VALUATION OF WATER RESOURCES IN THE PRAIRIE PROVINCES: SOME NEEDED RESEARCH AREAS

A REPORT PREPARED

FOR
THE PRAIRIE PROVINCES WATER BOARD
REGINA

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INTRODUCTION

Water is a commodity that, in recent period, has attracted more public scrutiny and debates in Canada and the world than any other natural resource. Appointment of the Inquiry on Federal Water Policy by the federal government, associated with various legislative changes (either already in place or in process) in various Prairie provinces are indicative of its growing national importance. Recent emphasis on the Internal Hydrology Programme (IHP) on water management, appointment of a special secretariat to develop indicators related to water resources development by the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2000), and the higher priority in assisting various countries in water resource-related infrastructural development by the World Bank, are indicative of such a trend internationally. Furthermore, since the development of Systems of National Accounts by the United Nations (1993), and the need for Natural Resource Accounting, as advocated by Ecological Economists, valuation of natural resources has become a topic for discussions, both in public arena and in academic circles.

The members of the Prairie Provinces Water Board (PPWB) have recognized the need for information on value for water in the prairie provinces. This need is perceived for aiding water managers. To this effect, a request for proposal (RFP) was issued by the PPWB. Although some studies on the topic have been conducted in the past, it was felt that there may exist a need for a fresh look at Prairie water resources – use and values. Detailed terms of reference for the study are presented in Annex A. The present report is submitted in partial fulfilment of this RFP.

BACKGROUND

Valuation of natural resources is required in situations where such a resource is facing a situation of natural scarcity – a situation where its demand outpaces its availability, when consequences of economic development activities on natural resources (including environmental) degradation need to be assessed, and/or where some public intervention is warranted either for above reasons or for other reasons. According to Freeman (1993) "...estimates of economic values of environmental and resource services can be a valuable part of the information base supporting resource and environmental decisions". Many of the legislation in the USA related to, for example, the air and water pollution act, development and management of river systems, exploration of natural resources, require knowledge of total social cost of such development. Included in the social

costs are the damages sustained by third parties, which is generally based on some knowledge of value of the resource / ecosystem being affected.

Valuation of natural resources, such as water, is an important aspect of development of the indicators for sustainable development. A conference on this topic was recently organized by the National Round Table on the Environment and the Economy[1]. Within this framework, the Environment Canada, in cooperation with Statistics Canada, has recently initiated a three-year study on "Value of Natural Capital". This project has two major objectives: (1) derive an estimate of the national value of Canada's water resources; and (2) develop a monetary national water resource account that could be integrated in a satellite account for natural resources. (McComb, 2001). This draft valuation framework is a result of a number of discussions and studies. For example, in 2000, the two agencies (Environment Canada and Statistics Canada) contracted for a study for developing a framework for monitoring value of water (see Gardner Pinfold Consulting Economists and GeoEconomics Associates, 2000). This study was summarized by McComb and Greval (2000) at the 2000 Canadian Resource and Environmental Economists Study Group annual conference.

The proposed Environment Canada and Statistics Canada's framework has built upon several previous attempts made for such valuation in Canada. For example, ADI et al. (1996) developed valuation of water for the government of Newfoundland and Labrador. The Saskatchewan Water Corporation (Sask Water) in 1985 commissioned a major and comprehensive study of use and valuation of water resources in Saskatchewan (see Dybvig and Kulshreshtha, 1989). A number of studies for the Prairies have been undertaken since the original Sask Water study, which would be reviewed in a latter section.

NEED FOR VALUATION OF WATER INFORMATION

Water is a commodity associated with a great deal of emotions. Most people recognize it to be a "priceless" element, and therefore, at the same time feel the need for making it available to all citizens. This suggests some type of allocation process to ensure that water is distributed fairly

[1] This Conference was held on March 27, 2001 in Ottawa. The Agenda included a Workshop on Natural Resource Accounts: A Systems View. Mr. Robert Smith of Statistics Canada was the lead speaker on the subject. Progress made towards resource valuation was reviewed. As of this time, no valuation of water and fish resources has been included in the new accounts at the Statistics Canada.

and equitably to all people. However, many groups feel that water is too vital to the society that its allocation cannot be achieved through market mechanisms. Some groups in the society are also afraid of valuation of natural resources and ecosystem functions. Their fear is that if you value something, this might be a prelude to pricing, and may result in some charge for water related services being provided currently. According to them, water should not be used for any monetary gain. Other groups in the society feel that water is too valuable and therefore, it should be protected at all costs. The above range of opinion on the value of water is not unique to Canada; sentiments related to water resources in most parts of the world run high. Regardless of this, the International Conference on Water and Environment in 1992 issued the Dublin Statement, which endorsed the following principle: *Water has an economic value in all its competing uses and should be recognized as an economic good.* In addition, the Conference noted that failure to recognize these values has led, and possibly in the future would lead, to wasteful and environmentally damaging uses of the resource.

In order to improve the process of water resource management, knowledge on many fronts may be considered desirable. These may include, although not necessary limited to, the following:

- How far should one go in developing water resource supplies?
- How far should one go in controlling water use?
- How should one provide water to all in a fair and equitable manner?
- How should water be allocated among its competing uses?
- How can we improve the efficiency of water use?

These question have both a technical aspect as well as a valuation aspect. Knowledge of value of water may be particularly useful for pursuing the following actions:

1. <u>Water Resource Development:</u> Water resource development competes for available (and quite frequently scarce) capital resources. Economic methodology commonly used for selecting worthy projects includes estimation of a number of criteria for the project, including net present value, internal rate of return, and to a limited extent benefit-cost ratio. When public funds are required, which is frequently the case, a project must show positive net benefits (sum of all net benefits from the use of that water, each of which is the surplus over and above costs) to the society. Ranking of various projects is typically done on the basis of the level of these added benefits.

However, estimation of benefits to society requires some knowledge of value of water.

Related to the above is the issue of justifying requests for public funds. Typically these requests are prioritized on the basis of level and distribution of benefits (on a net basis) from competing projects. Since water resource development competes with other economic development measures, proper valuation of the water resources is a must.

2. Estimation of Natural Resource Wealth: Development of satellite accounts for the National Income and Expenditures Accounts requires an inventory of various natural resources, and how their economic values have changed over time. The need for this information has grown since the report of the World Commission on Environment and Development (1987), in which linkages between economic activities and environmental damages were established. This led to, in certain circles of ecological economics, to a thinking for the development of natural resource accounting. This accounting requires a measure of quantity and quality of natural resources in a nation. Monitoring the level of natural wealth changes over time provides a better measure of sustainability than the current measure – gross domestic product, so commonly used. Since water is included among the various natural resources, its valuation is an important piece of information for developing these accounts.

3. Water Resource Management: Valuation of water is also an important ingredient for proper management of water resources. Riven basin planning is a major activity where major management decisions are made. In addition to information on features of water uses, value of water is required to prioritize alternative river basin management decisions for the society. One example of a situation commonly encountered in rive basin management is the conjunctive use of groundwater and surface water resources. In order to find optimal combination, net benefits from using either one of these or a combination of these (conjunctively) need to be ascertained. This requires some valuation of water resources as well.

4. Allocation of Water: Allocation of water among various competing uses is one of the major activity where information on value of water is vital. Such allocation

decisions, either explicitly or implicitly, take into account trade-offs that may exist or created when water is reallocated from one use to the other. If economic development is the goal of public policy makers, allocation of water must be based on contribution made to this objective by each of these uses of water.

5. Development of Economic Instruments: A major instrument for demand management has been the use of economic instruments, such as a charge for water. When a resource is undervalued, it is overused. Canadians pay far less for water than users in USA and in many of the European countries. For example, according to Environment Canada (1992) in 1989, average price for domestic water was $0.36 per 1,000 litres in Canada, as against $0.42 in USA, $0.66 in U.K., $0.86 in France, and $1.33 in Germany. Many of the critics of water pricing fail to recognize the difference between price of water vs. price of water control, transportation and treatment. This distinction is very important, particularly from the point of view of protection of the resource. Although cost of service is an important aspect of developing these charges, water users' willingness-to-pay is an almost equally important, if not more important, aspect of rate making. Willingness-to-pay for a certain good, including water, is related to the benefits received by the water user. This is tantamount to developing information on valuation of water in alternative uses.

6. Environmental Degradation: Economic development activities often result in damages to natural resources, including water resources. The social impacts of these damages need to be measured in order to show the impact on society as well as to formulate compensation levels to those who have been affected by the damage. Both of these require a social valuation of water.

7. Resource Conservation through Improving Economic Efficiency of Water Use: Conservation of resources is, in principle, a highly desirable activity for the society as a whole. Canadians, for example, are one of the high water users. According to Environment Canada (1992), an average Canadian domestic consumer uses 390 litres per day, as against 200 litres a day in U.K., and 150 litres a day in France and Germany. Such conservation in water use in other countries has been accomplished

through various structural and non-structural measures. Ranking of the users where such conservation would have the higher pay-off, requires estimation of the change in the economic welfare of the society – an entity requiring valuation of water.

8. Financing of New Infrastructural Development: Water resource development is a lumpy process and requires a large amount of initial financial resources. On account of existence of public benefits (those accrue to society as a whole rather than to a specific group of water users), such funds have typically been provided by the public sector. However, with more emphasis on cost recovery, financing of water resource projects requires determination of some charge to private beneficiaries. Development of fair and equitable user fees must consider joint production of private and public goods from these projects. Such a determination may involve allocation of total costs using a method, such as the separable cost - remaining benefits method. In order to apply this method, one requires knowledge of both costs of operations and benefits accruing to various users of water. The later requires some valuation of water resources.

9. Land and Natural Habitat Rehabilitation: One of the issues in various mining operations is that once all activities cease, the land must revert back to its original natural use (prior to mining operations). Such stipulations are imbedded in various provincial legislation, which require mining companies to search for rehabilitation / remediation options. For example, such a situation is currently being faced by the Saskatchewan Potash Producers. Potash tailings have been piled over the surface over a period of time. These need to be disposed off using some remedial measure. Selection of an optimum remedial measure requires its evaluation using a benefit-cost framework. One of the natural ecosystems affected by reclamation (or lack of it) include underground and surface water bodies. The impact of the proposed remedial measure(s) on water resources need to be estimated in a quantitative manner. This requires an assessment of damage avoided under various options, thereby involving valuation of water resources.

The above list by no means exhausts all situations where valuation of water is required and / or useful. However, it certainly establishes the need for value of water information, which has wider

applicability than just for establishing water price.

PREVIOUS STUDIES IN CANADA AND PRAIRIE PROVINCES

One of the earlier studies of value of water in North America was conducted for the USA by Young and Gray (1972). All major uses of water were included in this study, and methodology for valuation developed. Major uses here included both direct withdrawal and in-situ uses. These results were updated using secondary data by Gibbons (1986). For Canada, attention on value of water was drawn through the efforts of the Inquiry on Federal Water Policy (See Muller, 1985), and Economic Council of Canada (see Veeman, 1984). Muller (1985) provided a comprehensive valuation of water in Canada, including those in the Prairie provinces for all use-related values. Veeman (1984) addressed the issue somewhat partially, focussing it on the social desirability of irrigation development in western Canada.

One of the earlier attempt for estimating present and future water use by type of use was made under the auspices of the Saskatchewan Drought Studies. No attempt was made here for placing a value on the water uses. By the mid-eighties, a number of studies involving limited valuation of water resources were initiated. One of the comprehensive inquiry on this subject was commissioned by the Saskatchewan Water Corporation during 1986-88. In this study both water use and its value in alternative uses were addressed. Results were presented in a twelve-volume set, with a summary of this study provided in Dybvig and Kulshreshtha (1988). Value of water was assessed using a number of techniques (market based and non-market based) for the following uses: irrigation, mining, manufacturing, electric power generation, water based recreation, and residential (rural and urban communities).

Around the same time, interest in rehabilitation of irrigation infrastructure was renewed, leading to commissioning of several studies for Southern Alberta on various aspects of valuation of irrigation water by the Alberta Irrigation Projects Association (See AIPA, 1984; AIPA, 1993).

A number of other approaches to valuation of water have also been reported. The emphasis is changed from the water use level to all economic and ecological services provided by a natural resource. This approach to valuation has been applied, for example, to value water for the Carberry aquifer of Manitoba (see Kulshreshtha, 1994). Here although the intent was to value the entire ecosystem, on account of poor data availability emphasis was confined to agricultural and residential

water uses. A similar type of valuation of water using an ecosystem context was attempted for the South Saskatchewan River. The concept of Total Economic Value (TEV) was applied. The TEV criterion includes both use related and non-use related values (See Kulshreshtha and Gillies, 1995). Of a somewhat limited in scope, valuation of water resources has also been undertaken by Saskatchewan Water Corporation in connection with the development and financing of infrastructure for irrigation.

Value of water has also been estimated in the context of developing remedial measures for environmental damage. This case study was conducted for Potash Corporation of Saskatchewan in connection with disposal of potash tailing. Value of regional groundwater and surface water resources was a major part of this investigation. Results are reported in McNinch and Kulshreshtha (1994).

During the last decade, although no study has exclusively been devoted to the study of value of water in the Prairies, such information has been included as a part of river basin planning exercises. A number of river basins have been studied, including Assiniboine River (Saskatchewan - Manitoba), Red River Valley, Pembina Valley Water Study, and several others in Alberta. Without having an access to all of these studies, it is difficult to ascertain the nature of water valuation effort in these studies.

CURRENT ISSUES SURROUNDING VALUATION OF WATER IN CANADA AND PRAIRIE PROVINCES

Value of water in alternative uses must start with an identification of who the users are. The concept of use is complicated by the fact that for some uses, water is required and consumed during the process, while for other uses, no actual water is lost. The distinction between water intake and consumption, therefore, is crucial. Further complications are added in the valuation of water for situations where return flow may be present. These complications result from the fact that the quality of the return flow may be inferior, which may lead to damage to the environment and / or reduces the possibility of water use by others users located downstream without incurring additional costs.

Water use and value are interrelated in another sense. For comparing the values across various water uses, unit of estimation must be identical. However, some uses, such as agricultural

water use, information on the actual amount of water being used is limited. Much of the information is based on licenses issues by the water agency. These deficiencies in the information base may reduce the quality of valuation estimates obtained.

As time goes on, more and more water users would compete for the limited amount of water in the prairie provinces. With the probability of global climate change, resulting in increased frequency of droughts and floods in the regions, water managers would face major challenges. A number of issues arise in the context of placing an economic value of water:

1. An average value of water may not be adequate for a given use in all situations. Benefits are location and situation specific. Value of water differs from region to region, as well they change as situation changes (such as occurrence of droughts). How does one develop a meaningful value of water for guiding managerial decisions that change over time?
2. In order to place a value of water, one must first decide value to what? Is it water intake or water depletion? If water depletion is low, why should a water user be credited with its temporary use, except for situations where returned water is of inferior quality. Here the issue gets further complicated since now one must take into account not only the benefits that accrue to the user, but also the damage caused to other downstream users.
3. If values are based on some notion of benefits, it is important to recognize that value based on market price (marginal willingness to pay) would be different from the average willingness to pay. Use of market prices (resulting in marginal values) underestimates the true value of water. Which one of these is more appropriate to apply for various types of decisions?
4. Water can produce a number of benefits to individuals and to the society as a whole. For individuals, improvement of their economic welfare is paramount. However, for society as a whole, water may enhance regional economic development, bring forth economic stability, and enhance economic security of the region. Individual values and value to the society may not be the same. Which one should be estimated for a given water use?
5. A large degree of uncertainty exists in our knowledge of value of water for certain

uses. These, according to Muller (1985) and based on other water value studies, include: hydroelectric power generation, recreation, and municipal water uses. In addition, very few studies have addressed the value of water for wastewater assimilation.

For many regions, and communities in the prairie provinces, water quality issue is not totally separate from the quantity issue. With recent public attention to water quality issue in Eastern Canada (as well as in Northwestern part of Saskatchewan), need for monitoring and evaluation of water quality in various parts of the prairies is clear. However, if quality of water is below what is acceptable to the users, its improvement would be the next best alternative. This would invariably involve adoption of appropriate improvement measures. Selection of these measures requires some knowledge of benefits from water quality improvement. Our knowledge on this count is poor at best.

Another issue in any valuation exercise is whether it should be measured in the context of ecosystem or simply as an economic good either for its final use or as an input in the production process. To make the distinction between the two approaches more clear, let us take the case of a wetland. Such bodies of water perform a variety of functions besides being a source of water for some limited number of uses. How should such water bodies be valued? One approach is to identify various uses of water. But this approach would underestimate the natural ecosystem value. Similarly, large bodies of water, such as lakes, also provide a number of ecosystem services. How should one value such reservoirs in the context of the SNA satellite accounts?

A major water allocation challenge is how to allocate available quantity of water to various users. An approach that is typically followed is one that is based on some average value of water. Residential water use typically claims the top priority under this criteria. However, an alternative way to handle such allocations is based on the economic impacts of reduced water availability on the water users. The resulting value of water would be called marginal change value of water. Such values may guide short-run allocation decisions better.

Value of water resources could also be ascertained through public and private expenditures in developing and managing the resource. Thus, expenditures incurred by various levels of the governments could be used as a proxy of the importance of water for various regions.

The above discussion point out the complexity of issues surrounding valuation of water in

the Prairies (although the issues are not necessarily limited to the region). They also point out to the fact that a comprehensive valuation may not be a single monolithic study, but perhaps a combination of studies, internally consistent with each other. Five such studies are identified in this proposal. In my considered opinion, there may be several others that could be added to this list. The five studies include the following:

Study One, regional water use and value (average and marginal) of water studies for selected river basins (watersheds) of the Prairies;

Study Two, economic valuation of Prairie wetlands using an ecosystem approach;

Study Three, economic valuation of water quality enhancement on the prairies;

Study Four, estimation of in-situ water use value and that of water in large water bodies, and

Study Five, public and private expenditures on water resources in the Prairies.

Each of these studies can be conducted independently, or as an integrated package. For further discussion, each of these is treated as a separate study. Details on each of these are presented below. However, it is advised that further details on methodology and other aspects of the projects would need to be developed before such studies can be commissioned.

STUDY ONE

REGIONAL WATER USE AND VALUE STUDIES FOR SELECTED RIVER BASINS (WATERSHEDS) OF THE PRAIRIES

Objectives and Scope of the Study

The major objective of the study would be to estimate value of water for alternative uses for a region-specific situation. Particular attention would be paid to estimation of value for

hydroelectric power generation, recreation, residential, and for waste assimilation purposes. Furthermore, an attempt will be made to identify both average and marginal value of a selected water use.

The study would be limited to a single river basin, although various parts of the Prairies could be covered through a series of such studies, each specifically tailored to the specific situation of the river basin.

Study Methodology

Methodology to be followed for this study would be an improvement upon various valuation studies conducted under the auspices of the Saskatchewan Water Use and Value studies and subsequent literature. Major water uses to be included are:

I Withdrawal Use

- a) Agricultural water use
- b) Mining water use
- c) Manufacturing water use
- d) Construction and service industry water use
- e) Power generation water use
- f) Domestic water use
- g) Waste assimilation water use

II In-situ water use

- a) Recreation water use
- b) Aesthetics water use
- c) Navigation water use (if any)
- d) Flora and fauna and other in-stream water use.

This study would differ from the previous studies in identifying values from a water user's perspective and that from a society's perspective. In some instances, these value may deviate from each other significantly.

For each water use, method of valuation may be selected from the following list:

1. Revealed willingness-to-pay (Market Price) method, which is based on the valuation of a good in the market place. However, since water is not a market commodity, and

its valuation is not determined by the forces of demand and supply, its applicability is somewhat limited to a situation where water results in a product that is subsequently sold in the market place.

2. Revealed Willingness-to-pay using productivity (of an input) method, which is also called the derived benefits method. It can be used in situations where water is used in the production of commercial goods and services. Value of water is determined from the residual surplus left after all other factors of production have been paid for.
3. Revealed willingness-to-pay using the Hedonic Pricing method. This method is particularly applicable where water provides an environmental amenity such as aesthetics. People's willingness to pay for certain environmental attributes can be measured through differences in their valuation of commercial goods (such as land or houses). These differences could then be used for estimating the value of water.
4. Revealed willingness-to-pay using the Travel Cost Method. This method has been applied to valuation of recreation experience. The underlying premise of this method is that if people are willing to spend a part of their income on a certain enjoyment (such as the obtained through recreational activities), it must be at least worth that much to them. Thus, for recreational experience, time and travel cost to visit a site represent their willingness-to-pay for that experience, equivalent to a measure of price for a typical market based commodity.
5. Imputed willingness-to-pay using damage cost avoided method. This method is applicable in situations where society is affected by a damage and is willing to do something about it. The expenditures for reducing the magnitude of this damage are called averting expenditures. These are then taken as a proxy for value of water. This method is applicable to quality related attributes of water resources, particularly for prioritizing water quality improvement measures..
6. Imputed willingness-to-pay using substitute cost approach. If water could be obtained from two alternative sources, value of water from the present source is equal to the cost savings to the user if water had to be obtained from some other substitute source. An implicit assumption here is that the quality of water from the two sources is identical. If such is not the case, substitution would be imperfect, and

the method would not be applicable. An example of the situation where this method could be used is for the valuation of groundwater vs. surface water, where groundwater may be a close substitute for the surface water or vis-a-versa. Another example of its applicability is for valuing water for power generation where alternative methods for producing power exist, and water input in a given method of power generation may not be the same as in others.

7. Contingent or expressed willingness-to-pay method. This method involves directly asking people for their valuation of the resource, or the service derived from it. This method involves surveys. One of the major strengths of this method is that it can be used for use-related as well as non-use related values of water.

Selection of the appropriate method of estimation would be a major focus of this study.

Study Tasks and Modules

The major activities that are envisaged in undertaking this study include the following:

One, Development of baseline (current) profile of the region including identification of major water users and their estimated level of use within the river basin. This would provide the scope of investigation for the river basin in question.

Two, Conceptual framework for developing total, average, and marginal value of water in alternative uses;

Three, Selection of an appropriate method of estimation for a given water use for the selected region;

Four, Collection of data for estimation and estimation of value of water in competing uses; and,

Five, Estimation of marginal value of water and trade-off frontiers for alternative uses..

Further details on the study methodology would need to be developed at a later date. Furthermore, if non-use related values of water are required for this type of study, undertaking a survey would be a must.

Project Time Lines

It is expected that determination of value of water for a river basin would require 12-person

months plus additional resources for surveys, if primary data are to be collected. This cost could be reduced somewhat if valuation study were to be a part of a river basin management plan, since some of the data and information would have to be collected for other purposes.

Project Budget

Estimation of a the project budget would be greatly facilitated in light of the two factors: One, selection of the river basin; and Two, whether valuation would be a apart of an overall water management plan for the river basin. However, it is estimated that without any surveys, the cost of valuation of water may run in the magnitude of $60,000 to $65,000 per river basin, with $62,700 being the average cost. These costs are broken down as follows:

Senior Consultant	2 months @$8,000/month	$16,000
Junior Consultant	10 months @$3,500/month	$35,000
Materials and Supplies		$ 2,500
Travel (Non-survey)		$ 3,500
Overhead 10% of above		$ 5,700
Total Cost		$62,700

A survey, depending upon the its nature (mail, telephone, or personal interview), scope and sample size, could cost between $10,000 to $25,000 per river basin.

It must also be noted that the cost of a study of value of water would be higher for the first river basin; however, as the same (or similar) methodology is replicated to other river basins, the cost per river basin may decrease.

STUDY TWO

ECONOMIC VALUATION OF PRAIRIE WETLANDS USING AN ECOSYSTEM APPROACH

Objectives of the Study

Wetlands are an important natural ecosystem on the prairies. They provide a variety of natural and economic services to the society. Some of these are either directly or indirectly related to water resources. The major objective of this study is to value the wetland natural ecosystems using a ecosystem theory / context.

The scope of this investigation would be limited to a regional wetland. To reduce cost of the study, it would be preferable to select it for the same region as the river basin selected for Study One.

Study Methodology

The study would apply the concept of Total Economic Value (TEV) to the natural ecosystem. The TEV is a sum of use-related and non-use related values, as shown in Figure 1.

Each of the two sets of values can be further sub-divided into sub-groups. Use-related values include direct use values and indirect use values. In addition, society may reserve the right to have an option to use the resource at some future date, resulting in option values. Direct use values are generated by economic activities (commercial and non-commercial) associated with the ecosystem, Production of commercial goods would dominate the list, although many non-market goods may also be equally important. Indirect use-related values are generated though social / cultural and environmental systems. Ecological services, such as hydrology, water purification service, genetic reserves, and biodiversity, are some typical examples of these services.

Total non-use related values are a sum of two values: existence values (which arise from the knowledge that the resource people value does exist), and bequest values (which are a result of the satisfaction one drives from leaving the ecosystem to the future generations).

Study Tasks and Modules

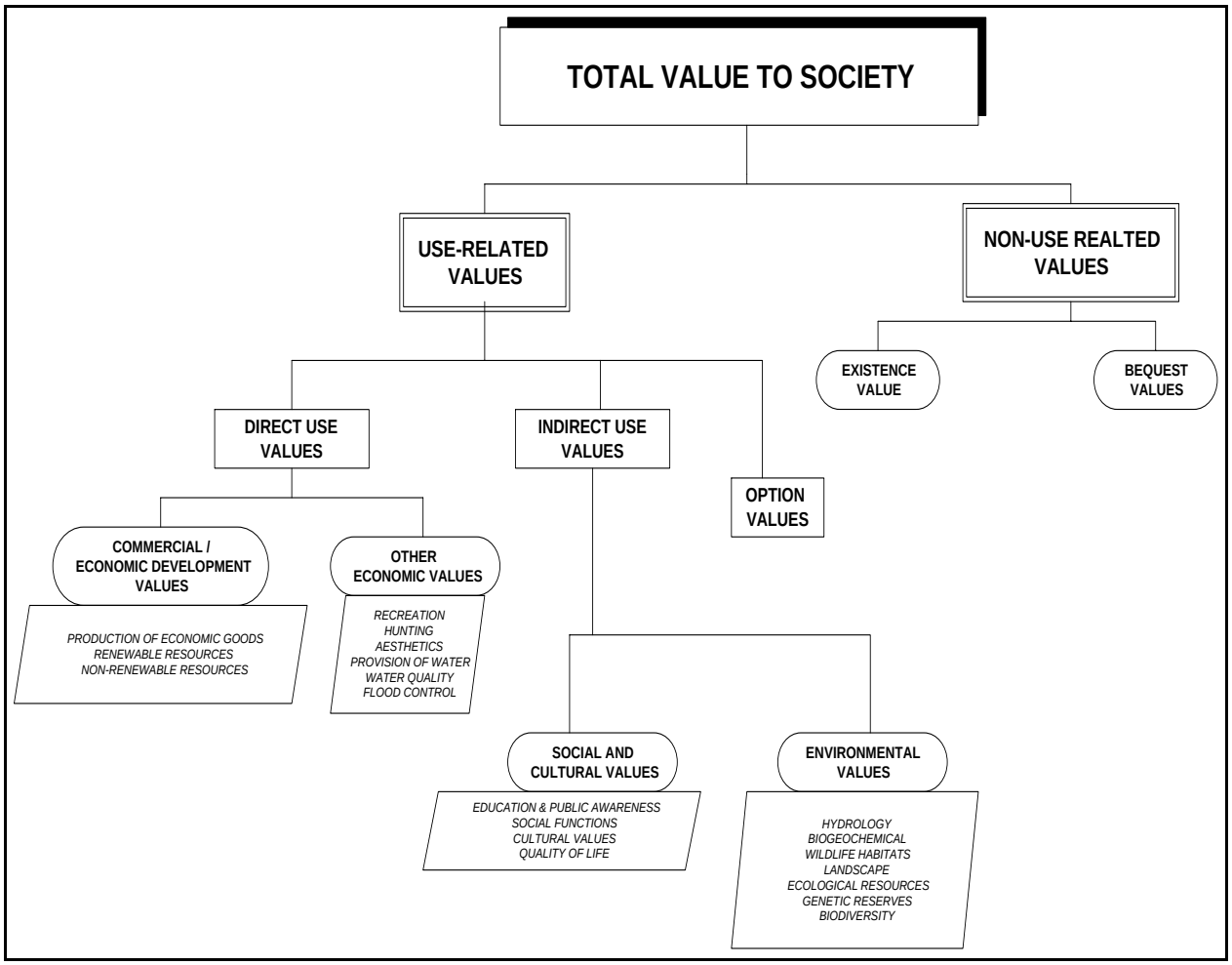

Figure 1. Valuation of Wetlands Benefits

This study would require an interdisciplinary team of natural scientists, biologists, and social scientists. The approach to the valuation would involve bio-economic modelling, particularly for waterfowl and other wildlife habitats. Primary data collection would be a virtual necessity. Major study tasks can be grouped under the following seven modules:

One, Development of baseline data and information about the wetland ecosystem, including land use;

Two, Identification of wetland function of relevance to various members of the society. This task would first require a decision on the accounting stance to be taken for the evaluation of the ecosystem;

Three, Estimation of commercial activities-related value of wetlands. This would require assessment of nature of commercial goods produced, their respective physical

quantities, and valuation using market price method;

Four, Estimation of non-commercial values of wetland functions. Included in this task would be the biological relationship between waterfowl / wildlife population and related recreational (consumptive and non-consumptive) activities associated with them.

Five, Determination of social and cultural use of wetlands;

Six, Estimation of hydrological relationships and effect on water quantity and quality;

Seven, Assessment of value of wetlands for other ecological services.

Project Time Lines

This project would require a multi-disciplinary team, consisting of wetland biologists, hydrologist, and an economist. Minimum time required for completing a single wetland system would be in the range of 18 person months. Depending upon data available from secondary sources, some of the time commitment could be reduced. Minimum time required to complete this study would be a 12-month period.

Project Budget

The project cost is estimated to be in the neighbourhood of $126,500. Detailed breakdown of this cost is as follows:

Senior economist	2 months @$8,000/month	$16,000
Junior economist	12 months @$3,500/month	$42,000
Wetland Biologist	2 months @$8,000/month	$16,000
Hydrologist	2 months @$8,000/month	$16,000
Other natural scientists		$10,000
Data collection		$10,000
Materials and supplies		$ 5,000
Overhead 10% of above cost		$11,500
Total Cost		$126,500

STUDY THREE

ECONOMIC VALUATION OF WATER QUALITY ENHANCEMENT ON THE PRAIRIES

Objectives of the Study

For water resources management, issues related to water quality and water quantity are intimately related to each other. During periods of water shortages, water quality deteriorates faster, and becomes an even more important issue. Water quality is very important both for human and livestock consumption. The problem becomes more acute if water quality remains poor over an extended period of time.

During periods of lower water quality, alternatives have to be found for improving the state of water resources. Adoption of these alternatives requires some knowledge of benefits of water quality improvements. The major objective of this study is to determine the economic value of water quality improvements in a selected river basin of the Prairie provinces.

Study Methodology

Benefits from water quality improvements can be identified in to the following four groups:

One, Health improvement impacts on human health;

Two, Productivity changes and other economic impacts resulting from improved water quality;

Three, Impact of poor water quality on the incidence of disease for livestock, by type of livestock;

Four, Reduced expenditures on water quality enhancement measures either on an on-going basis or during period of poor water quality.

The study would determine the value of water quality improvements using a combination of expressed willingness-to-pay (contingent valuation method) as well as avoided cost and market price methods.

Study Tasks and Modules

On account of the interactions between physical, health and economic variables, this project would need an interdisciplinary team of experts. Needed skills include: economics, health sciences (epidemiology), animal science, and water quality (including hydrological aspects) expertise. This study would undertake valuation of water from human as well as from livestock production point of view. Various sources of water used for human consumption and for stock watering use would be included. Development of study tasks should ideally await formation of this team. However, as a start, the following list of tasks is proposed:

One, Assessment of water quality in a given region (river basin). This would include first identification of water quality criteria, and then their assessment to determine the existing quality of water being used for livestock and humans;

Two, Identification of factors affecting changes in physical and chemical indicators of water quality both for stock watering and human consumption. Included here would be estimation of impacts of these changes on human and livestock health;

Three, Identification of factors affecting changes in the biological indicators of water quality. This investigation would be similar to the one listed above;

Four, Effect of water quality on human (residential) water use in terms of health and productivity;

Five, Effect of water quality on recreation and aesthetics;

Six, Effect on other commercial activities, (such as fisheries, forestry, agriculture), if any;

Seven, Effect of water quality on livestock production and profitability;

Eight, Identification of water quality improvement measures;

Nine, Benefits from water quality improvement measures;

Ten, Prioritization of water quality improvement measure for human and livestock production.

Project Time Lines

This project is expected to be completed over a two-year period. The length would be substantially reduced if some of the water quality monitoring and health and recreational related changes have been monitored. The project is expected to require 33 person-month of experts in

various areas.

Project Budget

The cost of the project is estimated to be $213,400, with the following distribution:

Senior economist	4 months @$8,000/month	$32,000
Junior economist	20 months @$3,500/month	$70,000
Water Quality Exp.	6 months @$8,000/month	$48,000
Health Scientist	3 months @$8,000/month	$24,000
Travel and Meetings		$10,000
Materials and supplies		$10,000
Overhead 10% of above cost		$19,400
Total Cost		$213,400

STUDY FOUR

ESTIMATION OF VALUE OF IN-SITU WATER USE AND LARGE SURFACE WATER BODIES

Objectives of the Study

Development of satellite accounts for water should not only include quantity and value of water use on a recurring basis, but also value of water bodies, which serve as a major reservoir for future water use. In addition, these bodies of water serve many other needs of the society, and bring benefits either directly or indirectly. Value of a water body can be more appropriately established through the use of the Total Economic Value criterion using an ecosystems functional / systems approach. In some sense, this would be similar to the wetland valuation, except that the economic and non-economic activities to be values would be somewhat different. .

The major objective of this study is to develop a procedure for valuation of large bodies of water in the Prairie Provinces. Three major components of the total value would include: Use related values, Non-use related values, and value of in-situ water use for natural ecosystems services. In addition the study would also examine the appropriateness of the Rent Method of valuation for such water bodies, as proposed under the Draft Valuation Framework of Environment Canada and Statistics Canada (See McComb, 2001).

Study Methodology

Methodology for this study would follow closely the development of TEV criterion for Study Two. Total value would be a sum of the following seven values:

1 Commercial goods production (agriculture, fisheries, mining, municipal) related value of water;

2 Generation of other economic goods (recreation, hunting, aesthetics, flood control) related value of water;

3 Quality of life impacts through enhancement of social and cultural values;

4 Ecosystem services related water use values;

5 Option values

6 Existence values related to the water body, and,

7 Bequest values related to the water body.

Methodology for the estimation of each of these values would be selected from the list provided under Study One, plus from those followed in Study Two. Thus, if Studies One and Two are already completed, this would facilitate the present study to be finished within a reasonable amount of time and resources. If however, such is not possible, new resources would be needed to undertake such activities.

Study Tasks and Modules

Determination of tasks and modules would be very similar to the list of seven groups of values indicated above.

Project Time Lines

In all likelihood, this is a project of a comparable complexity to Study Two, and therefore, would require a similar amount of resources. However, if Study One and Two are already completed, the time required to finish it could be cut into two-thirds. The precondition to this is that these projects are in the same river basin, and / or method of benefit transfer can be applied.

Project Budget

Budget for this project is prepared under two sets of assumptions.

Under assumption one: it is stipulated that no other information (other than secondary data) have been collected.

Under assumption two, a study on lines proposed under Study One and Study Two have been undertaken for the study region.

Assumption One:

Senior economist	2.0 months @$8,000/month	$16,000

Junior economist	12 months @$3,500/month	$42,000
Wetland Biologist	2 months @$8,000/month	$16,000
Hydrologist	2 months @$8,000/month	$16,000
Other natural scientists		$10,000
Data collection		$10,000
Materials and supplies		$ 5,000
Overhead 10% of above cost		$11,500
Total Cost		$126,500

Assumption Two:

Senior economist	2.0 months @$8,000/month	$16,000
Junior economist	8 months @$3,500/month	$28,000
Other Experts		$10,000
Data collection and Meetings		$10,000
Materials and supplies		$ 5,000
Overhead 10% of above cost		$ 6,900
Total Cost		$ 75,900

STUDY FIVE

ESTIMATION OF PUBLIC AND PRIVATE EXPENDITURES RELATED TO WATER RESOURCES IN THE PRAIRIES

Objectives of the Study

An alternative measure of value of water in a region is the society's willingness to pay for water resource development, regulation, and management. This measure is reflected in the public expenditures that are incurred on water resource projects. The primary objective of this study is two-folds: One, to estimate the public sector expenditures in the three prairie provinces on (1) water resources conservation and development, (2) water transport (if any), (3) water purification and supply, (4) pollution control, and (5) sewage collection and disposal. Two, contributions made by water resources to regional value-added and employment. These contributions would be direct contributions, and would not include any secondary impacts.

Study Methodology

This study would be based on secondary data available from Statistics Canada, Environment Canada, various provincial departments and / or crown agencies responsible for water management, plus Departments of Municipal Affairs in various provinces. In addition, expenditures by quasi-public agencies or non-governmental organizations, such as Ducks Unlimited, Wetland Conservation Corporations (or similar agencies) and other NGOs would also be included. Objective one of the study would simply be a compilation of data for the five types of water related programs. To remove lumpiness, information would be collected over a five year period. These expenditures would be contrasted against the revenues collected to show the amount of net expenditures from public sector. This would lead to a data base on the charges being levied by various agencies for water and wastewater related services. The second objective would involve estimation of water intake and consumption of various economic sectors using secondary data on water use (intake and consumption) coefficients. These coefficients would be obtained from secondary sources. Results would be expressed in terms of contribution to gross domestic product and employment of various industries in the Prairie provinces per unit of water intake and / or consumption.

Study Tasks and Modules

Major tasks envisaged for this study include the following:

1 Collection of public expenditures for water resources for federal government;

2 Collection of public expenditures for provincial governments and Crown agencies;

3 Collection of public expenditures for municipal governments;

4. Collection of data from NGOs;

5 Compilation of data by program category;

6 Collection of data on gross domestic product and employment by industries in the three Prairie provinces;

7 Obtaining water use and water consumption coefficients from a review of literature;

8 Compilation of contribution of water to regional gross domestic product and employment.

Project Time Lines

Estimated time for completion is estimated to be 6 months. However, since much of the data to be obtained are from various agencies, actual time may be subject to cooperation received from these agencies.

Project Budget

Senior economist	1.0 months @$8,000/month	$ 8,000
Junior economist	5 months @$3,500/month	$17,500
Data collection (incl. Data from Statistics Canada)		$ 5,000
Materials and supplies		$ 1,000
Overhead 10% of above cost		$ 3,150
Total Cost		$ 34,650

CONTACTS MADE

During the course of putting this proposal, several agencies and individuals were contacted. The list includes the following agencies and individuals contacted:

Federal Government:

•	PFRA Head office, Regina,	Mr. Bernie Ward
		Mr. Marc Bonneau
	North. Sask. Office	Mr. Darrell Corkal

Province of Alberta

•	Alberta Environment	Mr. Sal Figliuzzi

Province of Saskatchewan

•	Sask Water	Mr. Greg Argue

Province of Manitoba

•	Manitoba Conservation	Mr. John Towle
		Mr. Rick Bowering

International Institute for Sustainable Development

- Mr. Allan Tyrchnewicz, Executive Director

Academic Institutions

•	Brock University	Prof. Steven Renzetti
		Prof. Diane Dupont
•	University of Saskatchewan	Prof. Dirk de Boer

Response of these agencies /individuals has been very positive towards a water valuation study. These discussions are summarized in the following table.

Agency	Interest in Water Valuation Research	On-going Activity in Water Valuation	Funding Possibilities	Joint Research Initiative	In-Kind Contribution Possible
PFRA	X	Note 1	Yes	?	X
Alta. Environment	X	--	?	--	--
Sask Water	X	--	Yes	--	--
Manitoba Conservation	X	--	?	--	X
IISD	X	Note 2	--	?	X
Univ. of Saskatchewan	X	Note 3	Note 5	?	X
Brock University	X	--	--	--	X
Environment Canada	X	Note 4	Note 6	--	–

Note 1: PFRA is currently conducting some studies related to water quality.
Note 2: IISD has an active interest in developing a project in sustainable water use in Manitoba.
Note 3: The University of Saskatchewan was a part of the application to the Tri-Councils for a National Centre of Excellence in Water Resources. Since then the announcement for the Centre of Excellence has been made and the University proposal is not a part of the successful bid.
Note 4: Environment Canada has recently issued a draft valuation framework for valuation of the value of water.
Note 5: Further to Note 3, no funding under the NCE initiative is received by the University of Saskatchewan group initiating valuation of water. Therefore, no joint activity can be envisaged at this time.
Note 6: Funding availability under the current valuation project of Environment Canada is not clear. It is assumed here that some possibilities may exist.

POSSIBILITY FOR A JOINT RESEARCH INITIATIVE

To undertake a comprehensive study of valuation of water resources in the Prairie provinces could become a mammoth task. Some type of a joint funding initiative or even some assistance through in-kind contributions could be welcome. The following observations were made during the course of discussions with various agencies and / or individuals.

1 Professor Diane Dupont is keenly interested in the study. Although benefits of water

quality improvements could be on the top of this list, her interest lies in all the topics listed in this proposal.

2 Professor Steven Renzetti has an interest in the valuation of water resources. He is also one of the applicant for the Tri-Council proposal on the National Centre of Excellence for water in Canada. However, his role in any new study may be limited to an advisory one.

3 Professor Dirk De Boer is very interested in the valuation of water in the context of river basin management. However, funding for this type of research is essential.

4 PFRA has undertaken some studies related to water quality in the prairies. In addition, the recently completed PFRA project on Land Area Networks may also have a potential for water resource valuation.

5 There is a great deal of interest in the Saskatchewan Water Corporation for the work of this type. Some possibilities for funding research projects may exist, but needs further exploration once a topic of study (or studies) is finalized..

6 Manitoba Conservation has undertaken several river basin planning and management studies. Some more are planned for the future. Some valuation activities could be undertaken under the auspices of these studies.

7 Alberta has not undertaken any recent studies on value of water and none are planned for the near future. However, relevance of such a study is not questioned.

8 There is a considerable interest at the IISD for conducting some water valuation work, in the context water management, particularly sustainable water resource management.

RECOMMENDATION

Although the original expectation while commissioning this study may have been the development of a firm proposal that the Prairie Provinces Water Board directors could review and consider for funding, this report has not been able to accomplish it. This report marks just the first step towards the development of this proposal. In order to reach to this final stage, the following steps are suggested:

One, That the PPWB Directors discuss the relevance and appropriateness of the five

proposed studies as outlined in this Report;

Two, Once a shorter list of studies is generated, the Consultant attempts to identify the possibility for joint funding or assistance in kind from various agencies;

Three, a detailed proposal is developed for a project that received the highest success in terms of PPWB interest, development of partnership with non-PPWB agencies, availability of funding from partnership(s) and / or in-kind contributions.

Completion of these steps would mark a formal completion of the terms of reference as proposed in the RFP.

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ANNEX A

STATEMENT OF WORK

The Prairie Provinces Water Board (PPWB) members have recognized that with increasing demands being placed on our limited water supplies, it would be helpful to water managers to have a better understanding of the water values that exist for different uses of that commodity. The purpose of this contract is to provide the PPWB a study proposal for estimating the value of water in its alternative uses in the Prairie Provinces.

1 Identify and review what studies have been completed or are being proposed in the prairies that could be used to help provide estimates of the value of water.

2 Contact Greg McComb of Environment Canada (Ottawa), Steven Renzetti of Brock University, Allen Tyrchnewicz of the International Institute for Sustainable Development (Winnipeg), and other people who may become known during the undertaking of this contract, to determine if there is an interest to jointly participate in a value of water study. Any interest in other organizations to participate in a study through contribution of funds or in-kind resources should be identified and built into the proposal.

3 Prepare a proposal for undertaking a value of water study for alternative uses in the prairies. The proposal should:

- Be based on accepted defensible methodologies.
- Utilize methodologies that require secondary information. If primary data collection is required, the basis for needing such data should be clearly justified. Limitations of the recommended methodologies (e.g. the use of secondary data) should also be stated.
- Separate the major water use categories for which value estimates would be estimated into withdrawal and in-situ uses.
- Provide an indication of how the value of water estimates can be used by provincial/federal agencies along with the limitations of those data.
- Provide some examples of estimates of the value of water that have been found in other studies.
- Recommend a study team to undertake the study.
- Provide a cost and time frame for undertaking the study.

Two copies of the study proposal will be provided.