of groundwater are municipalities; in Alberta, Saskatchewan, and Manitoba, the agricultural industry for livestock watering; in British Columbia, Quebec and the Northwest Territories, industry; and in Newfoundland and Nova Scotia, rural domestic use. Prince Edward Island is almost totally dependent on groundwater for all its uses (Environment Canada, 1999).

The interactions between surface and groundwater are highlighted by the use of economic instruments. An increase in the price of surface water in the irrigation sector in Europe has, not surprisingly, led to increased use of groundwater. In many places, groundwater use is not regulated and, if the price of surface water rises, it can easily lead to excess pumping of groundwater and the degradation of the resource which can, in turn, affect surface water.

A better knowledge of groundwater is required, as the resource and its rate of replenishment differ widely from place to place. Moreover, "the intimate relationships between ground and surface water imply that these resources must be treated as an integrated resource rather than as a separate one" (Environment Canada, 2004d: 78).

Should groundwater and surface water be treated separately?

While groundwater and surface water are often treated separately in law, they are intimately connected in nature.

The arguments for separate treatment in policy are threefold.

- Groundwater is harder to track than is surface water.
- The rate of groundwater replenishment may be so slow that it should be treated as a non-renewable resource.
- Groundwater is not a habitat for fish.

Groundwater is replenished by surface water, in areas known as recharge zones – essentially areas where aquifers (permeable bodies of sediment or rock) intersect the surface. Groundwater flows under the surface, and may resurface as springs, or underwater into the beds of rivers and lakes, which may be sustained as much by groundwater as by run-off.

Groundwater studies in Canada are still at an early stage, with major aquifers still being mapped, and their flows evaluated. However, as we learn more about them, we increasingly find that they are dynamically connected with surface waters.

The rate of groundwater replenishment in some regions, such as parts of the Western Sedimentary Basin, may well be on the order of thousands of years – a basis for arguing that groundwater there should be treated as a non-renewable resource. However, some aquifers are replenished on an annual cycle, and should therefore not be treated differently from surface waters. Some lakes also have very long renewal times – the Great Lakes are estimated to be replenished on a 100-year cycle – so should also be treated as nearly non-renewable resources.

While groundwater is not itself fish habitat, its connection to surface water implies that any excess withdrawal of groundwater will affect surface water flows. Additionally, contaminated groundwater may eventually become contaminated surface water, just as contaminated surface water tragically became contaminated groundwater used for drinking in Walkerton in 2000.

Thus, the arguments for separate treatment of surface and groundwater are weaker than they may at first appear. It may be most appropriate to recognize their different yet similar natures by treating them distinctly, but jointly.

2 The Roles and Limitations of EIs for Water Demand Management: Theoretical Considerations

This section focuses on two main types of economic instruments as they are presented in theory. The first is fees, charges or taxes, used to control demand and fund infrastructure. The second – markets (see definition in introduction) – is used to determine price and allocate water efficiently between different uses, and is thus promoted to rationalize water demands.

2.1 Selecting the Appropriate Pricing Schemes

Economic theory suggests that demand for water should behave like that for any other good: other things being equal, water use should decline with rising prices. Thus, pricing water has often been suggested as a way of providing incentives through a price signal for water use reduction and/or efficiency. Pricing water is also promoted to internalize the environmental and social costs of water use, and serves to raise revenues for public water supply infrastructure and operations. The reality, however, may not be so simple.

In theory, water for each specific use has a "right" price, at which all costs are recovered, including environmental and social costs. This price will provide the right level of incentive for water use reduction and efficiency. In practice, this right price is elusive, in part because estimating the marginal cost of water supply, which determines the price at which allocation is economically efficient, even without considering externalities, is difficult and likely to be resource-consuming. Further, the environmental externalities of water use are poorly understood and vary through time (seasonally and annually) and space. This makes the right price a moving target.

There may be significant costs to implementing some pricing strategies, such as those requiring water metering, and a potentially significant administrative overhead. Nevertheless, pricing – even at a less than optimal price – may be a useful tool in many instances.

There are two major questions to be answered.

- What objectives can be best attained through specific pricing schemes?
- Will it be cost effective?

2.1.1 Prices as Signals

Different price structures can send different signals. For example, a flat rate (see accompanying description) is often said to provide the wrong signals, since it consists of an identical constant fee independent of water used and, hence, is assumed to lead to water-wasteful behaviours (Renzetti, Robinson, Horbulyk, Symposium). With a declining block rate, the price decreases with successive increases in pre-defined volumes (blocks) of water used, which is clearly not a strong incentive to reduce water use. Increasing block rates, conversely, are believed to encourage water reduction as the price increases with a pre-defined amount of water use.

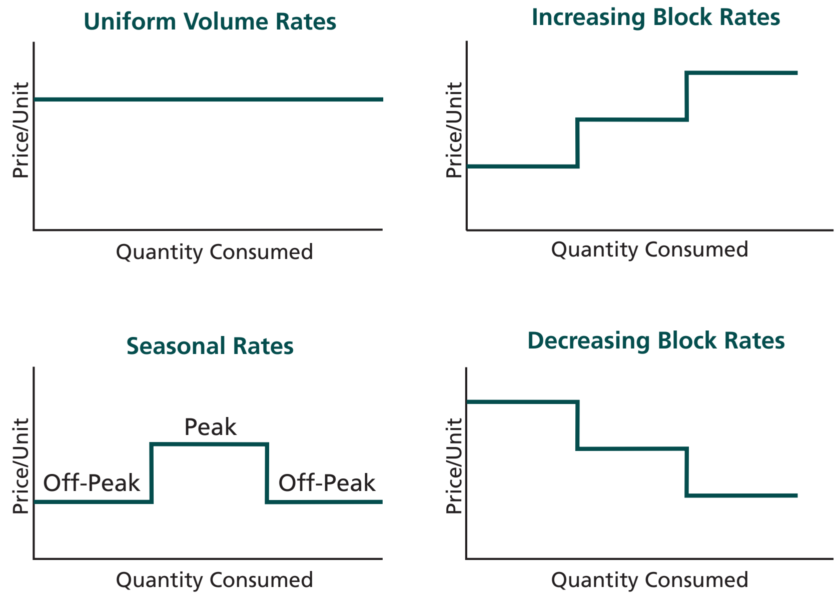
Municipalities get subsidies in the form of capital grants from provincial and federal governments for their water infrastructure, and most subsidize both the consumption of water and the extension of their pipe networks into new developments (Environment Canada, 2001). This can have the effect of reducing the price to all consumers irrespective of water use or income, and may be seen as a signal that governments view water as an essential service rather than a good. However, some would argue that from an equity point of view, "income subsidies needed for some people living in a community should be provided directly and not by reducing costs of water and wastewater system use." (Robinson, Symposium; see also OECD, 1999b).

Water Rates

- **Flat rates** charge a constant fee regardless of the volume used.
- **Uniform rates** charge for the volume used at a constant per-unit fee (e.g., $1/litre).
- **Decreasing block rates** (DBR) charge a volumetric rate that decreases for higher levels of use (e.g., a first block at $1.5/litre and a second at $1/litre).
- **Increasing block rates** (IBR) charge a volumetric rate that increases for higher levels of use.
- **Seasonal rates** charge a higher price during peak season, typically summer in Canada.

Note that in many municipalities, sewage fees are calculated as a set percentage of water fees, so are subject to the same rate structures.

Water Rates (continued)



Source: Chesnutt et al. (1997).

In many Canadian municipalities, and even in the agricultural sector, flat rates are a common price structure. In 1999, 43 percent of domestic water use in Canada was charged at a flat rate (Environment Canada, 2001). This can be explained by the fact that it is administratively simple and does not require metering. Uniform rates are the second most popular price structure used by Canadian municipalities (39 percent of domestic water use in 1999), followed by DBR (13 percent in 1999), which can be explained by the fact that it does reflect the declining cost to the water works of providing increasing volume to a given consumer (most of the cost being the pipes rather than the water itself or even its processing). The less popular is IBR (9.9 percent in 1999: Environment Canada, 2001).

Metering is not common in the agricultural sector; hence irrigation charges are often based on the number of hectares being irrigated rather than on the amount of water used (Tate, 1990). Additionally, many agricultural subsidies promote increased irrigation and irrigation-dependent crops. Subsidies encouraging irrigation crops in Europe provide few incentives for water use reduction (Strosser, Symposium). In Canada, agricultural water use may also be affected by water infrastructure subsidies, such as those provided by the Prairie Farm Rehabilitation Administration and by provincial governments.

In Canada, most industries abstract water directly from a water body, and many discharge used water with minimal treatment back to the environment. The price of the water in this sector is therefore the cost of self-supply plus any fees or taxes (usually minimal) imposed by governments. Environmental taxes and charges aim at internalizing the cost of environmental damage (pollution and excess withdrawal) caused by industrial water use. Taxing industrial water use may signal industry to reduce water use or increase efficiency through recycling and treating wastewater, but this is not widely done in Canada.

2.1.2 Full-Cost Pricing

In Ontario, municipalities have been directed by the provincial government to charge users the full cost of water. Like the "right" price, this can be first approximated by the cost to the municipality of supplying the water (infrastructure operation, maintenance, and eventual replacement or expansion), which is what the province intends with this directive. However, the true full cost is the same as the right price, including social and environmental externalities.

Including externalities in the full cost is difficult. Different surveys and econometric methods may lead to different results, and the estimates can differ greatly. Second, there are numerous positive and negative externalities, so it is a cumbersome task to account for all of them, let alone to measure them. Additionally, many of the environmental impacts of water use are poorly understood; in the absence of scientific understanding of the environmental impacts, their economic valuation is effectively impossible. The greatest difficulty, however, is the time and place dependency of the environmental costs: removing several thousand litres from a small stream during a drought could have a disastrous impact on fish, while removing the same amount from the St. Lawrence River during spring flood would have no detectable impact at all. The result is that such externalities are rarely calculated, and where they are, they can only be crudely estimated.

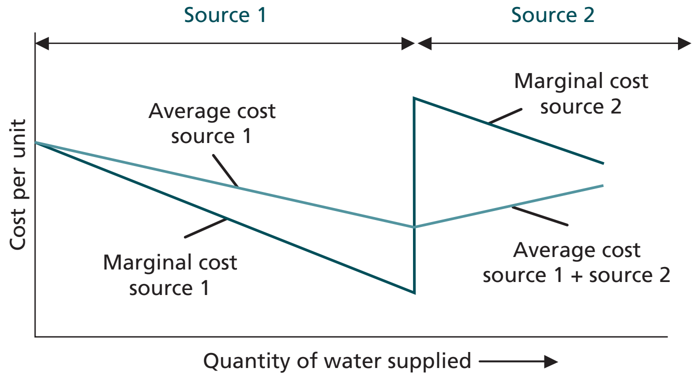
2.1.3 Efficient Pricing

Efficient pricing leads to the most economically efficient use of water. Among other things, it requires that prices reflect the volume of water used. Often, this is taken to include pricing to recover costs fully (as subsidies are assumed to be market distorting). However, cost recovery need not be entirely on a volumetric basis.

According to many economists, the greatest efficiency (see definition in introduction) is achieved by setting the price at the marginal cost (cost of supplying one more unit of water) (Tsur, Symposium). As indicated above, environmental externalities should be included in the calculation of the marginal cost. Based on this price, water users can do a cost-benefit analysis of increasing (or maintaining) their water use, and are able to make efficient decisions. It is important to note that economic efficiency can be achieved, irrespective of who pays for the fixed cost (e.g., plant construction and pipes, which can be covered through a non-volumetric charge). This is true as long as the price structure is set so the last unit paid is at the marginal cost (Tsur, Symposium). This implies that to a certain extent, cost recovery and efficient pricing are two distinct objectives (Horbulyk, Symposium).

In the short run, since water utilities are a capital-intensive industry, the average cost, which includes the fixed costs, is usually higher than the marginal cost. Hence, once the capacity is built, the more it is used, the lower both the average cost per unit and the marginal cost will be. However, in the longer run, if new capacity is required, the marginal cost (which will be mainly the cost of the new infrastructure) can become higher than the average cost (which includes both the new infrastructure and the water produced by the old infrastructure – Figure 1).

Figure 1: Change in Cost Structure Following Addition of New Supply



Source: Hanneman (1998b).

Since the marginal cost is either below or above average cost but rarely equal to it, marginal cost pricing can unintentionally lead to excessive profits or to deficits. The former can be corrected with an IBR price structure. To eliminate profit, the price for the first block in IBRs is set lower than the marginal cost in such a way that water utilities will raise just enough revenue to cover their operating cost, and for the last block the price is set equal to the marginal cost (Hanemann, 1998b). To correct a deficit, a two-part tariff, which includes a fixed-price component to cover the fixed costs and a volumetric price to cover operating and maintenance costs, has been promoted and used in practice (Tsur, Symposium).

An IBR is also said to promote water use reduction. The assumption is that consumers will be more responsive to prices in the higher blocks than in the lower blocks. However, as with any pricing regime, there is no assurance that the effect will be strong since as seen in Section 1.1, water use may be influenced by other factors, such as socio-economic variables and climate conditions. Pricing at the marginal cost, or any volumetric-based rate structure, requires metering. Some suggest that metering by itself, even without pricing, can educate water users and promote water use and leakage reduction. Of course, metering also has the advantage of providing useful data to better assess the effect of prices on water demand. However, metering comes at a cost, as discussed in section 1.1.

Since infrastructure investment in water supply is often due to peak use, many authors suggest that prices during peak periods should be higher than prices during off-peak periods. Water savings are potentially higher with peak use charges than with basic use charges, because the elasticity for more discretionary and seasonal outdoor water use is higher than for indoor residential water use (Robinson, Symposium).

The price structure can be a mix of different approaches, depending on the objectives. For example, IBR could be used to deal with peak periods, with each block corresponding to basic, normal, and excessive use. With this rate structure, large users will in effect subsidize smaller ones. A potentially more equitable variant on this would be a water budget-based rate. In this variant on IBR, the amount of water at which the price changes (the block size) differs among users, depending for example on family size (Robinson, Symposium).

Some authors (Tietenberg, 2004b; Zilberman, Horbulyk, Symposium) have suggested that as is the case with electricity (e.g., in California), prices could be set according to the time or location of use. Customers located farther from the water supply or at higher elevations (which need more pipes and pumping) are more expensive to serve and therefore should pay more. This could provide a minor incentive against urban sprawl, while more directly apportioning costs to the more expensive-to-serve clients.

2.2 Water Markets

It is not an easy task for regulators or policy makers to set the right price. So why not let the market do it?

Trading in resource access and use rights, such as land, timber, or milk quotas, is widespread. However, experiences with water are fairly new. During the past century, with increasing scarcity, governments have limited access to water through licensing systems, defining who can use it and under what conditions. More recently, in the face of continuing resource depletion, the introduction of markets has sometimes been proposed and implemented to foster a more efficient and sustainable use. Markets may also offer a non-political means to solve conflicts over water rights.

For example, with tradable permits for water withdrawals, regulators decide on an aggregate amount of water that can be extracted. Access rights for water are then allocated on some basis to water users, who can then trade them at prices determined by supply and demand. In a perfectly competitive market, sellers derive lower value from using the water, and buyers are those who value it more.

In addition to ensuring optimal allocation and efficiency, markets have the reputation of limiting the need for overall planning and management. Indeed, in theory, in a free and competitive ideal setting, markets are self-regulated and result in the maximum resource-use efficiency by moving water to its highest value use. In practice, however, water markets operate in far from perfect conditions due to natural monopoly, high sunk costs, and numerous externalities. Some have argued that tradable rights regimes "may be insufficiently responsive where environmental resources are most densely interactive, complex, and fluctuating" (Rose, 2004: 243).

Markets are often built over existing resource management frameworks, and therefore may co-exist with other institutional arrangements, and associated property rights systems. There are basically two other types of such arrangements: community-based management (associated with common property of a resource) and state-controlled (e.g., through licensing), the latter now largely dominant in industrialized societies. However, the recent policy movement toward watershed management, more developed in the United States than in Canada, has close links with the principles of community-based management. Indeed, according to the economist Tom Tietenberg (2004a: 222), water considered at the watershed level as "small-scale, complex resources with multiple externalities may be better managed by cooperative arrangements." It is still unclear if, and if so how, these different management regimes can co-exist.

An important political barrier to implementing markets is the fear that they will lead to the commodification of water (water becomes a tradable commodity in opposition to an essential service), making it accessible to whoever can pay for it, including through importation, irrespective of other social and environmental goals.

Three main points emerge.

- We need to better understand what specific objectives water markets can foster most efficiently, and in what context given the existence of other management regimes.
- Markets reduce state responsibility for prices and allocation, and may thus be more politically acceptable than direct intervention in some circumstances.
- At the same time, the state has to intervene to ensure environmental or other social goals are met, for example by determining the total amount of water that can be part of trading.

2.2.1 The Legal Framework for Markets

The way a market operates and functions depends on the legal framework. The laws that structure the market establish and regulate it, but the laws that define property rights are the most crucial to the functioning of markets. The way the rights of an entitlement are defined will influence the values that market participants put on it, especially, the definition of who will incur the related regulatory and financial risks (Horbulyk, Symposium). However, a clear definition of water rights can be a cumbersome task: it took 15 years to clarify pre-existing water rights when a water market was established in the Rio Grande Basin (Eaton, Symposium). Moreover, water's mobility, volatility, and variable (and changeable) quality make it difficult to define and regulate as property.

Ideally, if property rights are well designed, their exchange in a market leads to economic efficiency as water moves to the highest value uses. In reality, markets require regulations, which will limit transferability of water rights and thus the efficiency of the market. However, without restrictions on water transfers the market could result in the concentration of rights in the hands of one holder or a group of holders leading to a monopoly or oligopoly situation, excess withdrawals, out-of-basin transfers, or other undesirable outcomes. Regulation, such as limitations on the accumulation of water rights or permits, can mitigate or even prevent these outcomes.

There are several common restrictions on water rights. One is based on the use it or lose it principle: water rights must be fully used or they are lost. This is meant to discourage hoarding of rights, but obviously discourages water use reduction and investment in water-efficient technologies as users who saved water have their allocation reduced by the same amount.

Another important restriction is the allocation of priorities across categories of users. In most provinces, domestic needs come first, followed by municipal, agricultural, and commercial and industrial users. As a consequence, investments (e.g., in more efficient technologies) are not stimulated for the lower priority users, because their opportunity to make use of such investments is uncertain. This restriction also has impacts on the incentive to purchase rights on behalf of the environment. The fact that the right could be confiscated (as a low-priority use) in times of drought, when the environment is most threatened, militates against its acquisition (Tietenberg, 2004b).

Some rights regimes for using water also lack clarity (Matthews, 2004). For instance, with riparian rights, water use must be reasonable, which is open to interpretation. With appropriation rights, water use must be beneficial, which is equally open to interpretation and potentially inefficient. For the market to function, "not only must the operational rules for water use be certain, but specific information on each right must be available to potential buyers" (Matthews, 2004: 4).

Legal Frameworks

In Canada, as in the United States, two common legal approaches are the foundation of the allocation system: the riparian doctrine and the prior appropriation doctrine. In most of eastern Canada, water use is governed by modified riparian rights. As water became scarce compared to growing demands, as is the case in western Canada, riparian rights led to water shortages for most users in periods of low flow (Lucas, 1990). Consequently, these rights were progressively replaced by prior appropriation rights, which dominate in western Canada and the western states. More recently, water rights have been vested in the Crown in most jurisdictions, with riparian and prior appropriation rights "grandfathered" as appropriate.

2.3 Obstacles to the Implementation and Operation of EIs

Economic instruments, as with any other policy instrument, are not without cost. In some cases, the transaction costs (see accompanying definition) may outweigh the benefit of the transaction, in which case the transaction may not occur, and the benefits of the economic instruments will not be achieved. Also, there are distinct implementation costs, which can also outweigh the expected benefits.

Third-party impacts are the externalities that a market transaction has with regards to parties other than the buyer or the seller. The principal concern is the diminution in economic or environmental benefit to other stakeholders in the area from which the water is transferred. Another concern is the effect of decreased return flows, which can affect both in-stream and withdrawal uses downstream. Impacts of water use on downstream water quality are also a major concern.

Market rules can minimize the negative third-party impacts by allowing the selling of only water that is made available by use reduction or enhanced return flow. To minimize the impact on in-stream uses, criteria (even if arbitrary) could be set on how much water to allow into the market (i.e., reserving a share for the environment (Zilberman, Symposium). In Alberta, the Crown can withhold 10 percent of water transferred for in-stream needs (Yee, Symposium). Policy must be adaptive and continuously rebalance environmental and economic needs.

However, taking full account of third-party impacts increases transaction costs. These can become so prohibitive that the market would have very few or no transactions, and thus not be worth implementing.

Estimating the costs in moving from one allocation mechanism to another is also important to assess the cost of implementing markets. It is not an easy task (see p. 22), requiring that some measurement is done before or during the implementation. According to McCann and Easter (2004), most studies do not account for the costs of institutional changes required for market implementation, and thus underestimate what they refer to as the total transaction costs. However, better assessment of the factors affecting these costs will improve the cost-benefit analysis.

Certainly, the scarcer water is, the higher its marginal value, and thus the returns on water for buyers must increasingly outweigh both the price paid for water and all the transaction costs. So water markets may be an efficient way to allocate water in water scarce regions. Conversely, markets may not be economical in situations where water is abundant and the relatively invariant transaction costs may be larger than the difference in value between uses (Zilberman, Symposium).

Transaction Costs

Transaction costs are all the costs involved in a market transaction. They can be classified in two categories: administrative costs (e.g., expenses related to contract negotiation) and costs induced by the policy implementation (e.g., regulatory, monitoring, and compliance costs) (Archibald and Renwick, 1998).

What is Included in Implementation Costs?

The principal factors that influence implementation costs are the infrastructure and technology that already exist, the water rights framework, and the broader institutional and legal frameworks.

A typology for transaction costs associated with a change to a market mechanism should thus include (1) research, information gathering, and analysis, (2) enactment of enabling legislation, including its design, (3) design and implementation of the policy instrument, (4) support and administration of the ongoing program, (5) contracting costs, which are relevant for the case where a market has been set up, (6) monitoring/ detection, and (7) prosecution/ inducement/conflict resolution (McCann and Easter, 2004: 2).

Moving toward more complex price structures may also be costly to implement. It is important to account for the implementation costs, as a theoretically efficient pricing (such as an IBR) may become less efficient than other methods if the costs of installing and maintaining meters and administering and enforcing water fees are too high. Moreover, implementation costs differ according to the technology, location, and institutional environment already in place. Given the potentially high costs of implementation, it is important to ensure expected benefits – reduced water demand, extending the life of infrastructure, etc. – outweigh those costs. Clearly, each situation may call for a different method, and uniformity of approach is not justified (Tsur, Symposium). Indeed, the World Bank, long a major proponent of privatization and economic instruments, has recently acknowledged that: "...solutions need to be tailored to specific, widely varying natural, cultural, economic and political circumstances, in which the art of reform is the art of the possible." (World Bank, 2004: 22).

Revenue instability resulting from marginal cost pricing may be problematic for investments and, in the long term, can increase the financing cost of water utilities. Thus, a trade-off exists between the fixed and the variable components of a price structure, as higher fixed fees may lead to greater revenue stability but to less efficient price signals (Chesnutt et al., 1997).

In practice, setting the price at the marginal cost is not easy, since it requires detailed cost data that may not be available or reliable (Hanemann, 1998b; Renzetti, 2000).

A transparent price schedule is also important. Efficient pricing could be too complex for many consumers to understand the signals being sent. Transparent pricing ensures that water users understand the signal they receive clearly and that it has an effective impact on their technology investment choices, as long as the risk of unexpected change is reduced (Hanemann, 1998b). Achieving a balance between transparency (simplicity) and thoroughness of costing (complexity) is a major implementation challenge.

Setting an efficient tax rate for self-supplied industry is analogous to setting a price on the externalities for a utility: the costs are poorly known and possibly unknowable. Further, ensuring a desired level of incentive effect from a tax would require detailed knowledge of the industry's cost structure, which is similarly difficult and perhaps impossible to achieve.

Water prices and taxes raise the cost to industry and thus prompt fears of decreasing competitiveness. Even if water is only a small fraction of the budget for most self-supplied industries, some water-intensive industries (e.g., food or drink producers) may still be significantly impacted by an increase in water costs. In the European experience, abstraction taxes often represent an insignificant part of the total water cost and, thus, have no impact on competitiveness (Speck, Symposium). However, industries that might be expected to suffer from water taxes are often exempted. This makes the attempt to assess the impact of economic instruments on industrial competitiveness difficult, and there are consequently few such studies.

Lessons from Experience

So far, we have examined the theory of pricing and markets for water demand management. However, there can be a large gulf between theory and practice. There have been few detailed analyses of actual experiences from which the factors leading to success or failure of a pricing or market regime can be extracted. The question then remains: How does it work in practice?

3.1 One Target-One Instrument

It is often difficult to assess the effectiveness of economic instruments, as their primary objective is not always clear. Moreover, pricing and taxes are usually only a part of a more general policy package that includes, for example, regulations, public education, and investments in water-efficient fixtures; hence, it is not easy to distinguish the impacts of any single instrument.

Some argue that to have instruments that are effective and durable, they must rely on two principles (Young, Symposium):

- With the Tinbergen Principle, the number of instruments should be at least equal to the number of objectives. In other words, no instrument should be applied to more than one goal.
- The Mundell Principle states that the instrument that is most efficient for a target must be used for that specific target.

While the practical application of these principles bears further scrutiny, they emphasize that policies are normally implemented in packages (or suites), with a series of instruments, each designed to reach one or more objectives. Many authors have suggested that EIs can achieve multiple objectives with a single instrument. However, it can be very difficult to sort out the effects of particular instruments when they are normally applied in packages, and on top of existing policy packages.

While the ability to determine the effectiveness of a particular instrument in a package is important to our ability to learn from experience, there is a second and perhaps more important reason to further explore the one objective-one instrument paradigm: as in any complex system, unexpected effects, shocks, and other perturbations can at least in theory be best handled through a system of checks and balances, rather than through a single instrument. For example, in the case of markets discussed above, a regulation preventing the accumulation of water rights in the hands of any given individual or corporation can be used to prevent the development of a monopoly; a separate regulation can prevent out-of-watershed water transfers to reduce the risk of alien invasives; and priority quotas can be established to ensure sufficient water for environmental needs.

3.2 Experiences with Residential Water Use

Apart from the general statement that prices affect water use, it is difficult to assess the strength and even the shape of this relationship. Studies show that household water demand is relatively inelastic, and will not change much when prices change (Espey et al., 1997; Hanemann, 1998a; Renzetti, 2002). However, studies also show that elasticity increases in the long term – possibly because consumers replace inefficient fixtures and modify habits gradually rather than instantly (Carver and Boland, 1980; Agthe and Billings, 1980; Dandy et al., 1997; Renzetti, 2002).

There are strong indications that volumetric pricing is associated with lower water use, in Canada and elsewhere. However, these indications neither amount to proof nor do they provide explanations of the forces at play. The relative effects of pricing, metering, and other policy tools are unknown.

Indeed, some apparent contradictions need to be explained. For example, English and Welsh utility prices have increased to ensure full cost recovery. However, total water use has increased in the residential sector. The OECD (1999b) noted that metering in these situations is not universal (the UK regulatory agency rejected universal metering after a cost-benefit analysis), pointing out the ineffectiveness of pricing that is not volume-based for demand management.

Another apparent contradiction, in Canada, is the fact that, in 1999, Charlottetown had a flat rate price and, yet apparently had one of the lowest per capita water use rates in Canada, at 156 litres (Brandes and Ferguson, 2003a). A less drastic but still puzzling example is the fact that in Toronto, also in 1999, only three quarters of the population was metered, but used less on average than citizens of Victoria, who were fully metered. While these and a number of other apparent contradictions may be artifacts of data collection, they are still to be explained.

More generally, while coupled price increases and reduced water consumption have been observed in a number of European countries, public education and other instruments have usually been applied simultaneously such that the effect of pricing itself has not been shown to be very significant, and the declines in usage have not been satisfactorily explained (Barraqué, 2003).

In Canada, a recent study shows that the choice of price structure (e.g., IBR, flat rate, or other) varies between municipalities as a consequence of local conditions (including water scarcity and pollution) (Reynaud and Renzetti, 2004). The same study suggests that the price structure is important to explain the effect of price, that past a certain (variable) price threshold, water demand is more elastic, and that the price structure has a greater effect on water use than the price level (Reynaud and Renzetti, 2004). Here also, the relative effects of pricing and meters are not known.

In Denmark, water consumption declined over several years. A tax on water use (introduced after the decline had started) was found in a survey to have been responsible for 40 percent of the decline, while education was responsible for 60 percent (ECOTEC, 2001). According to Vickers (2001: 16), the principal sources of residential water waste are “old, inefficient plumbing fixtures and appliances, leaking toilets and faucets and wasteful water-use habits.” While these may be addressed through pricing measures, there is ample room for non-pricing measures (e.g., education, leakage reduction) or EIs (e.g., subsidies to adopt more efficient water appliances, to reduce domestic water demand).

Studies in psychology raise serious doubts as to the effectiveness of financial incentives to promote changes in behaviour (Thøgersen, 1994). Among some of the important issues raised is the observation that individuals may modify their behaviour in the short term in reaction to price changes, but in the longer term revert to their old habits. This is referred to as adaptation level theory in the literature.

As we see later on, studies in community-based social marketing (see box on p. 37) emphasize the fact that positive incentives (EIs, such as rebates) are more effective than negative ones. This would mean, for example, that providing subsidies for adopting water-efficient technologies works better than increasing the price of water if the intention is modifying behaviour with respect to water use.

To conclude, as Barraqué suggests (2003: 209): “In the US, decline in domestic demand is more the result of information policies and subsidies to individual conservation measures than rising prices alone.”

3.3 Experiences with Industrial Water Use

There are few empirical studies of the effects of water pricing in the industrial sector, but they all seem to agree that industrial water demand is more responsive to price than domestic or agricultural demand. More specifically, self-supplied plants are responsive to the marginal cost of water (Renzetti, Symposium). Nevertheless, elasticity is not high. In a study of the effectiveness of a tax on industrial groundwater use in the Netherlands (where groundwater accounts for most of the water used) demand was found to be only moderately elastic (ECOTEC, 2001).

It would seem that, in most places where they have been implemented, the primary goal of environmental and abstraction taxes is to raise revenue in a politically acceptable way rather than to change behaviour[1] (Strosser, Speck, McClellan, Symposium). In addition, exporting industries that are highly dependent on water have generally been shielded from taxes. While these taxes/charges may have had an effect on water use, it is difficult in practice to isolate their role (ECOTEC, 2001).

In Canada, licensing fees or permits to use water have been introduced in a number of provinces. However, the fee is usually small, set for administrative cost recovery only (OECD, 1999b). Moreover, fees are generally not volume based, which would require metering and monitoring. This limits the influence on water use reduction and our knowledge of industrial water use.

Effluent charges and sewer discharge fees have been introduced in British Columbia. Effluent charges not only provide an incentive to reduce pollution, but since most of the effluent water was intake water, they can also reduce water use. Their use is still limited in Canada, but international experiences suggest they can be effective as part of a package that includes strong stakeholder buy-in and the use of revenue to fund other instruments, such as education and technological improvements (Andersen, 1999; Green, 2003).

Studies also show that water recycling is an important characteristic of the industrial response to water pricing. Indeed, when the price of water or effluent discharge increases, industrial water demand is reduced mostly through increased recycling. However, before considering any implementation of EIs, there is still a need for a better understanding of the interactions between industrial water demand, recycling, and wastewater discharge (Renzetti, Symposium). Few studies have been done on the interactions of water price and the price of inputs other than water (Renzetti, 2002).

Note

1. The government of Quebec has announced the imposition of a water abstraction charge of .01$ per m^3 for large water users, including municipalities. However, the stated intent is not much to affect demand, but to raise targeted revenue for research and the work of newly created watershed organisations.

Difficulties also arise in implementing water-saving policies in this sector since water use characteristics and thus potential water savings differ widely across sub-sectors and even between similar firms (Vickers, 2001). However, water costs seldom account for more than one percent of a firm's total budget (other than in water-intensive industries, such as food and drink industries (Renzetti, Symposium). This is important for policy makers, since water-saving measures might not be a priority for manufacturing plants.

Industrial water use, in situations where the resource is publicly supplied, offers a particular opportunity: saving public infrastructure costs without actually reducing demand, by shifting demand from peak to off-peak times. Peak demand charges can be implemented through many price schedules. Seasonal rates that charge higher prices for summer use are not really effective in practice (Robinson, Symposium). To be more efficient, peak load pricing should be on a weekly or even daily or hourly basis, but this might be expensive since it implies special "smart" meters.

Load Shifting

Leamington has adopted a different strategy to manage water demand: load shifting. The agri-food industry – a water-intensive industry – has a significant presence in Leamington. Participation of the food company in the management of water was key to the approach chosen when Leamington reached capacity hurdles. In essence, working with the company indicated early on that significant savings and deferred expenses could be achieved by shifting water use to non-peak moments, and steering the public utilities toward the adoption of sound financial planning and maintenance of its infrastructure.

Water is constantly (24 hours/seven days a week) drawn and stored for later use by water-intensive enterprises. This means water production capacity is fully used at all times, with no strong daily peak in demand. This storage, in turn, means that enterprises have all the water they need, when they need it, without requiring the utility to build excess capacity. This strategy, adapted in time to fit the addition of new large water users, such as the greenhouse industry, made adaptation possible and cost effective. Pricing and particularly metering are important for all users, but the key to Leamington's success is that efficiency efforts have targeted the biggest users, not so much the residential ones.

While this approach does address the infrastructure goals of demand management, it does not necessarily reduce total water withdrawals from the environment.

Source: Phil Dick, Symposium.

Peak demand reduction strategies, such as that used in Leamington, Ontario (see accompanying sidebar) bring into clear focus a key lesson found in successful cases of water demand management: the early and full buy-in of key stakeholders.

"The potential benefits of demand management in industry are so large because it is potentially possible to save money four times: a reduction in metered water use, a reduction in the energy required for heating or cooling, a reduction in the charges for wastewater treatment, and through the recovery of materials from the wastewater. Nevertheless, the evidence is persuasive that prices are ineffective at optimizing consumption." (Green, 2003: 249).

3.4 Experiences with Agricultural Water Use

The main factors influencing agricultural water demand are production levels, inputs other than water (and their relative prices), water availability and quality, land quality, crop type, the irrigation technology used, prevailing climate, and seasonal weather (Renzetti, 2002). In dry years, when supply is low, agricultural water demand is highest. Another characteristic of the agricultural sector is the importance of uncertainty in irrigation water use. Farmers will often over-irrigate to insure against adverse weather (Eaton, Symposium). Indeed the more the farmer is risk averse, the more he or she will use water (Renzetti, 2002). Risk factors and a consideration of the users' risk-tolerance should be incorporated in any agricultural water project (Howitt, Symposium; Renzetti, 2002).

In most empirical studies, irrigation water demand is found to be relatively unresponsive to price changes, as a given crop requires a certain amount of water in a given setting (Garrido, 2002). This could be due to the low cost of subsidized water and to the fact that relatively small price increases do not change the incentive provided by crop prices and other subsidies very much (Malla and Gopalakrishnan, 1995). It has been argued that demand for irrigation water would remain inelastic until water costs rise substantially, an hypothesis supported by recent simulations (Bazzani et al., 2004). In addition, irrigation water demand becomes more price sensitive in settings where farmers have choices between crops with varying water requirements.

Another important feature of agricultural production is the use of crop subsidies to support production. In this context, to the extent water-demanding crops are promoted, higher water prices have a limited effect on water use (Strosser, Eaton, Symposium).

Inefficient irrigation technology is often seen as a key factor in excess water use. However, for many farmers, replacing existing and working equipment with new equipment is not cost effective at any reasonably expected price for water. In planning reforms to pricing and cost recovery, and in promoting more efficient water use in the agriculture sector, it might make sense to transfer part of the costs of adjustment from agricultural to urban users as a first step toward agricultural water use reduction. For example, urban users (or taxpayers in general) could subsidize efficient irrigation technologies through taxes on residential water use (Garrido, 2002). This would make such investments more attractive to farmers (Robinson, Strosser, Symposium). This investment on the part of urban consumers would be repaid in the form of environmental benefits and possibly reduced food prices (Tsur, Symposium).

As suggested earlier, in theory, as long as these subsidies affect only the fixed costs of water provision, and prices are set at marginal cost, subsidies have no impact on the efficient allocation of the resource and determining who and how the fixed costs are covered should be based on equity principles (Tsur, Symposium).

However, while higher price levels might have an effect on water use in the irrigation sector, the environmental and social effects of such changes still need to be better understood. As suggested in Section 1, little is known about the environmental consequences at the watershed or basin level of adopting more efficient irrigation technologies. For example, increased efficiency could reduce return flows and groundwater recharge, which may or may not reduce stream flows, and may or may not lead to lower volume of more concentrated pollutants entering waterways. Also, under certain conditions, water-conserving technologies can lead to increased water use at the basin level. (For more details, see Garrido, 2002: 25; Freeman and Wahlin, 2004; Van Camp, 2004).

On the socio-economic side, a main cause of opposition to water price increases from the farming community lies in the fact that the value of water subsidies has been captured in the value of their land, which would then be reduced. In addition, a recent simulation of price increases in a region of Spain (Gómez-Limón and Riesgo, 2004), resulting from the policy direction proposed in the European Union Water Framework Directive, showed the following:

- Even within a homogeneous area in terms of soil, climate, and other factors, there are large differences among farmers' reactions to price changes.
- There could be a significant decrease in farmers' incomes due in particular to a change from water-intensive crops, such as fruit, which are often the more profitable crops, to less water-intensive crops, such as grains.
- Reductions in agricultural employment would lead, most probably, to an increase in part-time farming.

The net result is that irrigation-pricing reform has not generally led, and may not lead in the future, to significant reductions in water use (Garrido, 2002). Full cost-recovery charges may nevertheless be seen as necessary (though not sufficient) for new irrigation projects to achieve other aims, such as increasing self-reliance of water users' associations or reducing pollution. However, some form of assistance for farmers to adopt and use new technologies, and to upgrade infrastructures, could be desirable.

Metering Program in the South East Kelowna Irrigation District (SEKID)

A metering program was introduced in 1994 in the South East Kelowna Irrigation District (SEKID). The implementation was done in two phases. In the first phase (1994 to 2000), meters were installed and an emphasis was put on educating the farmers to use water more efficiently. However, no metered rate was set, and farmers were assured it would not be for five years. Farmers were also given tensiometers (soil moisture meters) with which they could tell when a field did not need irrigation. This was done with the help of the provincial government (senior government grants for metering programs and technical assistance). Data (meter readings) were collected monthly. The first phase resulted in a 10 percent reduction in water use. Meters also increased the ability to detect leaks and ensured that the distribution of the resource was equitable in the SEKID.

During the second phase, an allotment of water was decided upon for each farm based on average needs, and an inclining block rate for excess water use was applied as a deterrent, not as a source of revenue. This proved to be effective in further reducing water use.

Source: Toby Pike, Symposium.

3.5 Summary of Experiences with Pricing and Taxes

This report does not claim to have reviewed all existing evaluations with respect to the use of pricing and taxes, but it is clear that there are still important limits to our understanding of their effects on water use, particularly in Canada. “Many countries face multiple concerns regarding the growing scarcity of water, including associated conflicts among users and ways of transferring water from low-value to high-value uses. It has often been stated that having users pay the full cost of water would solve these problems. Experience has shown the situation to be considerably more complex and nuances, requiring more than extolling the virtues of pricing.” (World Bank, 2004: 22).

While there are indications that volumetric pricing is associated with lower water use in municipalities, this relation is not well understood, and there is not enough evidence to support the assertion that it is pricing per se, and not other factors (metering, education, regulation of fixtures, etc.), that lead to the largest reductions in water use. There is not enough evidence that this relation holds for agriculture and, in general, other factors than price have a greater effect on irrigation water use. Little is known about the industrial sector.

Another issue is the relative effects of metering and pricing. Volumetric pricing, by definition, needs metering. It might well be that metering alone could explain a large portion of the observed changes in water use patterns. It could also be the case that education campaigns, associated with the introduction of metering are the major factor in water use reduction, as seen in the South East Kelowna Irrigation District example (see accompanying box).

However, there are also cases where metering does not seem to be related to lower water use, and these need to be explained.

We have seen that the price structure may have a greater impact than the price level. This is important since some experts have argued that merely increasing flat water charges may actually have the perverse effect of increasing water consumption, as people feel they are entitled to more water, because they are paying more for it (Dinar et al., 1997). In addition, psychological studies raise doubts with respect to the effectiveness of pricing alone on changing behaviour.

In addition, as we have seen above, in most places where they have been implemented, the primary goal (or at least the primary effect) of environmental and abstraction taxes has been to raise revenue in a politically acceptable way rather than to change behaviour.

All of this should not be construed as saying that pricing or taxing does not have an effect on water use, or that these strategies should not be explored further. The point is that there is not yet enough evidence to show that pricing or taxing are the most efficient and cost-effective policy instruments for water demand management.

To make such assessments, furthermore, would suppose that the objectives for which pricing and taxing are proposed are clearly defined. This is simply not the case. A related point, as was emphasized above, is the fact that it is doubtful that many objectives can be achieved through a single instrument such as pricing. In particular, as Horbulyk (Symposium) suggests:

> [I]t is generally not the case that use of just one policy instrument can meet the twin goals of efficient resource allocation and meeting public revenue needs or targets. Sooner rather than later, this choice has to be made in a way that allows effective use of the instrument for one purpose or another.

To conclude, more studies are needed to understand how different policy instruments interact to affect water use, and which ones are more efficient and cost effective in achieving their objectives. In addition, a better understanding of water use behaviour, employing all the tools provided in the social sciences, is also warranted.

3.6 Experiences with Water Markets

Water markets have developed in areas of high water scarcity such as Chile, Australia, the western United States and southern Alberta, where rights to access the resource exceed its availability. The importance of market exchanges in overall water allocation is variable. In Chile, they are the main allocation tools while in California, they represent from three to six percent of annual water use. It may be obvious, but is still worth noting that markets can develop where the existing infrastructure allows water to circulate (Zilbermann, Symposium). Each market is particular to its own local and institutional conditions and, consequently, each experience is different.

The older water markets were first implemented in Chile, when changes to the water code were adopted in 1981. They are also the least regulated, where most water management decisions, including creating a market are, in effect, made by individual water rights owners and private associations of irrigators. Recent analyses suggest that a number of issues still have to be resolved, including dealing with externalities, and a better definition of water rights. These explain why, in practice, trading is still limited in many regions of the country. In addition, markets have not had the effect of increasing agricultural water use efficiency. The social and environmental effects of the Chilean experience need more study (Bauer, 2004).

The Rio Grande case shows an example of a relatively simple market design (Eaton, Symposium). Annual and permanent water rights are leased and traded, usually within the same sector. Regulation is limited to accounting for all water used and to securing water title. Although it has led to efficient allocation (i.e., water has migrated to the most economically beneficial uses), the Rio Grande market has resulted in little investment in efficiency technologies (other than through government subsidies), and total water use has actually increased. It is also inequitable, as smaller and poorer user organizations and municipalities are disadvantaged (Eaton, Symposium).

Another rule of the Texas market is the beneficial use rule, whereby water must be used for economic gain. This has a significant consequence: environmental non-government organizations have been prevented from buying water rights for ecosystem preservation, as that is not economically profitable.

By contrast, in the California market, it is not water rights that are traded but water itself, and the trades occur among a small number of water agencies rather than a large number of direct users. Local water districts are the most involved in the transactions as buyers and sellers, followed by federal agencies. Only three to six percent of total annual water use is traded. However, the market is expanding, in part due to increasing state purchases of water for the environment (Howitt, Symposium).

Another interesting characteristic of the California experience is the introduction of option contracts for water sales to offset uncertainty. Further, the need for conjunctive management of surface and groundwater is an issue in California, whereas in the Rio Grande market, groundwater is too saline to be a substitute for most uses.

Some of the main features of the evolution of this market from 1990 to now include the central role of state institutions in putting a water market to work, the flexibility markets can provide to access water, and significant remaining points of conflicts: the social implications for source communities (i.e., where the water can be imported from, the need for conjunctive management of surface and groundwater, and maintaining funding to ensure allocation of water for the environment.

The Australian experience is again different. When markets were first introduced, the legislation was not designed to adapt to a market, resulting in many environmental, economic, and social damages (Young, Symposium). Hence, a new approach is being implemented. This new approach attempts to clarify fully the associated risk of entitlements that are defined as perpetual shares. The interactions between surface and groundwater, as well as all the impacts of different land-use activities on downstream water quantity and quality are recognized as serious issues and are to be accounted for through the licensing system. Hence, entitlement and allocation systems will be separated as suggested by the Tintenberg and Mundell principles. Moreover, the country is exploring using a bank-like system to manage allocations in a cost-effective way. The order in which the reforms are implemented is crucial. A robust accounting system must be in place before defining title as perpetual shares (Young, McColl, Symposium).

While positive effects of the Australian water trading approach on the environment and communities can be observed, they are, in great part, due to strong regulation. For example, to be involved in trading, farmers have to show they have adopted water efficiency practices. This being said, there are emerging social issues such as the difficult position of smaller family farms and the effect on some source communities of large water transfers. The latter have the effect of reducing substantially economic activity in these areas.

In Alberta, a water market has recently been put in place to allow transfer of an allocation under a licence, and will allow entry of new water users where water is fully allocated. Transfers can be made on either a permanent or temporary basis, with government approval, which can be obtained only when an approved management plan is in place. Since its inception in the late 1990s, five transfers have occurred.

While the economic aspects of markets have been examined, and suggest that under the right conditions trade can lead to increased economic efficiency, few empirical studies have assessed the impacts of water markets on society and the environment (Bauer, 2004; Bjornlund, 2004). Clearly, markets seem to work best when accompanied by other instruments (e.g., regulations, education) to ensure equity and environmental goals are met: "The water market can be a very good servant to move water around between competing uses and drive the process towards sustainable rural communities, but if left to its own forces, it could prove a very unforgiving master" (Bjornlund, 2004: 11).

3.7 Complementary Policy Tools

Economic instruments are only one incentive among many that can influence water users (Eaton, Symposium). Because it is recognized that prices have limits, economic instruments are seldom proposed to replace other demand management tools. On the contrary, different tools should probably be combined into a coherent management strategy to complement and support each other. The difficult question is, given limited resources, what role should each of them play, in what context, and for what objective? In Canada, demand-side management strategies are still in their infancy. Possibly as few as 20 percent of municipalities in Canada have a demand management program (Pleasance, Symposium).

3.7.1 Information and Regulatory Oversight

Water utilities know little about what their customers want. However, a better knowledge of how users perceive the service would help to predict the consumer behaviour impacts of a price or service change (Dupont, Symposium). Canadians are willing to pay more for water if the service is reliable and the water is safe. Indeed, Canadians have increased their in-home consumption of bottled water and home filtration devices and, hence, their actual spending on water. Dupont (Symposium) uses social survey techniques with the potential to explain how the public, or a more specialized group, interpret choices and issues. To better integrate consumers' preference into the decision process, Dupont recommends implementing regulatory oversight, as is the case in the United Kingdom, to push water utilities to set performance targets, meet these targets, and be more transparent and more open to public scrutiny.

Another powerful information tool is consumer education. Although the interactions between education and water use are not well known, the ground has been prepared for examining them (Baumann and Haimes, 1988). Public recognition of a problem is crucial to conceiving and implementing alternative options for water conservation and environment protection, and recognition occurs through education: "Public education is probably the most valuable approach to developing demand management programs in the agricultural sector. The objective here would be to educate the farmers on the alternative forms of water efficient irrigation systems technology as well as on the crops most adaptable to using less water" (Tate, 1990: 32).

Community-Based Social Marketing

Community-based social marketing (CBSM) is based on the observation that merely providing information rarely brings about a significant change in behaviour. In this approach, behaviour change is achieved through initiatives delivered at the community level, which focus on removing barriers to addressed behaviour (e.g., composting, reducing water use for gardening, car pooling) while simultaneously enhancing the behaviour's benefits. Community-based social marketing programs are designed to discover and address the specific sets of barriers and benefits that go together with each activity being promoted. Pilot programs and program evaluation are also integral parts of program design. (McKenzie-Mohr and Smith, 1999).

The CBSM builds on a number of tools, including techniques to secure a commitment to a specific behaviour, prompts that remind people to actually do what they are committed to doing, and others such as incentives. Other important tools are direct contact and demonstration to implant the desired behaviour in community norms.

To the extent economic instruments are applied to modify behaviour, they are considered as a type of incentive (which can also include non-financial incentives).

Gardner and Stern (1996) suggested a number of guidelines for the use of incentives.

- Incentives should be used to reward positive behaviours rather than to punish negative ones.
- Incentives should be closely paired with behaviour. The closer in time the incentive is presented to the behaviour it is meant to affect, the more likely that it will be effective.
- Incentives should be visible. People have to be made aware of the existence and purpose of the incentive.
- The size of a financial incentive should be carefully considered, particularly by examining other communities' experiences.
- People often try to avoid an incentive that strongly rewards a positive behaviour and punishes another (e.g., separate lanes for multiple-occupant vehicles). Consequently, the possibility that people try to beat the incentive (e.g., single car occupants using separate lanes) should be planned for in the incentive program.

Sources: McKenzie-Mohr and Smith (1999); Gardner and Stern (1996).

3.7.2 User Involvement

Case studies reviewed in the application of EIs for water demand management as well as for pollution control indicate that in addition to better information exchange, user participation can contribute to a more effective implementation (see boxes in section 3). This finding is in line with the conceptual view of integrated water resource management as a highly consultative process, engaging communities and stakeholders to foster the sustainable use of water resources.

Evaluation of the application of economic instruments for water management, including for pollution control, confirms that some type of public involvement is often a necessary condition for the successful application of economic instruments. Anderson and Farooqi (2003: 27), in a review of Canadian and international experiences, conclude: "The most successful programs have wider objectives and begin with popular support."

While this statement does not detail the conditions that lead to getting such support, European and American policies and experiences suggest that direct participation by users is key. In its 2003 *Water Quality Trading Policy*, the United States Environmental Protection Agency stated that a condition for successful implementation of pollution trading programs is that watershed stakeholders and the state regulatory agency be willing to try an innovative approach and engage in trading design and implementation issues. A review of European experiences with the use of taxes also confirms this view (Andersen, 1999). With respect to residential water planning, American and Canadian experiences with citizen committees involved with planning appear to lead to effective and cost-efficient solutions (Chesnutt et al., 1997; Mee, 1998; Waller and Scott, 1998).

It would thus appear that user participation is key to the successful implementation of economic instruments and, arguably, to the successful development and implementation of water demand management strategies more generally. The form of this participation, however, varies. In some cases, large water users were directly involved in the management of the public utility. In others, reference is made to consultation processes or to decentralizing decision making. From a public policy perspective, we need a better understanding of how these processes work, of how users are involved and for what type of decisions. In the context of IWRM, it might also be helpful to explore the extent to which decisions and authorities related to making use of economic instruments should be shared with, or delegated to, watershed organizations and their members.

3.7.3 From Water Use Reduction to Conservation

One interesting approach to more sustainable water management, called water soft paths, is designed on the experience gained with soft energy paths (Brooks, Symposium). This approach aims at a drastic structural and behavioural change. The objectives of sustainable water management (i.e., environmental sustainability and equity concerns), are at the centre of the concept.

The approach focuses on demand side management, and more specifically on the services that water provides, rather than the water itself. For example, if the service sought is a pleasing front yard landscape, then a rock garden with native, low-water-demanding plants (a xeriscape) may satisfy the need without significant water use. This approach allows the analyst to envisage many more opportunities to satisfy demands and reduce water use.

Moreover, to satisfy service demands in an efficient way, the quality of water must be provided according to the end use. For example, high-quality water is required for drinking, while low-quality water is sufficient to flush toilets, allowing the use of recycled water or captured rainwater rather than “new” water.

Finally, the core of the methodology is scenario planning with backward analysis. In other words, a sustainable and water-efficient future is described and from there, analysts find appropriate policies and transition technologies to achieve that vision.

Like IWRM, this approach seeks to protect the environment, reconcile efficiency and conservation, and encourage public participation. This approach should be implemented, at least for a transition period, together with other demand management tools. However, to work properly, the methodology relies heavily on statistical data, and information on societal preferences and consumer motivations that are often not available. Perhaps more difficult to achieve, water soft paths require that policy makers and stakeholders find agreement in defining long-term objectives with respect to water use.

Conclusions

There remains a great deal of uncertainty over potential roles of pricing, taxes, and markets for water demand management and allocation in the municipal, industrial, and agricultural sectors in Canada. Within the municipal sector, the commercial and institutional sectors were not addressed in this report. The conclusions presented here cannot be generalized to all economic instruments or to pollution control. In what follows we first summarize the main issues explored in this report and then examine policy research implications and recommendations.

Many economists recommend marginal cost pricing and equivalent taxing schemes as leading to the most efficient allocation and use of water. However, these may not be the most efficient solutions, because of implementation costs and equity concerns. Marginal costs are difficult to calculate in practice: they can be expected to vary in time and space (particularly if environmental externalities are included), and can lead to revenue variability, which can increase the long-term financing costs of water utilities. A transparent and simple pricing scheme is also important for users.

A limited review of experiences with pricing and taxes reveals that while they can have some effect on reducing water use, it is not clear that they are more effective in doing so than other instruments. For one thing, metering and the accompanying public education may be the main explanation for some instances of water use reductions. Also, there are examples of low water use despite flat rate tariffs, suggesting that other policy tools may be able to achieve the same objective.

Cost recovery concerns can be the primary purpose of reforms to water pricing. But this goal has to be clearly distinguished from efficient water pricing in the sense that, as we have seen in Section 2, the question of who covers fixed costs should not, in theory, affect decisions to use water. Viewed from a different angle, cost-recovery charges signal the fact that water provision is not subsidized, while efficient pricing deals with finding the price that will optimize water use. Ideally, any pricing scheme should include all the costs of supplying water, including the social and environmental costs. In practice, however, social and environmental costs are not easy to assess.

A major issue in the implementation of a market that may be cumbersome and may take time is a clear but nonetheless full definition of water rights or entitlements and of the associated risks. It is also important to account for the interactions between surface and groundwater, and the impacts of related land-use applications and therefore to have good scientific data.

Creating a water market can be an answer to managing competing water demands when water is scarce. The main concerns are third-party and environmental effects, as well as transaction costs. Planning for a water market has to include ways to limit social issues and strong regulation to address environmental damage. However, this may increase transaction costs, which need to be low for a market to function properly. More generally, given potentially high transition costs to a new management system, water trading may only be worth considering in situations of scarcity.

EIs are usually only a part of a larger policy package. They are often combined with other tools into a management strategy. There is clearly potential to reduce water use through demand side management, and water demand seems to be at least somewhat sensitive to properly implemented EIs, at least in some sectors. Experiences indicate that public and/or stakeholder direct participation in planning is key to the development of successful strategies.

However, water use reduction in itself is not the ultimate objective: sustainable water use is. Water use reduction can be the consequence of more efficient water use, for example as a result of the application of different technologies. Furthermore, water use reduction in one sector may or may not lead to conservation on a larger scale. Also, in some regions, current water use may already be sustainable, and reduction may not be needed. Water use reduction may help achieve sustainable water use, but they are not equivalent.

The impacts of EIs on the Canadian economy and their cost effectiveness when compared to other tools to address water demand are still not well known. And it may be that institutions in Canada are not yet ready for the implementation and enforcement of EIs. It would therefore be wise to move slowly, as some policies can be difficult and costly to implement, and reverse if necessary. Monitoring, evaluation, and measurement are key to implementing EIs.

Thus, the striking lack of data in the water sector is a barrier to policy research and development.

Policy Research Implications and Recommendations

1. Clarity of Objectives

Policy makers should be clear about the objectives being sought through the application of EIs. Pricing changes are often proposed for the diverse purposes of sending a signal, modifying behaviour, environmental objectives, recovering costs (including or not environmental costs), increasing water use efficiency, raising taxation revenues, and maybe other goals. It is doubtful that prices, or any other policy tools, can accomplish all of these effectively and cost efficiently.

From a policy research perspective, there is a need for detailed ex-post evaluations of specific water demand management experiences to understand what tools, or suites of tools, were most effective and cost efficient in achieving specified objectives. There is also a need to better document the implementation costs of different instruments.

2. Multiple Instruments as Checks and Balances

If the application of EIs is to contribute to sustainable development, we also need to learn what other instruments should be included in the policy package. It might well be that some economic instruments applied to the agriculture sector, for example, are best used to promote efficient water use, or to maximize the economic benefits accruing from the use of available water (such as through the creation of markets). But this does not tell us what instruments can best meet environmental or social objectives, assuming we have defined what those are. We have seen that markets can increase the economic benefits of water use but tools have to be developed to address their social and environmental effects.

From a policy research perspective, there is a need to better understand how different pricing, taxation and market experiments have tackled third-party and environmental effects, and their success in doing so.

3. Subsidizing Infrastructure

Subsidies are often blamed for high water use. This is theoretically true only if subsidies cover variable costs of water provision and not fixed costs. In other words, there are different types of subsidies proposed to attain different objectives and without more clarification of these, it is difficult to assess the role of subsidies.

Another claim is that water works, such as impoundments for agriculture, for example, bring social benefits, such as waterfowl habitat and recreational opportunities, that are not included in discussions about water pricing, and asking farmers to pay the full cost of irrigation networks would actually be asking them to subsidize these benefits for all society.

There is a need to clarify the public expectations, purpose, and scope of subsidized water provision and treatment, and the consequent role of water pricing reform strategies. It might well be that pricing changes in Canada may be mostly required to recover operating costs, to modernize water infrastructures or to delay new construction in an era of fiscal restraint, and only secondarily to achieve environmental benefits.

From a policy research perspective, there is a need to hold a public debate about the social desirability and financial feasibility of subsidizing water provision (and treatment).

4. Data for Planning the Use of EIs at the Appropriate Geographical Scale

The notion that water management should be tackled at the watershed or basin level has important implications for the design of pricing strategies. It is easier to argue for the need to introduce pricing for water use reduction in specific sectors if, indeed, a local and regional water deficit is forecasted. At a broader level, knowledge of the overall water use patterns, water availability, and issues of water quality are important to inform debates over the main management objectives in a watershed.

From a policy research perspective, there is a critical need for better information. Without information on water balances and longitudinal information on water use in various sectors, it is difficult to know if water use reduction strategies have the desired effect, or if they are even needed.

5. Uniformity of Approach Neither Necessary Nor Necessarily Desirable

Different sectors face different challenges, as do different users within these sectors. Also, existing property rights and policy regimes vary across Canada. To insist on a one-size-fits-all approach would ignore these real differences. Further, some regions of Canada are more water-rich than others.

From a policy research perspective, it is crucial that regional and sectoral differences be well understood, and considered in policy development.

6. Making Use of All the Social Sciences

Water issues and sustainable development in general are multidisciplinary, relying on both the social and physical sciences. This would be necessary, in a general sense, to bridge the different views on how water should be valued (see description in section 1). This also applies to the analysis of economic instruments.

From a policy research perspective, a better understanding of the role and effect of EIs needs the contribution of all social sciences. This includes a better understanding of all social aspects of water use, including perceptions, attitudes, and beliefs of consumers, industry, and operators. Determining the key factors that drive water use decision making and behaviours is of particular importance for the analysis of economic instruments.

7. Collaboration Between Levels of Government, with Stakeholders and the Public

Water management in Canada is mainly a provincial role, but there are important constitutionally defined federal responsibilities related to water. Public support and some form of public participation appear to be necessary components to designing and implementing water demand strategies – including pricing.

From a policy research perspective, it might be worth examining best practices in public/stakeholder involvement, through ex-post evaluations of experiences, to understand what type of participation works best and at what stage in the planning process. This is crucial in light of the need to generate a better mutual understanding of the different sources of values for water.

In addition, it is necessary to examine more carefully, in practice, how federal departments can support the work done in provinces to establish watershed-based planning and develop water demand management strategies.

8. Planning for the Future

Water is still abundant in most regions of Canada – the crisis is not yet upon most of us. Thus, in many respects, Canadians have time to better plan and evaluate the appropriate role for EIs in water demand management. Such a statement should however be qualified by two considerations: the limited information we have about our water resources, particularly groundwater, and the need to take into account the effect of water demand management strategies on water quality, and vice-versa. That is, water demand strategies could also be beneficial in dealing with pollution in some circumstances.

Seventeen years after the adoption of the 1987 Federal Water Policy, the overriding role given to prices seems optimistic and perhaps premature. More importantly, it seems that the policy underestimated the need to better understand how pricing can be applied, in what context and sectors, and in the most efficient and cost-effective way.

From a policy research perspective, controlled experiments where significant federal involvement is warranted from a jurisdictional perspective, in co-operation with the appropriate provinces, would allow an examination of how EIs, in conjunction with other policy tools, can contribute to achieving the goals of sustainable development. Such experiments could be the starting point for the collaborative application of adaptive management strategies, based on the conscious effort to learn from experience.

Appendix 1: Agenda

Day 1 — Monday, June 14

Introduction

Chair Ian Campbell, *Policy Research Initiative*

Speakers Jean-Pierre Voyer, *Policy Research Initiative*
Stephen McClellan, *Environment Canada*
Donald Tate, *GeoEconomics Associates*

Session 1 Economic Incentives and Water Management in Urban Settings

This session will examine some options utilities have to manage water demand, emphasizing the use of economic instruments, including pricing for peak demand, clients expectations for water quality and the price they would be willing to pay for it. Finally, we explore the feasibility of a more radical demand-side approach, water soft paths.

Chair Bill Jarvis, *Environment Canada*

Speakers Jim Robinson, *University of Waterloo*
Diane Dupont, *Brock University*
David Brooks, *Friends of the Earth*

Discussants Oliver Brandes, *University of Victoria*
Glen Pleasance, *Water Efficiency Coordinator*, *Durham Region*

Session 2 Water Pricing in the Agriculture Sector

Through the analysis of Canadian and international experiences, this session explores the issues involved in determining the "right" price for irrigation to foster efficient water use. Consideration will be given to complex issues such as equity, ecosystem needs, the role of existing institutions and asymmetry in information between water pricing agencies and water users in implementing pricing changes, including setting up water trading mechanisms.

Chair Carl Neggers, *Agriculture and Agri-Food Canada*

Speakers Toby Pike, *South East Kelowna Irrigation District*
Yacov Tsur, *The Hebrew University of Jerusalem*

Discussants Michel Villeneuve, *Environment Canada*
Stephan Barg, *International Institute for Sustainable Development*

Session 2 Part 2

Speakers David Zilberman, *University of California at Berkeley*
Pierre Strosser, *Consultant*

Discussants Chandra A. Madramootoo, *McGill University*
Andrew Cullen, *Agriculture and Agri-Food Canada*

Day 2 — Tuesday, June 15

Session 3 Economic Incentives, Water Demand Management and Industrial Competitiveness

This session first examines how water demand management can lead to cost-savings for utilities through targeted demand management of Wet Industry using a price-modeling tool called Activity Based Costing. More generally, opportunities and barriers for enhanced reliance on economic instruments are identified by taking stock of what is known about the economic characteristics of Canadian industrial water use. Finally, the experience of some European countries will shed light on the impact of abstraction charges on industry competitiveness.

Chair Mark Pearson, *Natural Resources Canada*

Speakers Phil Dick, *Ontario Ministry of Agriculture and Food*
Steven Renzetti, *Brock University*
Stefan Speck, *Consultant*

Discussants Carol Salisbury, *Ontario Ministry of the Environment*
David Sawyer, *Marbek Resource Consultants*

Session 4 Market Forces and the Allocation of Water Resources

After a presentation of Alberta's allocation system based both on a commitment to the "First in Time, First in Right" principle and the introduction of water markets, the session examines the potential in Canada for using economic instruments to improve the allocation of water resources across sectors in the economy, identifying prerequisite policy issues and policy research. The session will also be an opportunity to discuss lessons learned from experiences in Australia and the United States (California and Texas), and in particular the need for an incremental approach to reforms.

Chair David Runnals, *International Institute for Sustainable Development*

Speakers Mike Young, *CSIRO Land and Water, Australia*
Beverly Yee, *Alberta Environment*

Discussants Rob de Loë, *Guelph University*
Nigel Bankes, *University of Calgary*

Lunch Speaker Karen Brown, *Environment Canada*

Session 4 Part 2

Chair David Runnals, *International Institute for Sustainable Development*

Speakers Richard Howitt, *University of California*, *Davis*
David J. Eaton, *University of Texas*, *Austin*
Ted Horbulyk, *University of Calgary*

Discussants Dean Smith, *Agriculture and Agri-Food Canada*
Catrina Tapley, *Human Resources and Skills Development Canada*

Summary Needs for Policy Research in Canada

Speakers Dan Shrubsole, *University of Western Ontario*
Bernard Cantin, *Policy Research Initiative*

Closing Remarks

Appendix 2: Cited Symposium Participants

Brooks, D. B., Friends of the Earth Canada, speaker.

Dick, P., Ontario Ministry of Agriculture and Food, speaker.

Dupont, D., Brock University, speaker.

Eaton, D. University of Texas (Austin), speaker.

Horbulyk T.M., University of Calgary, speaker.

Howitt, R., University of California (Davis), speaker.

Pike, T., South East Kelowna Irrigation District, speaker.

Pleasance, G., Water Efficiency Coordinator (Durham Region), discussant.

Renzetti, S., Brock University, speaker.

Robinson, J.E., University of Waterloo, speaker.

Speck, S. U., consultant, speaker.

Strosser, P., consultant, speaker.

Tsur, Y., The Hebrew University of Jerusalem, speaker.

Yee, B., Alberta Environment, speaker.

Young M., CSIRO Land and Water (Australia), speaker.

Zilberman, D., University of California (Berkeley), speaker.

Appendix 3: Recent Publications from the Sustainable Development Project

Report

Advancing Sustainable Development in Canada

Briefing Notes

Integrated Water Resource Management

Integrated Landscape Management Models for Sustainable Development Policy Making

Exporting Canada's Water I: Outside of NAFTA

Market-Based Instruments for Water Demand Management I: The Use of Pricing and Taxes

Market-Based Instruments for Water Demand Management II: Water Markets

Horizons

(2004, 6:4): Sustainable Development: Where Next?

Coming Soon

A special issue of *Canadian Water Resources Journal* on Economic Instruments for Water Demand Management

Briefing Note: *Federal Commitments to Freshwater: Three Generations of Sustainable Development Strategies*

Briefing Note: *Agricultural Water Pricing: The South East Kelowna Irrigation District Experience*

Briefing Note: *Do Water Abstraction Taxes Affect Competitiveness? A European Perspective*

Recent publications from the Policy Research Initiative's Sustainable Development Project are available by request (questions@prs-srp.gc.ca) or on-line at <www.policyresearch.gc.ca>.

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