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Lake Winnipeg Management Options:
Lake science and lessons from international best practice

Working Paper

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Introduction to the Study

This report documents the first part of a multi-year research agreement between the International Institute for Sustainable Development (IISD) and Environment Canada. The goal of this ongoing research is the effective governance and management of the Lake Winnipeg watershed. The objectives of this research project are to identify effective nutrient management tools and institutional capacity for this purpose.

Towards this goal, our first year's research began with a background study on integrated water resources management (IWRM) and its principles as an appropriate framework. IWRM has been identified as an appropriate model for water management at the federal and provincial levels of Canadian government. This report then introduces the context of Lake Winnipeg, with some emphasis on its nutrient loads and resulting eutrophication. A synthesis of existing lake data includes point and non-point sources of nutrients and some priority issues surrounding the lake.

An international best practice component in the context of IWRM helps to identify lessons for effective watershed management. These lessons are synthesized according to their applicability to the Lake Winnipeg watershed. Finally, instruments for nutrient management that might be useful in managing nutrient loads in the lake are discussed. A synthesis of instruments, including regulatory, economic and social instruments for nutrient management, is provided in the study. These instruments are indicative of the range of tools available for effective lake management, but do not comprise an exhaustive research of all available mechanisms.

Future research within the work-plan agreement will aim at identifying institutional capacity for nutrient management in the Lake Winnipeg watershed. Appropriate institutional capacity will eventually be matched with the appropriate instruments for most effective lake management. This will potentially lead to solutions incorporating IWRM principles, existing capacity and the use of innovative market-based instruments for nutrient management in the Lake Winnipeg watershed.

1. Water Resources Management

The Canadian Prairies agro-ecosystem is the source of well over half of the Canadian agricultural production, but is constantly afflicted by hydrologic extremes of floods and droughts, resulting in high social and economic costs. IISD has conducted research and commented on the threats to prairie ecosystems and water resources. IISD's Prairie Water Policy Symposium in September 2005 explored the policy implications of the cumulative biophysical stresses on, and the fragmented governance of, prairie water resources. The National Symposium on Ecological Goods and Services (EGS) in Agriculture in Winnipeg (February, 2006) similarly observed that EGS strategies cannot be developed in isolation of water management principles and policy objectives. In a recent article appearing in the prestigious *Proceedings of the National Academy of Science*, David Schindler and his colleague W. F. Donahue (2006), confirmed IISD's observations, arguing that the cumulative effects of climate change, drought and human activity on the prairies force an urgent need for catchment-scale planning for managing and conserving fresh waters. The capacity for doing so, however, is seriously constrained.

The Lake Winnipeg watershed demonstrates all the characteristic vulnerabilities of drylands agriculture to water mismanagement, climate change, and nutrient pollution—described by the Millennium Ecosystem Assessment (2003) as an "outstanding global environmental problem." The issues manifest as inter-sectoral competition for water resources (for example between agriculture and petroleum in Alberta), and complex transboundary nutrient management challenges such as the Devils Lake outlet controversy and Lake Winnipeg eutrophication.

Integrated Water Resources Management provides an integrated land and water resource management framework. The *logic* of IWRM is almost universally accepted—which stands in sharp contrast, however, to the generally weak institutional and financial capacity for IWRM implementation. Canadian and international IWRM success stories often describe watershed management institutions imbued with convening power, multi-stakeholder participation, skilled facilitation, technologically sophisticated use of decision support systems, iterative decision-making, monitoring and adaptive management, and above all stable and adequate financial resources (Heathcote, 1998; Leach and Pelkey, 2001).

As reviewed by the IISD for the Prairie Water Policy Symposium research, the provincial governments in the Prairies embrace the logic of lWRM delivered through local watershed management authorities. However, the requisite long-term financing commitments are less certain.[1] For example, the Government of Manitoba's water strategy revolves around watershed-based conservation districts assuming responsibility for IWRM. However, the resources to actually affect this policy are always constrained. Schindler and Donahue (2006) describe water resources management on the prairies as reactionary, and derived piecemeal by government agencies with little coordination—exactly the inchoate process that IWRM is designed (but seldom adequately resourced) to avoid. In the 2006–07 Manitoba provincial budget, for example, the overall level for IWRM funding was small and static compared to that for conventional water management through rural municipalities. Meanwhile, the budget for drainage works (largely a crisis response measure to recent flooding) was doubled.[2]

In spite of their low priority in government budgeting, healthy watersheds, however, are increasingly recognized as providing real economic benefits that could be harnessed for building local IWRM capacity. For example, in the 1990s New York City negotiated agreements with landowners and municipalities in the Catskill-Delaware watershed, the source of the city's drinking water, to protect the recharge area from environmentally disruptive development. New York thus avoided the need for a massive investment in a new water treatment plant and is saving on the order of a billion dollars (Postel and Thompson, 2005). Harnessing ecological goods and services (EGS) payments for building and sustaining local IWRM capacity could be a mutually reinforcing "virtuous cycle" but poses numerous implementation challenges.

Furthermore, watershed protection initiatives such as the New York example, benefiting and paid for by cities, creates very important communication and outreach opportunities for engaging urbanites in the fundamental economic logic of rural environmental stewardship. This rural-urban outreach is highlighted in a few case summaries in the following section.

At the regional scale, issues like the eutrophication of Lake Winnipeg at the tail-end of the vast watershed encompassing 90 per cent of the agricultural land on the Prairies, also reflect the urgency of regional coordination across provinces and among federal agencies. The federal regulatory role is constitutionally defined and limited to water allocations at provincial boundaries and to the provisions of the Fisheries Act. The potential federal role—in emergent areas like payments for EGS that could serve both water conservation and water quality objectives, and allow the federal government to play an important coordinating role—is still weakly understood and articulated, but a strong new policy direction in Canada.

1.1 Integrated Water Resources Management

While there is no single accepted definition of Integrated Water Resources Management (IWRM), the Food and Agriculture Organization of the United Nations reinforces the understanding of 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."[3] Practitioners agree that this requires a highly consultative process, engaging the watershed communities as well as stakeholders.

[1] Background papers and synthesis available at www.iisd.org/pdf/2005/pwps_water_strategies.pdf

[2] www.amm.mb.ca/bulletins/2006/March%2029.pdf

[3] IWRM definition in http://www.fao.org/ag/wfe2005/glossary_en.htm

1.1.1 Dublin Principles

Integrated water resources management is generally presented based on the Dublin Principles,[4] adopted by an international conference in Dublin in 1992:

- Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.
- Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
- Women play a central part in the provision, management and safeguarding of water.
- Water has an economic value in all its competing uses and should be recognized as an economic good.

While these principles are intended to apply globally, the principle attributing women with the central responsibility in the management of water may not be as applicable in the context of North America as it would be in rural contexts in developing countries.

According to a World Bank Study on lake management, the principles of integrated river basin management include "devolution of responsibility to the lowest applicable level, coordination across sectors affecting lakes, and involvement of all relevant stakeholders." Figure 1.1 shows the World Bank's representation of how water resources management requires coordination across all relevant stakeholders. The Policy Research Initiative in Canada, in its Briefing Note on Integrated Water Resource Management (2004), comments that, "IWRM integrates land use and water management at a watershed level, to optimize economic, social and environmental outcomes simultaneously."

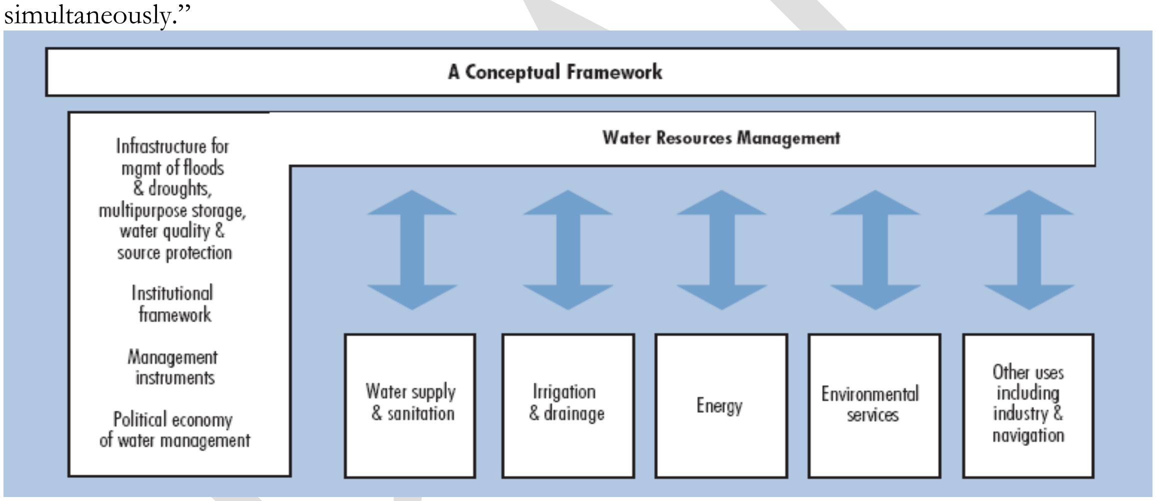


Figure 1.1: Conceptual framework showing the relationship between water resources and sectoral use of water (World Bank, 2005)

1.1.2 IWRM in Canada

Canada's contributions to the Millennium Development Goals (MDGs) and the World Summit on Sustainable Development (WSSD) water and sanitation targets use IWRM as an overarching approach to water issues. Water management in Canada is shared between the federal and provincial or territorial governments, with the provinces, territories and municipalities as the primary managers of water. Transboundary water management is a key issue within an IWRM context. Canada has long-standing experience with transboundary water issues: domestically, bilaterally with the United States, and abroad through its Official Development Assistance Program.

[4] World Meteorological Organization. The Dublin Statement on Water and Sustainable Development. *Available at* http://www.wmo.ch/web/homs/documents/english/icwedece.html (accessed 15 November, 2006)

In late 2004, Environment Canada initiated collaborative work with provincial and territorial water managers, and other federal departments, to prepare a report on Canada's progress on IWRM and water efficiency at home and abroad. Key examples of water management related to science, information, governance, and instruments and tools are described, including case summaries of several on-the-ground initiatives. The report identifies shared principles for IWRM, shows how sustainable water use and management contribute to Canada's social, economic and ecological health, and provides clear signs that Canadian jurisdictions are promoting IWRM as a central water management strategy (Temple, 2006). Challenges and opportunities for IWRM implementation are also discussed. The report, to be released soon, is expected to be available on the Environment Canada website at: www.ec.gc.ca/water/e_main.html.

1.2 Millennium Ecosystem Assessment: Policy insights

The Millennium Ecosystem Assessment (MA), a United Nations initiative that assessed the consequences of ecosystem change for human well-being, the scientific basis for conservation action and the sustainable use of those systems through the involvement of over 1300 experts worldwide, had two critical policy insights for the water sector. First, the MA states that a future scenario consistent with improved provision of EGS is one in which, "regional watershed-scale ecosystems are the focus of political and economic activity" (Millennium Ecosystem Assessment, 2003). Local institutions are strengthened and local ecosystem management strategies are common; societies develop a strongly proactive approach to the management of ecosystems consistent with principles of Integrated Water Resource Management.

The second major insight of the MA is the need for increased use of market-based instruments based on ecological goods and services that mitigate or reverse serious ecosystem degradation, such as:

- Payments to landowners in return for managing their lands in ways that protect ecosystem services, such as water quality and carbon storage, that are of value to society
- Market mechanisms to reduce nutrient releases and carbon emissions in the most cost-effective way.[5]

The MA says that payments for water conservation can increase water availability but cautions that payments for watershed-based services that have been narrowly focused on the role of forests in the hydrological regime, should be developed in the context of the entire flow regime, including land cover, land use and management practices. The recommendations stress that the value placed on watershed services would depend on stakeholder confidence in the effectiveness of proposed management of actions for ensuring that the service continues to be delivered.

Water policy on the Canadian Prairies is currently a complex mix of municipal, provincial and federal strategies and procedures with often confused jurisdiction over water resource decision-making. Nonetheless watershed-based IWRM and payments for EGS are clear but *independent* policy directions on the Canadian Prairies, which, if integrated, could greatly clarify water resource management by creating better local management capacity.

While the case has been made for the coupling of PES mechanisms for effective IWRM implementation, there are numerous other instruments available for the IWRM policy-makers' toolbox. Section six of this paper highlights the role and potential of market-based instruments such as payments for ecosystem services, but also explores the potential of other market-based instruments, regulatory instruments and instruments for social change as well. Offset banking approaches to nutrient management are becoming increasingly popular in other parts of the world, as are regulations for nutrient management including those to deal with phosphates in detergents and dish-washer soaps. Behaviour change in watershed communities is fundamental to its nutrient management and is discussed through instruments including education and conflict resolution in the context of watershed management.

[5] www.millenniumassessment.org//proxy/document.429.aspx

2. Lake Winnipeg Management

2.1 The state of Lake Winnipeg

Lake Winnipeg is a large lake in central Manitoba, with an approximate area of 24,400 km². It is the fifth largest freshwater lake in Canada, the tenth largest freshwater lake in the world and is part of North America's second largest drainage basin—the Nelson River Basin. One of its remarkable features is its large watershed; it has a 40:1 watershed area-to-lake surface area ratio, one of the largest in the world. The watershed covers parts of Alberta, Saskatchewan, Manitoba, Northwestern Ontario, Minnesota, as well as North Dakota and South Dakota.

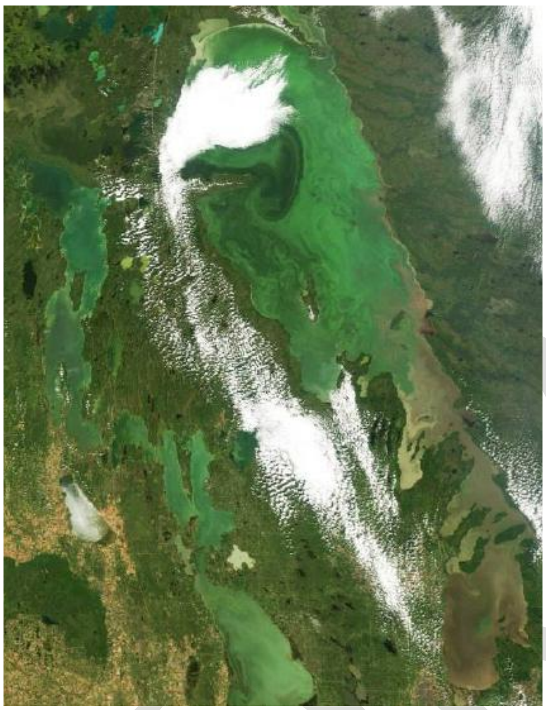


Figure 2.1: Algal Blooms in Lake Winnipeg. LWSB. 2006

Water flowing into and through Lake Winnipeg serves over an estimated six million people, passes through 55 million hectares of agricultural land and supports 17 million livestock. Over 23,000 Manitobans live along the shores of Lake Winnipeg and take advantage of its recreational opportunities. In addition, Lake Winnipeg supports the largest commercial freshwater fishery in Western Canada estimated to return more than CDN$20 million per year (LWIC, 2005). It is a source of livelihood for the local aboriginal peoples, and a source of hydroelectric power for the region and for export.

Lake Winnipeg has been facing increased frequency and severity of algal blooms in the last few years, indicative of its eutrophic state. Eutrophication is the process by which a body of water becomes enriched in dissolved nutrients (as phosphates) that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.

Primary sources of nutrients that contribute to eutrophication comprise human and animal sewage, chemical fertilizers, detergents with phosphates and those occurring through natural watershed processes. Eutrophication in the Lake Winnipeg is attributed to higher nutrient levels from increases in human population in its watershed, a lack of tertiary sewage treatment, intensive cropping and increased use of fertilizers and increased cattle and hog production.

The increased levels of eutrophication in the lake has led to reduced recreational appeal, degraded aquatic habitat, drinking water problems with taste and odour issues, clogged fishing nets and toxic algae (Armstrong, 2006). These increased levels of nutrient loads and algal blooms have led to research on change in nitrogen and phosphorus loads over time, the amount of nitrogen and phosphorus in rivers and streams that drain into Lake Winnipeg, and the sources of nitrogen and phosphorus for the Lake Winnipeg basin. The next sections of this paper will attempt to address these questions in a systematic manner.

2.2 Lake Characterization

2.2.1 Drainage Basin

Figure 2.2: Lake Winnipeg watershed

Lake Winnipeg is a remnant of glacial Lake Agassiz and is situated on the boundary between the Precambrian Shield to the east and sedimentary strata to the west and south (Brunskill, 1973). The watershed extends westward through Saskatchewan and Alberta to the Rocky Mountains, east into Ontario and south into North Dakota and Minnesota and small portions of South Dakota and Montana. Table 2.1 demonstrates the relative ratios of the North American Great Lakes and Lake Winnipeg.

Table 2.1: Watershed area-to-lake area ratio in major North American lakes (Hendzel et al., 2006)

Lake	Lake Area	Watershed Area (sq. km)	Ratio
Erie	18,960	64,000	3.4
Ontario	25,700	78,000	3.0
Huron	59,600	134,000	2.2
Michigan	57,600	118,000	2.0
Superior	82,100	127,000	1.6
Winnipeg	25,000	1,000,000	40

Four main river systems discharge into the Lake Winnipeg: the Winnipeg River (mean monthly flow of 771 m^3/s); the Saskatchewan River (mean monthly flow of 667m^3/s); Red-Assiniboine Rivers (mean monthly flow of 159 m3/s); and the Dauphin River (mean monthly flow of 57 m^3/s) (Lewis and Todd, 1996). Numerous smaller rivers enter the lake, in particular along the eastern shore. Terrestrial drainage areas and run-off of the tributaries as calculated by Brunskill et al. (1980) are provided in Table 2.2.

Table 2.2: Terrestrial drainage areas of rivers tributary to Lake Winnipeg, and annual run-off for the watersheds (Brunskill et al., 1980)

Basin	Tributary	Geology of drainage area	Drainage area (km^2)	Run-off (cm)*
South	Winnipeg River	Precambrian Shield	126,400	31
	Red River	85% Sedimentary	287,500	2.8
	Other	-	16,700	-
North/Narrows	East side rivers	Precambrian Shield	41,050	-
	Saskatchewan River	Sedimentary	340,000	6.4
	Dauphin River	Sedimentary	80,000	3.7
	Other	Sedimentary	61,200	-

As noted by Brunskill et al. (1980), the characteristics of these watersheds result in very different water quality and nutrient loads in tributaries entering the lake. These differences are further highlighted in section 1.3 of this report where we discuss point and non-point sources of nutrient to Lake Winnipeg and differentiate the nutrient loads by the tributaries.

2.2.2 Lake Hydrology

A literature review for setting nutrient objectives for Lake Winnipeg, conducted by North/South Consultants on the request of the Lake Winnipeg Stewardship board attempts to pull together all existing information relating to Lake Winnipeg and the management of nutrients loads to it. They report that in 1976, the outflow of Lake Winnipeg was regulated by the construction of the Jenpeg Generating Station just upstream of Cross Lake on the west channel of the Nelson River (flows along the much smaller eastern channel are unregulated). According to North/South (2006), the Lake Winnipeg Shoreline Advisory Group (2000) and one of its associated technical reports (Baird and Stantec, 2000) represents the most complete published report, describing mean monthly lake levels, inflows and outflows for Lake Winnipeg prior to and after regulation.

Four major river systems discharge into the lake: the Winnipeg River (mean monthly flow of 771 m^3/s); the Saskatchewan River (mean monthly flow of 667 m^3/s); Red-Assiniboine rivers (mean monthly flow of 159 m^3/s); and the Dauphin River (mean monthly flow of 57 m^3/s) (Lewis and Todd, 1996).[6] Numerous smaller rivers enter the lake, in particular along the eastern shore. The eastern watershed, including the Winnipeg River, drains the soils, muskegs and boreal forests overlying the igneous bedrock of the Precambrian Shield (Brunskill et al., 1980). The southern, western and northwestern portions of the drainage basin are within the Paleozoic and Mesozoic sedimentary terrains of the Prairie provinces and north-central United States of America (Burbidge et al., 2000). These areas were originally prairies to the south and mixed forests to the west and northwest; the southern areas now support extensive agriculture and several large cities (Brunskill et al. 1980).

[6] According to Schindler, D.W. and Donahue, W.F. (2006) in contrast to annual flows, summer flows in major rivers of the Western Prairie Provinces (WPP) have declined rapidly during the 20th century. Current summer flows in the WPP are 20–84 per cent lower than they were in the early 20th century. A comparison of rivers suggests that damming, human water withdrawals and increased warming via its effects on evaporation, evapotranspiration and winter snowpack have contributed to the declines in flow.

River	Mean monthly flow (cubic metres per second)	Percentage of total
Winnipeg River	999	45
Saskatchewan River	567	26
Red River	252	11
Other flow into Lake Winnipeg*	400	18
Totals	2218	100

Source: Manitoba Water Stewardship, Water Science and Management Branch

* Other flows include that from the many smaller rivers that flow into the lake but does not include precipitation and evaporation.

Table 2.3: Mean monthly flows into Lake Winnipeg in cubic metres per second (percentages rounded). Period of Record 1964–2005 (Lake Winnipeg Stewardship Board, 2006)

2.2.3 Lake chemistry

Nitrogen and phosphorus concentrations during the open-water season in the north and south basins of Lake Winnipeg have been measured in numerous surveys conducted since 1992. Despite the monitoring, there are no published reports synthesizing the findings from these data (North/South Consultants Inc., 2006). According to the authors of the nutrient literature review (North/South Consultants Inc., 2006), the most recent measurements of nitrogen and phosphorus on the lake were collected by agencies participating in the Lake Winnipeg Research Consortium during surveys conducted in the early summer, mid to late summer and fall during the period of 2002–2004 and fall 2005. While nutrient data for the lake is currently being analyzed by a number of organizations, (Manitoba Water Stewardship, Department of Fisheries and Oceans and Lake Winnipeg Research Consortium included), preliminary analysis suggests that levels of nitrogen and phosphorus are highest in the south basin, particularly at the mouth of the Red River, and lowest in the north-west corner of the north basin (North/South Consultants Inc., 2006).

2.2.4 Lake biology

Some of the earliest studies of biological components of Lake Winnipeg are by Bajkov (1934), who provided a qualitative description of the plankton of Lake Winnipeg; however, it is difficult to ascertain in which years the sampling was conducted (North/South Consultants Inc., 2006). Bajkov (1934) mentions that diatoms are common, and the numbers of diatoms and green algae increase in late winter/early spring. The blue-green algae, *Aphanizomenon flos-aquae,* he states, are most common during the second portion of the summer. According to his report, it reaches maximum abundance in August and often forms a thick carpet on the surface.

The abundance of cyanobacteria in Lake Winnipeg has resulted in concerns related to the presence of toxins produced by those species. On September 9,1996, a sample collected at Victoria Beach on Lake Winnipeg had a microcystin-LR concentration of 300 µg/L. whereas microcystin levels had declined to 0.2 µg/L in a follow-up sample taken later in the month (Gurney and Jones, 1997). The majority of microcystin-LR samples collected in Lake Winnipeg since 1999 have generated microcystin-LR levels of 3 to 15 µg/L range with one exception at 331 µg/L at Sandy Beach, Lake Winnipeg in August 2004 (North/South Consultants Inc. 2006). The toxic levels in a draft report on Canadian Recreational Water Quality Guidelines is 20 µg/l (*pers. comm.* Armstrong, N. 2007)

2.3 Increase in nutrient loads over time

Human activities in the watershed, significant run-off events such as the flood of 1997 in the Red River Basin and increased flows of the Red in the last decade have contributed to the increase in nutrients into and eutrophication of Lake Winnipeg. According the Lake Winnipeg Stewardship Board (LWSB) report (2006), human sources of nutrients in Lake Winnipeg include municipal sewage discharges, leaking septic fields, crop fertilizers, industrial discharges, livestock manure and urban run-off carrying nutrient-rich contaminants such as lawn fertilizers and pet waste. Armstrong (2006) states that based on the change in nutrient concentrations and the loads currently received by Lake Winnipeg, nitrogen and phosphorus loads have increased by about 10 per cent over the past three decades.

While there is some unpublished data from 1969, a study conducted to examine the effects of the 1997 Red River flood on Lake Winnipeg by Stewart et al. (2000) examined the historic record of total nitrogen (TN) and total phosphorus (TP) in the south basin using samples from surveys conducted by the Freshwater Institute in 1969, 1994, 1996 and 1998 and by the Province of Manitoba in 1992. The data presented by the authors is presented in table 2.3.

Table 2.3: Summer mean concentrations of total nitrogen and total phosphorus from the south basin of Lake Winnipeg.

Year	TN (mg/L)	TP (mg/L)
1969	0.573	0.083
1992	0.446	0.074
1994	0.880	0.095
1996	0.751.	0.060
1998	0.902	0.117

2.4 Evolution of Lake Winnipeg management policy

A Water Strategy document was initially developed through the work of the Manitoba Round Table and multi-stakeholder negotiations in October 2001. A detailed review of this by a multi-stakeholder committee led to recommendations which led to the current **Manitoba Water Strategy**, released in April 2003. The strategy's key goals (described as Policy Areas and Objectives) are focused on:

1. Water Quality – To protect and enhance our aquatic ecosystems by ensuring that surface water and ground water is adequate for designated uses and ecosystem needs.
2. Conservation – To conserve and manage the lakes, rivers, and wetlands of Manitoba so as to protect the ability of the environment to sustain life and provide environmental, economic and aesthetic benefits to existing and future generations.
3. Use and Allocation – To ensure the long term sustainability of the province's surface water and ground water for the benefit of all Manitobans.
4. Water Supply – To develop and manage the province's water resources to ensure that water is available to meet priority needs and to support sustainable economic development and environmental quality.
5. Flooding – To alleviate human suffering and minimize the economic costs of damages caused by flooding.

6. Drainage – To enhance the economic viability of Manitoba's Agricultural community through the provision of a comprehensive planned drainage infrastructure.

The implementation components of the Manitoba Water Strategy include:

I. Development of an integrated water planning and management system

Watershed-based planning will be supported through the creation of "watershed districts" (subsequently called "watershed planning authorities") across the province, building on the existing efforts of Manitoba's conservation districts—which are primarily based on municipal boundaries, but employ sub-watershed-based local committees. Larger basin-level or aquifer districts may also occur where appropriate. Planning partners will be important at every level.

II. Review and consolidation of water legislation

There are at least 20 separate provincial acts and several more legislative regulations related to water in Manitoba. The province hopes to consolidate most existing water legislation into a single act, based on extensive public consultation. Some acts will be repealed, some may be revised, and some (such as those related to federal legislation) may not change or be consolidated. Relevant current water legislation includes:

Conservation Agreements Act
Drinking Water Safety Act
Fisheries Act
Floodway Authority Act (Crown Corp.)
Manitoba Habitat Heritage Act (Crown Corp.)
Manitoba Natural Resources Transfer Agreement
Water Commission Act (repealed)
Water Resources Administration Act
Water Services Board Act (Crown Corp.)
Water Protection Act
Conservation Districts Act
Dyking Authority Act
Fishermen's Assistance Act
Groundwater and Water Well Act
Lake of the Woods Control Board
Public Health Act
Water Power Act
Water Supply Commissions Act
Water Rights Act
Water Resource Conservation and Protection Act

III. Development of mechanisms for financing water management and planning

Locating adequate, long-term funding in support of comprehensive water management has been an ongoing challenge, though crisis-related funding is more readily available (i.e. flooding). Funding to support the maintenance of provincial waterways, and watershed restoration projects ought to reflect an equitable distribution of costs, in accordance with benefits received among all users.

Year	Initiative
February 2003	Release of Lake Winnipeg Action Plan
April 2003	Release of Manitoba Water Strategy
July 2003	Lake Winnipeg Stewardship Board (LWSB) formation
February 2005	Interim Report for LWSB
May 2005	Lake Winnipeg Implementation Committee formation
November 2005	Lake Winnipeg Implementation Committee final report
December 2006	Release of LWSB Final Report
February 2007	Announcement about an increased mandate of LWSB to include lake watershed and to coordinate integrated watershed management plan development of conservation districts in Manitoba

Table 2.4: Timeline of Manitoba's current water policies

In February 2003, as a response to the problem of nutrient loading and associated management issues in Lake Winnipeg, Manitoba had unveiled a provincial action plan to protect the lake. Among the six points in the **Lake Winnipeg Action Plan** was the establishment of the Lake Winnipeg Stewardship Board (LWSB). The first provincial department of Water Stewardship was created soon after in April 2003 as a sign of the priority given to the management of water resources at the provincial level. In July 2003, the LWSB was formally established to assist the Province in implementing the Lake Winnipeg Action Plan and to identify actions necessary to reduce nitrogen and phosphorus loading to Lake Winnipeg to pre-1970 levels.

The **Lake Winnipeg Stewardship Board** (LWSB) presented its interim report in 2005 with recommendations in 32 areas directed at protecting Lake Winnipeg and improving its state of health. LWSB formally released its annual report in February 2007 with 135 recommendations for improving the state of the lake. The provincial response to these recommendations has been favourable and progress has been made on a significant number of the recommendations. An announcement made in February 2007 by Manitoba Water Stewardship acknowledged the role of the Lake Winnipeg Stewardship Board by expanding its mandate to include providing advice to government on the health of the Lake Winnipeg and its basins. The board has accordingly taken on additional responsibilities to coordinate development of a basin-wide watershed management plan in cooperation with regional watershed authorities led by local conservation districts. In addition to the provincial authority overseeing the work of the Conservation districts, the LWSB is also mandated to prepare periodic "state of the lake" reports through contacts with lake users, communities, scientists and others. These reports will be presented to the government and will include information on the status of government action in implementing the board's recommendations and the status of progress toward reaching nutrient reduction targets. This mandated authority for the LWSB and a connection with the conservation districts working on water resource management provides a policy direction for a sophisticated form of integrated water resources management but does not yet provide adequate resources for such integrated management.

In May 2005, the **Lake Winnipeg Federal/Provincial Implementation Committee** was formed as a joint initiative of the Governments of Canada and Manitoba. The committee released its report *Restoring the Health of Lake Winnipeg*. The highlight of this report is the set of 22 recommendations for governments. The report acknowledges the efforts and actions to date, but emphasizes the need for federal-provincial coordination, dedicated and adequate resources and the need to address science gaps regarding our knowledge of Lake Winnipeg. The report also outlines a Healthy Lake Winnipeg Basin Council Charter that is proposed to serve as a basis for stakeholders to work together and coordinate their activities.

2.5 Nutrient loading in Lake Winnipeg: Non-point and point sources

Bourne et al (2003) refer to the amount of nutrients in a stream at a given time as total measured stream nutrient load (TMSNL). The TMSNL is dependent on the volume of water flowing through the stream, as well as the nutrient concentration, so that a high volume of flow might have the same TMSNL as low flow volume with high nutrient concentrations.

Several natural and anthropogenic processes contribute to the TMSNL in any given stream (Bourne et al., 2003). Processes that directly influence the TMSNL of a stream are referred to as within-stream processes, while those that have a somewhat indirect, but no less significant, impact on the TMSNL are referred to as watershed processes. These processes and their calculation are briefly introduced below.

Within-stream processes: Two of the three general within-stream processes have both anthropogenic and natural components, while the direct discharge of liquid effluent is considered to be solely anthropogenic in origin.

1. Direct effluent discharge: The direct discharge of liquid effluents to surface water is a significant anthropogenic source of nutrients to aquatic systems in Manitoba and elsewhere.
2. Release from stream bed and stream bank sediments: Nitrogen and phosphorus are often associated with sediment particles in streams. Depending on the flow and inherent energy in the stream, these particles can be scoured from the stream bed or stream bank and redistributed further downstream where the nutrients can be released into the water column.

3. Infiltration of ground water: Infiltration of ground water via the stream bed often provides a majority of the base flow in some streams during periods of low flow such as fall and winter. Ground water usually contains only trace amounts of nitrogen and phosphorus. However, under some circumstances, it can contain elevated levels of nitrogen. For example, the downward leaching of nitrates and nitrites from animal manure and inorganic fertilizer applications, and leakage of municipal sewage lagoons and private septic systems can add nitrogen to groundwater.

Watershed processes: Two of the five general watershed processes have both anthropogenic and natural components while the remaining three have only anthropogenic components.

1. Atmospheric deposition: Nitrogen and phosphorus are deposited directly into land and water through rainfall and particulate deposition. These calculations do not include losses to the atmosphere.
2. Animal manure: The application of livestock manure to agricultural land, lawns, and gardens is a potential source of nutrients since nitrogen and phosphorus in the manure can be transported to surface waters during periods of heavy rainfall and spring run-off.
3. Release from soils and vegetation: Nutrients are released from soils and decaying vegetation and may be available for transport to surface water with rainfall or snowmelt.
4. Enhanced drainage and reduced riparian vegetation: Enhanced drainage networks and the drainage of wetlands cause nutrients to be transported more quickly from land surfaces to adjacent bodies of water. Loss of riparian vegetation also allows nutrients to be more readily moved directly into surface water and cause stream banks to become less stable and more prone to erosion of nutrient-rich sediments.
5. Inorganic fertilizer: The application of inorganic fertilizer to agricultural lands, lawns and gardens can also provide a source of nutrients that may later be transported with rainfall or snowmelt to surface water.

The following data shows total measured stream nutrient loads at water quality monitoring stations in Manitoba (Bourne et al., 2003).

Stream	1994	1995	1996	1997	1998	1999	2000	2001	Mean
Assiniboine River									
At Kamsack	222	1,712	630	561	189	290	148	502	532
At Brandon	1,275	4,119	2,977	1,892	1,100	3,433	871	3,177	2,355
At Treesbank	1,387	4,545	3,162	2,046	1,349	3,985	1,306	3,642	2,678
At Portage Spillway	1,518	4,638	3,357	2,664	2,532	4,957	2,229	4,484	3,297
East of Portage	1,668	4,840	3,551	2,641	2,905	5,661	2,374	4,119	3,470
At Headingley	1,740	4,444	3,575	3,440	3,619	5,535	2,465	4,638	3,682
Assiniboine River Tributaries									
Qu'Appelle River	509	631	1,004	738	227	793	158	507	571
Little Saskatchewan	188	440	233	n/a	n/a	n/a	173	371	281
Souris River, Westhope	n/a	n/a	949	680	327	2,563	n/a	n/a	1,130
Souris River, Treesbank	334	1,688	2,380	1,244	861	4,144	527	1,811	1,624
Cypress River	20	65	56	74	102	22	7	101	56
Red River									
At Emerson	14,020	19,200	18,058	23,206	19,628	21,869	15,085	20,801	18,983
At St. Norbert	17,128	27,298	25,716	24,329	25,273	26,601	16,522	25,785	23,582
At Selkirk	22,121	36,370	34,558	37,871	35,303	33,681	24,459	37,755	32,765
Red River Tributaries									
LaSalle River	54	152	344	436	183	51	111	565	237
Roseau River	478	418	899	869	549	969	569	1,008	720
Rat River	76	107	235	438	294	118	184	309	220
Boyne River	43	145	107	n/a	n/a	n/a	n/a	n/a	98
Cooks Creek, RM boundary	16	15	33	n/a	n/a	n/a	n/a	n/a	21
Pembina River	719	1,623	1,509	1,268	1,456	623	66	1,032	1,037
Seine River	84	61	101	n/a	n/a	n/a	n/a	n/a	82
Other Streams									
Brokenhead River	251	111	173	197	192	81	346	507	232
Burntwood River	7,603	8,527	12,304	17,633	13,549	7,423	12,260	10,103	11,175
Carrot River	502	804	920	850	296	336	379	75	520
Dauphin River	1,144	3,637	5,102	n/a	n/a	n/a	n/a	n/a	3,294
Mossy River	231	777	571	279	347	378	195	930	463
Nelson River	4,474	4,663	5,707	7,144	6,191	4,642	7,129	6,624	5,822
North Duck River	27	24	22	19	24	22	12	25	22
Ochre River	28	40	30	12	24	28	51	80	37
Red Deer River	493	922	1,112	724	229	286	214	64	506
Saskatchewan River, above Carrot River	9,098	11,110	14,284	16,320	10,440	9,863	7,317	4,981	10,427
Saskatchewan River, at Grand Rapids	6,938	7,016	9,467	n/a	n/a	n/a	n/a	n/a	7,807
Swan River	325	957	538	389	176	160	194	247	373
Turtle River	20	66	64	14	33	49	43	213	63
Valley River	135	492	358	180	146	148	74	226	220
Vermillion River	67	422	46	38	45	40	39	131	103
Waterhen River	2,922	2,031	2,723	2,811	3,879	2,420	2,075	2,029	2,611
Whitemud River	74	470	449	113	280	392	277	1,292	418
Wilson River	62	200	70	30	97	n/a	n/a	n/a	92
Winnipeg River	14,021	15,613	19,663	18,731	8,491	16,259	17,639	24,118	16,817
Woody River	201	326	223	213	98	104	97	120	173

n/a = data not available

Table 2.5: Total measured stream TN load (t/yr) at water quality monitoring stations in Manitoba

Stream	1994	1995	1996	1997	1998	1999	2000	2001	Mean
Assiniboine River									
At Kamsack	30	176	54	32	35	29	19	38	52
At Brandon	185	649	400	330	186	540	97	453	355
At Treesbank	219	691	427	351	247	412	118	577	380
At Portage Spillway	247	899	499	408	558	810	210	701	542
East of Portage	252	947	531	455	631	964	267	788	604
At Headingley	310	811	634	551	875	989	285	642	637
Assiniboine River Tributaries									
Qu'Appelle River	74	75	124	107	26	129	19	68	78
Little Saskatchewan	21	43	24	n/a	n/a	n/a	16	41	29
Souris River, Coulter	n/a	n/a	244	88	57	449	n/a	n/a	209
Souris River, Treesbank	64	294	470	236	165	674	72	477	307
Cypress River	2.9	10	9.0	9.1	21	2.8	1.2	18	9.3
Red River									
At Emerson	1,708	1,981	2,430	3,666	2,710	2,896	1,874	3,029	2,537
At St. Norbert	2,037	2,347	3,226	3,235	2,947	3,757	1,749	5,524	3,103
At Selkirk	2,661	4,165	4,418	8,176	4,266	5,425	2,782	7,344	4,905
Red River Tributaries									
LaSalle River	16	47	88	89	40	10	28	97	52
Roseau River	43	23	52	70	47	69	45	86	54
Rat River	8.0	13	28	57	32	11	23	23	24
Boyne River	5.8	13	7.9	n/a	n/a	n/a	n/a	n/a	9.0
Cooks Creek, RM boundary	2.1	1.8	4.6	n/a	n/a	n/a	n/a	n/a	2.8
Pembina River	107	356	221	252	228	144	9.3	130	181
Seine River	12	10	15	n/a	n/a	n/a	n/a	n/a	12
Other Streams									
Brokenhead River	15	5.6	10	14	13	4.7	16	20	12
Burntwood River	897	643	926	1,182	1,240	886	1,325	1,203	1,038
Carrot River	49	55	136	59	26	40	28	12	51
Dauphin River	19	53	78	n/a	n/a	n/a	n/a	n/a	50
Mossy River	23	100	72	32	23	26	12	57	43
Nelson River	264	249	258	260	386	278	339	373	301
North Duck River	1.4	1.4	2.3	4.9	1.9	1.7	1.1	1.5	2.0
Ochre River	2.7	6.1	2.7	1.5	1.2	1.6	5.1	6.1	3.4
Red Deer River	45	38	71	15	10	17	8.7	2.3	26
Saskatchewan River, above Carrot River	741	1,031	883	1,052	1,078	807	581	438	827
Saskatchewan River, at Grand Rapids	289	271	362	n/a	n/a	n/a	n/a	n/a	307
Swan River	70	123	45	102	32	13	13	29	53
Turtle River	1.4	6.1	6.3	1.4	2.1	4.1	3.2	22	5.8
Valley River	6.3	45	18	16	11	6.4	1.8	23	16
Vermillion River	6.5	106	6.2	15	4.1	4.0	2.8	18	20
Waterhen River	44	41	126	118	101	59	48	50	73
Whitemud River	6.1	37	33	9.2	31	33	22	70	30
Wilson River	16	26	5.9	6.6	9.0	n/a	n/a	n/a	13
Winnipeg River	618	682	848	879	428	844	883	1,121	788
Woody River	30	42	17	41	11	8.0	11	4.3	20

n/a = data not available

Table 2.5: Total measured stream TP load (t/yr) at water quality monitoring stations in Manitoba (continued)

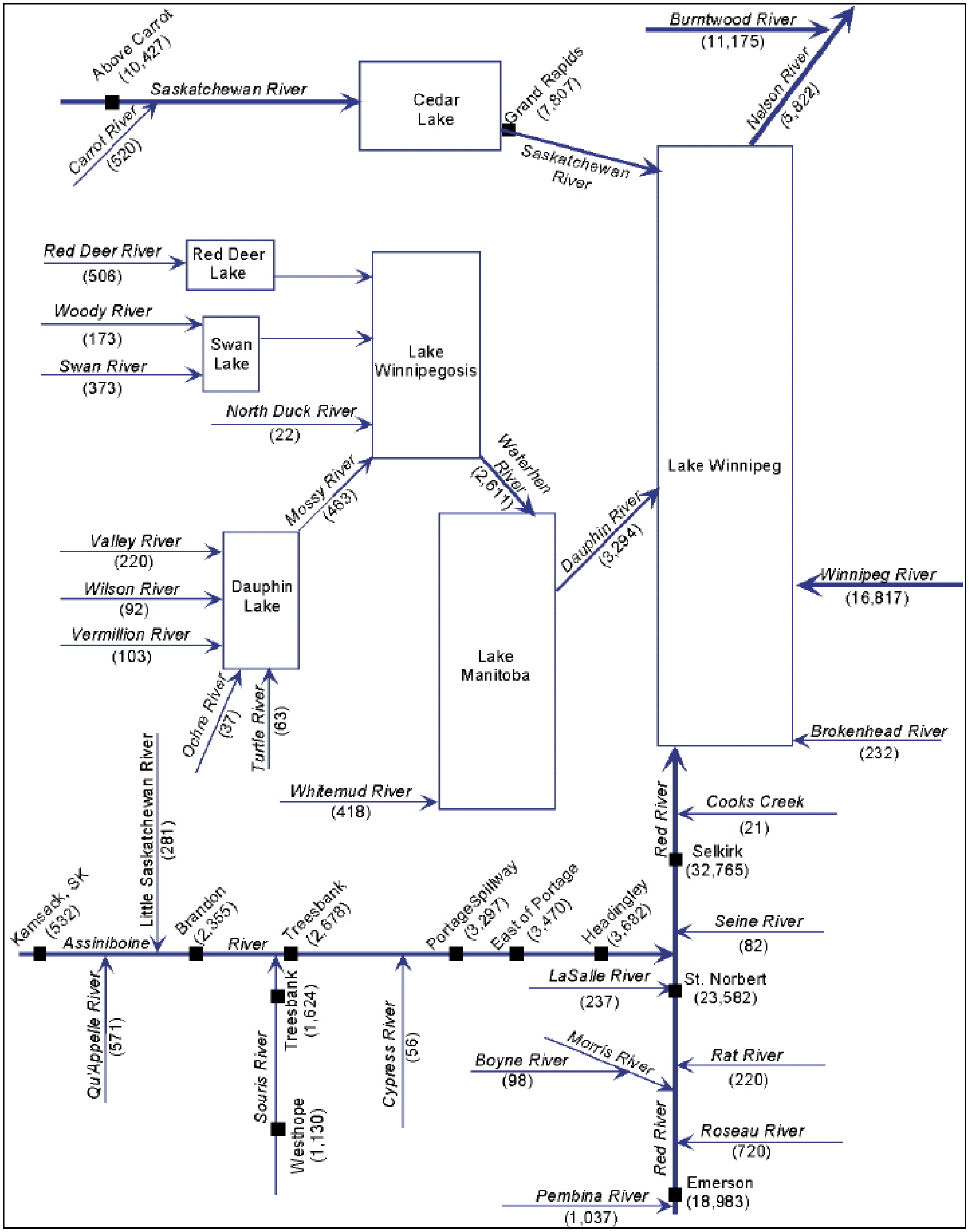


Figure 2.3: Schematic diagram of mean annual TN load (t/yr) in streams at long-term monitoring stations in Manitoba (1994–2001). Diagram not to scale. (Source: Bourne et al., 2002)

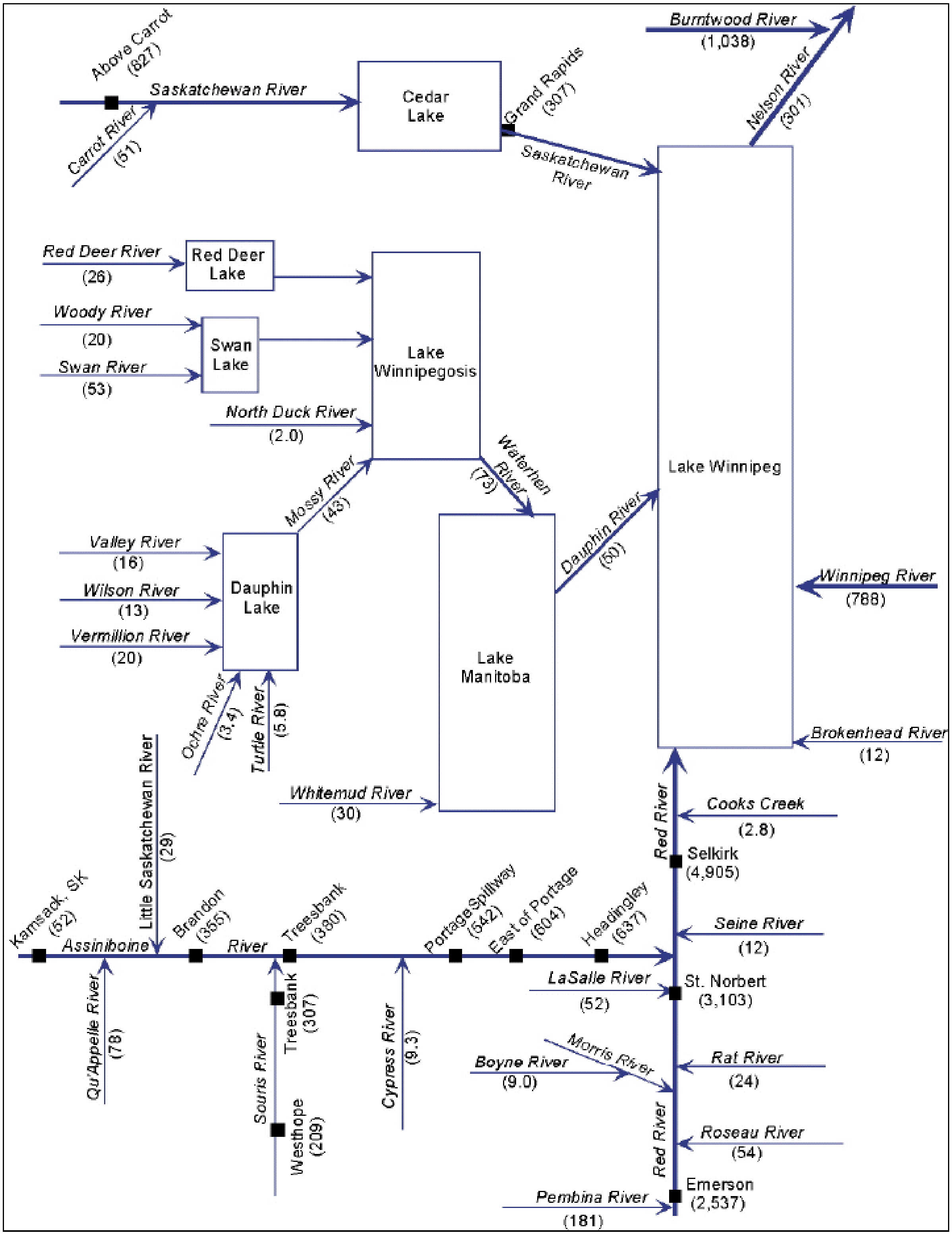


Figure 2.4: Schematic diagram of mean annual TP load (t/yr) in streams at long-term monitoring stations in Manitoba (1994–2001). Diagram not to scale. (Source: Bourne et al., 2002)

Cash (2006) explains that at high concentrations, nitrogen and phosphorus cause inland and coastal water eutrophication and that these forms of nitrogen are toxic:

- NO_3 to fish, amphibians, livestock and humans
- NH_3 to aquatic invertebrates and fish

	Total Nitrogen (t/year)	Total Phosphorus (t/year)
Nutrient Load to Lake Winnipeg (all sources)	96,000	7,900
Nutrient load leaving Lake Winnipeg via the Nelson River (East and West Channels)	39,700	2,000
Nutrient Load Retained in Lake Winnipeg	**56,300 (58%)**	**5,900 (74%)**

Table 2.6: Estimate of the amount of nutrients (tonnes per year) retained in Lake Winnipeg. Figures are based on the amount of nutrients entering Lake Winnipeg via all sources, and the amount of nutrients leaving the lake via the Nelson River. Period of recording: 1994–2001). (Source: Manitoba Water Stewardship)

While there is much debate about the largest sources of nutrients to Lake Winnipeg, it is commonly understood that the sources are fairly diverse and the solutions must be multi-faceted in their approach. For the purpose of the report, we are reporting data compiled by the provincial department of water stewardship.

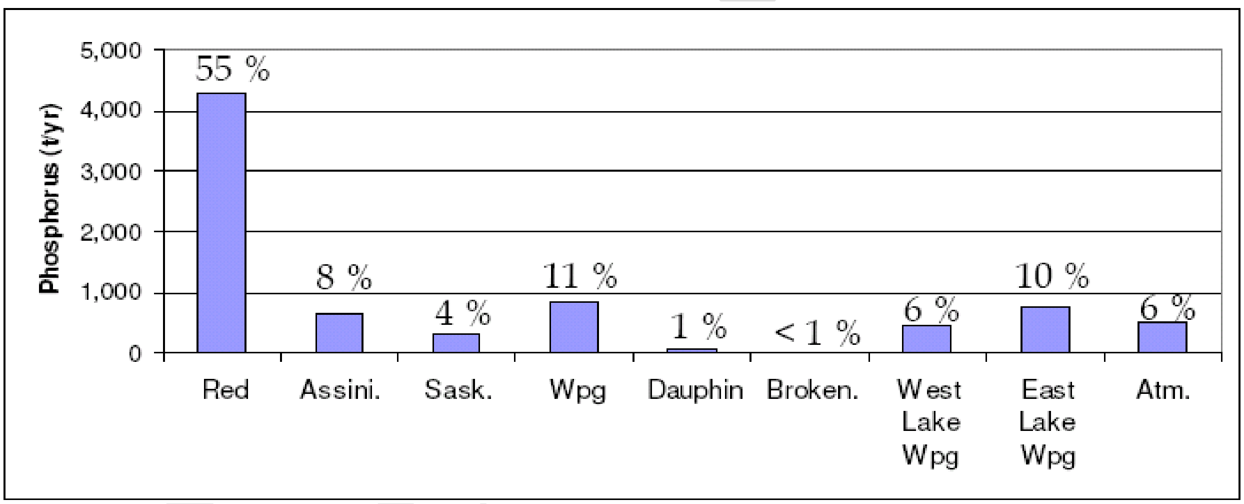


Figure 2.5: Phosphorous loads to Lake Winnipeg (Source: Armstrong, 2006)

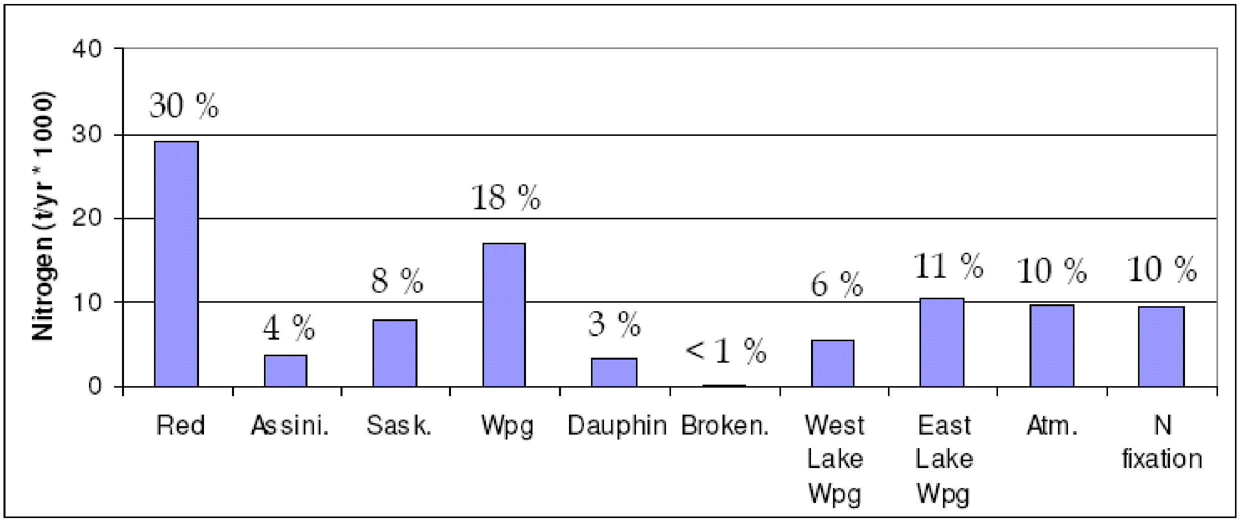


Figure 2.6: Nitrogen loads to Lake Winnipeg (Source: Armstrong, 2006)

Non-point sources: Non-point sources refer to a collection of non-specific sources. Lake Winnipeg Implementation Committee (2005) states that the Red River watershed is the largest source of nitrogen and

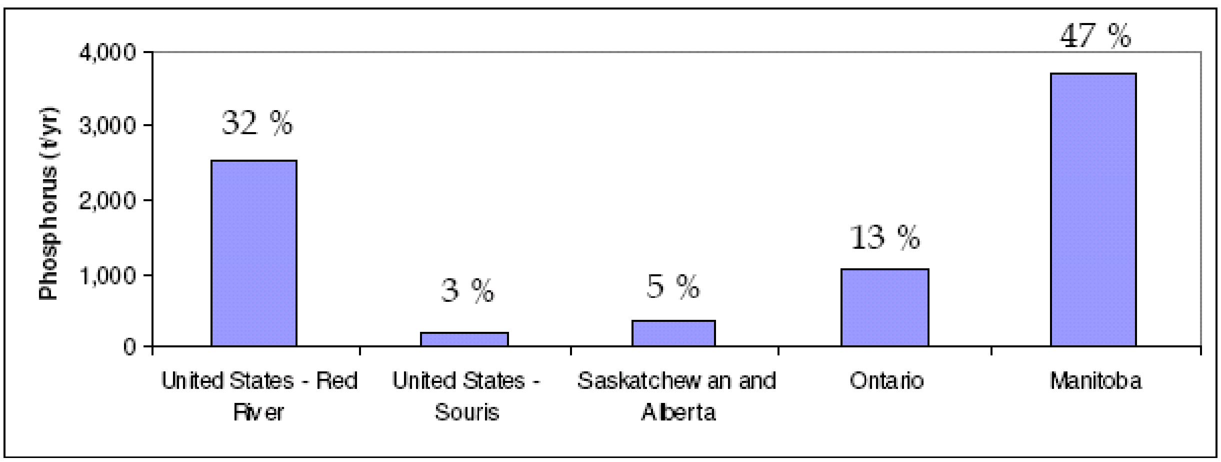


Figure 2.7: Phosphorus loads to Lake Winnipeg by jurisdiction (Source: Armstrong, 2006)

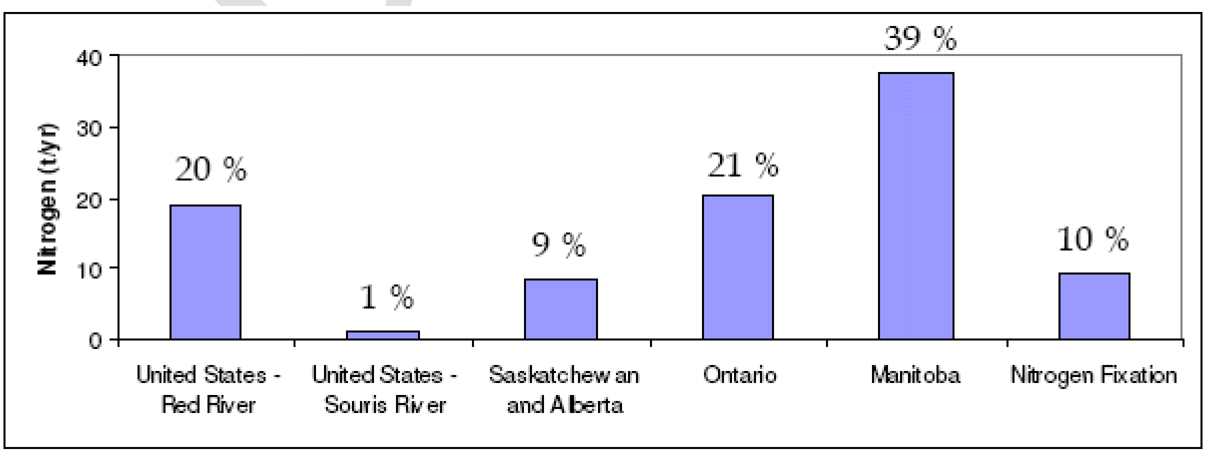


Figure 2.8: Nitrogen loads to Lake Winnipeg by jurisdiction (Source: Armstrong, 2006)

phosphorous to the Lake Winnipeg. More nutrients come from the U. S. via the Red River than from all other sources in Canada combined.

The report clarifies that while the Winnipeg and Saskatchewan Rivers contribute more water to the Lake Winnipeg than the Red, the Red contributes the most nitrogen and phosphorus to the lake. Sources of nutrients in the Red River are agriculture, natural processes such as erosion and deposition from the atmosphere and direct wastewater effluent discharges.

The above graphs clearly indicate that while the sources of phosphorus to the lake are its many streams and rivers, the Red River is by far the largest phosphorus contributor despite its relatively low flow. Figure 2.7 clarifies phosphorus sources by jurisdiction, and also clarifies that, although the Red River is the largest single river source of phosphorus, the province of Manitoba is the largest political boundary contributing to the phosphorus loads to the lake. These data provide us with important insights into policy development to minimize nutrient loads in Lake Winnipeg.

Data on nitrogen loads to the lake indicate that there are some minor differences from phosphorus sources, but that the Red River is the largest source of nitrogen as well as phosphorus to Lake Winnipeg. A graph of nitrogen sources to Lake Winnipeg by jurisdiction show that Manitoba, once again, is the single largest jurisdictional source of nitrogen loads to the Lake Winnipeg.

Point sources: Point sources are single, specific sources that contribute significantly to the nutrient loads in the watershed and the lake. Although most of the nutrient loading to Lake Winnipeg is considered to be from non-point sources, some of the largest sources of phosphorus in the Red River Basin are municipal wastewater treatment facilities (LWIC, 2005). Table 2.3 shows the estimated amounts and proportions of total phosphorus reaching Lake Winnipeg each year, on average, between 1994 and 2001 (updated from data presented in Bourne et al., 2002, as presented in the Issues and Options Paper by Manitoba Water Stewardship, 2006, describing the proposed regulation defining Water Quality Management Zones for Nutrient). According to LWSB (2006), the proportion of contribution from point and non-point sources will vary in wet and dry years, with the relative proportion from point sources higher in dry years and lower in wet years. However, both non-point and point source contributions are significant contributors

Category	Average Total Nitrogen (t/yr)			% of Total Nitrogen to Lake Winnipeg (% of Manitoba sources)		
Upstream jurisdictions	48,900			51%		
United States (Red River)		19,000			20	
United States (Souris River)		1,100			1	
Saskatchewan and Alberta (Assiniboine and Saskatchewan)		8,300			9	
Ontario (Winnipeg River)		16,800			17	
Ontario (Other rivers)		3,700			4	
Manitoba Sources	47,100			49%		
Manitoba Point Sources		5,100			5 (11)	
City of Winnipeg (Wastewater sources)			3,700			4 (8)
All others (Wastewater sources)			1,400			1 (3)
Manitoba Watershed Processes		23,200			24 (49)	
Natural background & undefined sources**			18,100			19 (38)
Present day agriculture			5,100			5 (11)
Atmospheric Deposition		9,500			10 (20)	
Internal Lake Processes - Nitrogen Fixation***		9,300			10 (20)	
Overall annual nitrogen load to Lake Winnipeg	**96,000**			**100%**		

* An update of these loading figures is currently being prepared by Manitoba Stewardship.
**Estimated natural background and undefined sources would also include contributions from sources such as forests, wildlife and septic fields.
*** Nitrogen fixation: it has been estimated that species of blue-green algae are adding about 9300 tonnes of total nitrogen per year to Lake Winnipeg, by fixing the nitrogen gas found in the atmosphere.(Source: Len Hendzel, DFO, Winnipeg, 2006).

Table 2.6: Summary of estimated phosphorus loading to Lake Winnipeg 1994–2001 (tons per year, rounded to the nearest 100 tonnes). (Source: Manitoba Water Stewardship, LWSB Report, 2006)

Category	Average Total Phosphorus (t/yr)			% of Total Phosphorus to Lake Winnipeg (% of Manitoba sources)		
Upstream jurisdictions	4,200			53%		
United States (Red River)		2,500			32	
United States (Souris River)		200			3	
Saskatchewan and Alberta (Assiniboine and Saskatchewan)		400			5	
Ontario (Winnipeg River)		800			10	
Ontario (Other rivers)		300			3	
Manitoba Sources	3,700			47%		
Manitoba Point Sources		700			9 (19)	
City of Winnipeg (Wastewater sources)			400			5 (11)
All others (Wastewater sources)			300			4 (8)
Manitoba Watershed Processes		2,500			32 (67)	
Natural background & undefined sources**			1,300			17 (35)
Present day agriculture			1,200			15 (32)
Atmospheric Deposition		500			6 (14)	
Internal Lake Processes	Currently there are no estimates available for internal phosphorus cycling that may occur in the lake.					
Overall annual total phosphorus load to Lake Winnipeg	**7,900**			**100%**		

* An update of these loading figures is currently being prepared by Manitoba Stewardship.
**Estimated natural background and undefined sources would also include contributions from sources such as forests, wildlife and septic fields.

[69] Bourne, A., N. Armstrong and G. Jones. 2003 A preliminary estimate of total nitrogen and total phosphorus loading to streams in Manitoba, Canada. Manitoba Conservation Report No. 2002-04. Winnipeg, MB, Canada. 49 pp.
[70] Issues and Options Arising from the Initial Consultation on Water Quality Management Zones for Nutrients, Manitoba Water Stewardship, February 3, 2006.

Table 2.7: Summary of estimated annual nitrogen loading to Lake Winnipeg1994-2001 (tonnes per year, rounded to the nearest 100 tonnes). (Source: Manitoba Water Stewardship, LWSB Report, 2006).

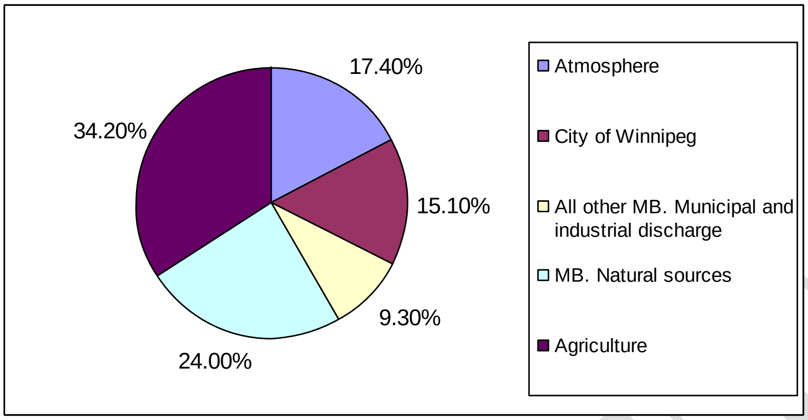


Figure 2.9: Relative phosphorus loads to Lake Winnipeg from **Manitoba** sources. (Source: MB Water Stewardship. Data 1994–2001)

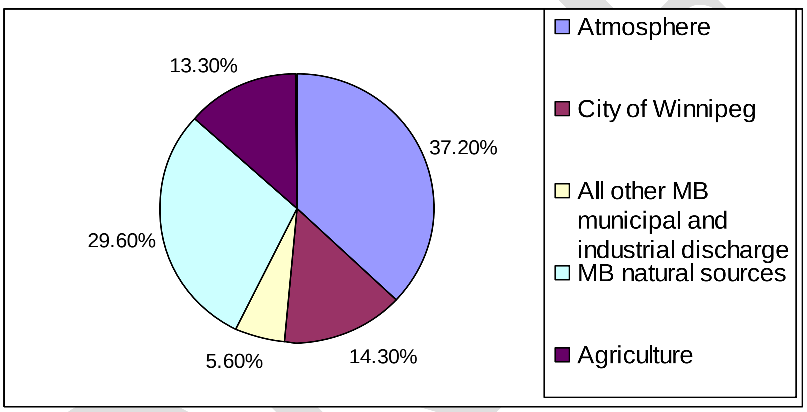


Figure 2.10: Relative nitrogen loads to Lake Winnipeg from **Manitoba** sources. (Source: MB Water Stewardship. Data 1994–2001)

2.6 Gaps in nutrient data for Lake Winnipeg

2.6.1 The nitrogen versus phosphorus debate

While nitrogen and phosphorus are both needed for the growth of aquatic plants, or algae in the lake, there has been some debate on whether nitrogen or phosphorus is the main culprit. An experiment at the experimental lakes in Northwestern Ontario proved that phosphorus is the nutrient that determines the amount of algal growth because its supply in nature is limited. Nutrients are supplied in nature in the proportions needed for plant growth, i.e., about 15 parts of nitrogen to 1 part of phosphorus. If the ratio of nitrogen to phosphorus equals, or exceeds the 15:1 proportion, populations of algae known as greens and others groups will develop. These are algae characteristic of healthy lakes and form the base of a healthy aquatic food-chain. On the other hand, if the ratio of N:P is less than 15:1, blue-green algae, also called cyanophytes will grow instead of green algae. Blue-green algae obtain the extra nitrogen they need from the atmosphere by nitrogen fixation. These are the nuisance algae and are generally not edible and do not

A Faster Way to Save the Lake? (An excerpt from the Winnipeg Free Press. March 12, 2007)
Manitoba is working on a plan to overhaul Winnipeg's sewage system, one that could give Winnipeggers a break on their sewer rates and kick-start the cleanup of Lake Winnipeg. The total cost to the City of Winnipeg to upgrade wastewater treatment systems so that such spills will not occur in the future is estimated to be $750,000,000. Controversy exists regarding the ability of the city to carry this cost, when the upgrade to the wastewater treatment system will be done, and whether the Government of Manitoba will assist the City with the work. [The CEC recommended that Winnipeg accelerate its intended capital works schedule]. The issue is that there might be a faster and cheaper way to remove phosphorus from the effluent that's pumped into the Red River following the sewage treatment process.

Latest thinking on the issue has been around the relatively simple addition of another chemical into the existing sewage treatment process to deal with the phosphorus and leave some wiggle room for the more expensive process of removing nitrogen. This will save the city arguably the largest capital project investment it has ever seen, leaving money for some nutrient management approaches with potentially higher levels of sustainability. If the city opts for a "phosphorus first" plan, it could likely remove phosphorous from its wastewater in a couple of years, with a about a quarter of the cost for the full nutrient removal plan that the province has mandated. While the Freshwater Institute is supporting this approach, the province has some reservations in taking a chance and leaving the removal of nitrogen till this method is tried and tested. According to them, it may be too late.

contribute to the aquatic food chain. Some such algae even produce toxins. As these algae blooms die and decompose, oxygen is depleted in the water, particularly in the bottom of the lake. This effect is compounded by the shallow nature of Lake Winnipeg, which contributes to the algae growth.

According to Welch (2007), the blue-green algae that is suffocating Lake Winnipeg—and spawning blooms that can be seen from space—are special. Like most algae, they need both nitrogen and phosphorus to grow, but they are one of the few kinds that can suck nitrogen from the air. Casey (2006) explains that, just like the nitrogen-fixing legume family of terrestrial plants (including beans), blue-greens can tap into atmospheric nitrogen, which constitutes 78 per cent of the air we breathe, and convert it for cellular use. So blue-green algae are both a symptom and a cause of nutrient overloading in the lake—they feed on nitrogen pollution only to add more of their own. Hendzel et al. (2006) point out that this group of algae is not readily eaten by zooplankton and represent primary productivity that is not passed up the food chain. In addition, this type of algae thrives in environments that have high levels of phosphorus and low levels of nitrogen—a low nitrogen: phosphorus ratio—and is capable of, and usually produce, a variety of algal toxins.

The argument being made is that no matter how much you limit the flow of nitrogen into the lake, the algae will just extract what it needs out of the air. If you cut off (or drastically reduce) the supply of phosphorus, you target the algae chiefly responsible for suffocating the lake. Going with a "P-first" approach is being propagated to immediately deal with lake eutrophication. Removing phosphorus from city sewage is also cheaper and faster than building a complete system that removes both nitrogen and phosphorus. It can be done without building any major new facilities, by simply adding another chemical such as

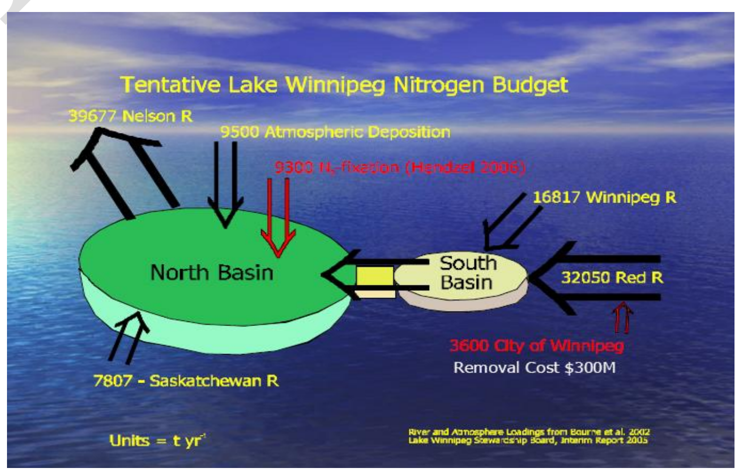


Figure 2.11: Tentative Lake Winnipeg Nitrogen Budget. Source: Hendzel *et al.* (2006)

iron or alum to precipitate out the phosphorus (Welch, 2007). Conversely, a biological nutrient removal process that removes phosphorus, nitrogen and ammonia from the waste water that is pumped back into the river would require large investments and double the size of existing treatment facilities in the city.

While the debate of nitrogen versus phosphorus ensues, Hendzel et al. (2006) give the following graphical depiction of a tentative nitrogen budget for Lake Winnipeg, monitoring nutrients inputs and outputs from existing data (Fig. 2.11). While an immediate solution is not forthcoming, the setting of priorities for nutrient management is simplified by this budget. The Red River is the primary source of nutrients in general, and specifically nitrogen into the Lake Winnipeg. Any solution to the nutrient loading problem would have to effectively deal with loading into the Red River from U. S. sources, the City of Winnipeg and rural Manitoba jurisdictions.

While nutrient management emerges as the primary goal for the management of the Lake Winnipeg watershed to address the issue of Lake eutrophication, a primary constraint appears to be the coordination of such an attempt. Institutional capacity for a watershed-level governance and management structure is something that is agreed upon but prominently lacking. It is through the building of such institutional capacity that instruments such as payments for ecosystem services can be most effectively utilized for watershed management.

3. Policy Implications of Nutrient Sources and Impacts for Lake Winnipeg Nutrient Management

Sources of nutrients to the Lake Winnipeg watershed have shaped agricultural, water and environmental policy in Manitoba, other Canadian provinces, and the U. S. to some extent. Agriculture is responsible for at least 15 per cent of phosphorus in Lake Winnipeg and 32 per cent of Manitoba contributions of phosphorus to the lake. Proper management of fertilizer nutrient-rich run-off and manure-rich run-off from agricultural lands has been reflected in provincial policy and legislation in recent times. The balance between higher agricultural production meeting growing consumer demands and the need for economic growth needs to be balanced with a need for best management practices from an environmental standpoint. Agriculture, therefore, is an integral part of the solution for Lake Winnipeg's nutrient loading problem and is being addressed through a number of extension programs through a variety of federal and provincial initiatives.

In addition, provincial legislation, such as the proposed nutrient management regulations for Water Quality Management Zones in Manitoba are aimed at reducing the negative impacts of manure and fertilizer application on soils and water in the province. The water quality management zones are defined based on factors largely defining agricultural capability, including topography, soil texture, erosion, soil characteristics, crop yield potential and a few other factors.

3.1 The role of institutions and governance in lake basin management

The World Bank (December, 2005) states that institutions are at the core of lake basin management. Formal institutions can have resource development, service delivery, regulatory, advisory, or coordinating roles. Informal institutions, such as NGOs, can also play important roles. According to the World Bank report on lessons for managing lake basins for sustainable use, successful institutions develop a diversity of linkages. The most important of these links are those to senior decision makers, including politicians. These links take time to construct and should be built as early as possible in the process of watershed management.

Policies that support the development of financial, human and technical capacity for watershed management are fundamental to IWRM implementation and the effective use of instruments including economic and regulatory instruments.

3.2 Management options for Lake Winnipeg nutrient loads

The issues that would need to be addressed for an effective nutrient management strategy for Lake Winnipeg include:

- The large area of the Lake Winnipeg basin,
- The large number of relatively small sources of nutrients within the lake basin, and
- The large number of jurisdictions involved in managing nutrient sources to the rivers and streams draining into Lake Winnipeg.

Past strategies for mitigation of lake eutrophication have utilized a variety of strategies, mostly aimed at the reduction of nitrogen and phosphorus loads to the lake. The language around these past strategies have been said to have been evolving (Hendzel et al., 2006) and include:

- Reduction in load by a specific percentage, such as 13 percent for nitrogen or 10 percent for phosphorus (although percentage of what is not clear)
- Return lake to a condition that existed at some point in the past. (e.g. "1970 conditions")
- Removal of nitrogen and phosphorus from point sources (manage urban effluent to a discharge concentration)
- Managing to a target lake concentration (e.g. 25 μg/l P)

- Dominant nuisance algal group biomass is largely determined by available phosphorus and the ratio of nitrogen/phosphorus.

On February 18, 2003, the Lake Winnipeg Action Plan announced a commitment to reduce nutrient loads to Lake Winnipeg to pre-1970s levels (Williamson, 2006). This would involve a 10 per cent reduction in phosphorus loads and a 13 per cent reduction on nitrogen loads. This Action Plan also resulted in the formation of the Lake Winnipeg Stewardship Board, which has worked on Lake Winnipeg management since 2003 and produced an interim report in February 2005 and final report with 135 recommendations in December 2006.

Attempts to address the large number of relatively small sources of nutrients in the lake basin are being made through provincial regulations and localized management through agencies such as the Conservation Districts in Manitoba. Consolidated efforts in this direction are, however, lacking.

The large number of jurisdictions involved in the Lake Winnipeg basin has been a deterrent to effective integrated management. Attempts have been made in the past towards a basin-wide plan for nutrient management and towards the creation of a basin-wide coordinating body. This need was re-iterated at a Lake Winnipeg stakeholders' forum organized by the federal/provincial Lake Winnipeg Implementation Committee in Winnipeg in February, 2007. Follow-up action on this need remains to be clarified. Another attempt at bridging this gap was made by the Department of Water Stewardship in Manitoba with their February 2007 announcement expanding the mandate of the provincially appointed Lake Winnipeg Stewardship Board (LWSB) from the lake to the lake basin. also It was announced that the LWSB would be the coordinating agency for the development of integrated watershed management plans through the Manitoba Conservation Districts.

3.4 Lake Winnipeg Stewardship Board recommendations

The provincially appointed Lake Winnipeg Stewardship Board has recently released its final report on reducing nutrient loading to Lake Winnipeg and its watershed. In the report (LWSB, 2006), they have given 136 recommendations in 38 different categories. While the detailed recommendations can be accessed by downloading the report from the LWSB website at www.lakewinnipeg.org, we are listing the recommendation categories below:

1. Public Education on Water Quality Protection
2. Curriculum Development and Implementation in Manitoba Schools
3. A Scientific Basis for the Protection of Lake Winnipeg
4. Setting Long-Term Ecologically Relevant Objectives for Nutrients in Lake Winnipeg
5. Transboundary and Inter-jurisdictional Issues
6. Integrated Water Management Planning
7. Cosmetic Use of phosphorus-Based Fertilizers
8. Water Usage, Sewage Treatment, and Related Financing
9. Water Use Efficiency
10. Regionalization of Wastewater Treatment Services
11. Development of Nutrient Abatement Plans for Large Wastewater Treatment Facilities in Manitoba Communities
12. Environmental Planning for Urban, Rural and Cottage Development
13. Stormwater Retention Ponds

14. Nutrient Abatement Options for Small Wastewater Treatment Facilities
15. Effluent Irrigation/Land Application of Municipal Effluents
16. Appropriate Lagoon Design, Operation, and Storage Capacity
17. Constructed/Engineered Wetlands
18. Chemical Treatment of Lagoons (e.g. Alum, Ferric Salts, Magnesium Salts, etc.)
19. Conversion of Lagoons to Wastewater Treatment Plants with Nutrient Removal Capabilities
20. Other Innovative Approaches that will Achieve Nutrient Reduction
21. Environmental Licensing Fees and Environmental Review Processes for Small Wastewater Treatment Facilities
22. Leachate Handling
23. Nutrient Management Issues in First Nations Communities
24. Septic Field Maintenance and Alternatives to Septic Fields
25. Management of Domestic Septage and Greywater
26. Manitoba Water Services Water Board
27. Phosphoric Acid Use in Water Supplies
28. Phosphorus Content in Cleaning Supplies
29. Nutrient Loss from Confined Livestock Areas and Over-Wintering Sites
30. Livestock Access to Riparian Areas and Waterways
31. Soil Fertility and Manure Testing
32. Matching Nutrient Inputs with Crop Nutrient Requirements and Exports, and Establishing Soil phosphorus Limits
33. Evaluation of Beneficial Management Practices as Nutrient Reduction Strategies
34. Nutrient Inputs from Agricultural Tile Drainage
35. Drainage of Surface Water from Agricultural Lands
36. Natural Wetlands as Nutrient Abatement Options
37. Retention Basins as Nutrient Abatement Options
38. Implementation of Lake Winnipeg Stewardship Board's Recommendations

Some of these recommendations have already been acted upon at the governmental and non-governmental levels, while there are many that are easily implemented with the existing resources implementation capacity, but have not been allowed adequate consideration. While the recommendations cover different approaches to integrated water resources management, some are broad policy principles and some provide implementation directions for nutrient management.

While all recommendations may provide significant solutions to the nutrient loading problem, some idea of the costs and benefits associated with each of these recommendations would help construct the ideal roadmap for setting priorities for their implementation. In the absence of such cost-benefit analyses, which in itself is an expensive and time-consuming proposition, a priority list needs to be developed keeping in mind the ease of implementing a certain nutrient management approach and the benefits in reducing nutrient loads in the lake.

A plot of phosphorus removed from lake loads versus the cost per unit of phosphorus removed (Fig. 3.1) may be attempted for the recommendations yet to be acted upon. A proposal to build a new City of Winnipeg wastewater treatment facility, with an approximate capital cost of CDN$1 billion dollars for example, will only remove 5 per cent of the phosphorus load to Lake Winnipeg (the per cent load currently attributed to the City). We argue that other instruments for nutrient management might give higher nutrient management benefits per unit of nutrient management cost. This argument supports the need for further research into potential nutrient management solutions that might require a lower resource investment level with a higher return rate of nutrient removal.

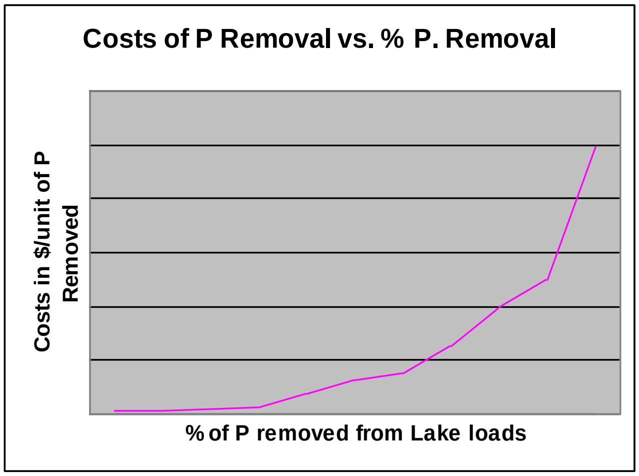


Figure 3.1: Cost of phosphorus removal vs. % phosphorus removal

To gain some insight into IWRM implementation for nutrient management across the world, the next section of this paper reports on some international best practice cases with some emphasis non-market-based instruments including payments for ecosystems services. Lessons for the Lake Winnipeg watershed are also summarized for each case.

4. Integrated Water Resources Management Best Practice

This working paper uses international best practices to demonstrate strengths and challenges of IWRM implementation at community, regional, provincial and international transboundary levels. Institutional structures, inter- and intra-institutional dynamics, funding arrangements and multi-stakeholder participation are explored within the international cases as part of this study. This paper also goes explores the linkages between IWRM and PES using the case summaries to demonstrate the range and scales of PES implementation and the use of PES mechanisms in achieving IWRM goals.

Criteria for case summary selection

These case summaries were selected and reviewed to demonstrate and compare best practices in integrated water resources management in the international and Canadian contexts from an institutional point of view. We identify institutional components of successful integrated water resources management projects from these selected cases. Case summaries are described and analyzed with respect to:

- Motivations for IWRM initiation (water quality, water quantity, etc.)
- Stakeholder participation and interagency cooperation
- Watershed management implementation
- Decision-making authority/dynamics between stakeholders
- Budget and funding sources
- Watershed services (where relevant)
- Beneficiaries (where relevant)
- Evaluation of IWRM, watershed management implementation (including improvement in water quality, access, etc.)

While the number of case summaries selected is not enough to quantify our institutional findings, we do attempt qualitative analyses with the help of existing reports of these case studies, where available. Some of the selected case summaries are well known examples of IWRM, such as the New York watershed in the United States and the Fraser Basin Council in Canada.

The case summaries are organized by scale, starting with the smallest, community-level summaries, followed by regional level summaries, provincial or national and international levels of IWRM case summaries.

4.1 Community-level case summaries

4.1.1 Lake Bhoj, India

Watershed Size: 361 km^2
Population: City of Bhopal, 1.7 million
Major Watershed Issues: Reduced water quality and reduced storage capacity due to siltation

Fig 4.1: Location and Map of Lake Bhoj watershed. (adapted from www.ilec.or.jp/eg/lbmi/reports/04_**Bhoj_Wetland**_27February2006.pdf)

Evolution and Motivations

The state of Madhya Pradesh in central India is one of the poorest in the country, with an estimated 37 per cent of the population below the officially accepted "poverty line," compared to the 26 per cent for the country as a whole (Madhya Pradesh Human Development Report, 2002). The state experiences at least one drought every year, and several parts of the state show severe over-exploitation of groundwater (Overseas Development Institute, 2002). The city of Bhopal in central India is best known for the infamous 1984 Union Carbide gas leak and the 20,000 people that were killed in its aftermath. Since then, the city has focused, amongst other rebuilding initiatives, on reducing pollutants and protecting its watersheds. The Bhoj Lake was built in the eleventh century and now provides around 40 per cent of the drinking and household water for the city's 1.7 million inhabitants. Lake conservation efforts had previously focused on reducing pollution, particularly sewage and solid waste, from urban sources.

Previous initiatives have involved infrastructure development, including a new urban sewage system and a mass education campaign towards better lake water management by the state-level government. The initiatives have been supported through recognition of the Bhoj wetlands as a RAMSAR site; a wetland area of global ecological importance.

Support and Participation

As most of the catchment is rural, the state government of Madhya Pradesh realized that it was vital to address rural issues in order to maintain water quality in Lake Bhoj. Farm beneficial management practices (BMPs), such as organic farming, are being encouraged to reduce nutrient loads from chemical fertilizers and pesticides. While these initiatives are being implemented by the state government with financial aid from the Government of Japan through the Japan Bank for International Cooperation (JBIC), payments for ecosystem services mechanisms are being considered for the long-term sustainability of these programs. These payments would be made by the residents of Bhopal, by local industry and tourism operators who would benefit from the maintenance of the lake and its water quality. Winrock International India, a local NGO, has been working on developing a PES scheme for the Lake Bhoj watershed and has completed a communications and outreach strategy and a "willingness to pay" survey to this end in 2006. This project demonstrates the community-building potential of well-designed PES systems, through community capacity and economic benefits to farmers and other stakeholders.

Ecosystem Services

Intensive cash crop farming had led to the use of inorganic pesticides and fertilizers in the region. Additionally, there was a problem of dung from the large number of cattle. A drive to promote organic agriculture and to encourage farmers to use compost made from cow dung as fertilizer was initiated by the state government. Trials are also being conducted with earthworm-based vermi-composting, open stack composting and bacterial starter inoculants to see if these methods can speed the conversion of the dung. Another affiliated program uses local prison inmates to round up stray cattle and produce manure for the prison nursery. Inmates are now training local farmers in manure production and organic farming. All these initiatives directly or indirectly affect water quality in the Bhoj Lake.

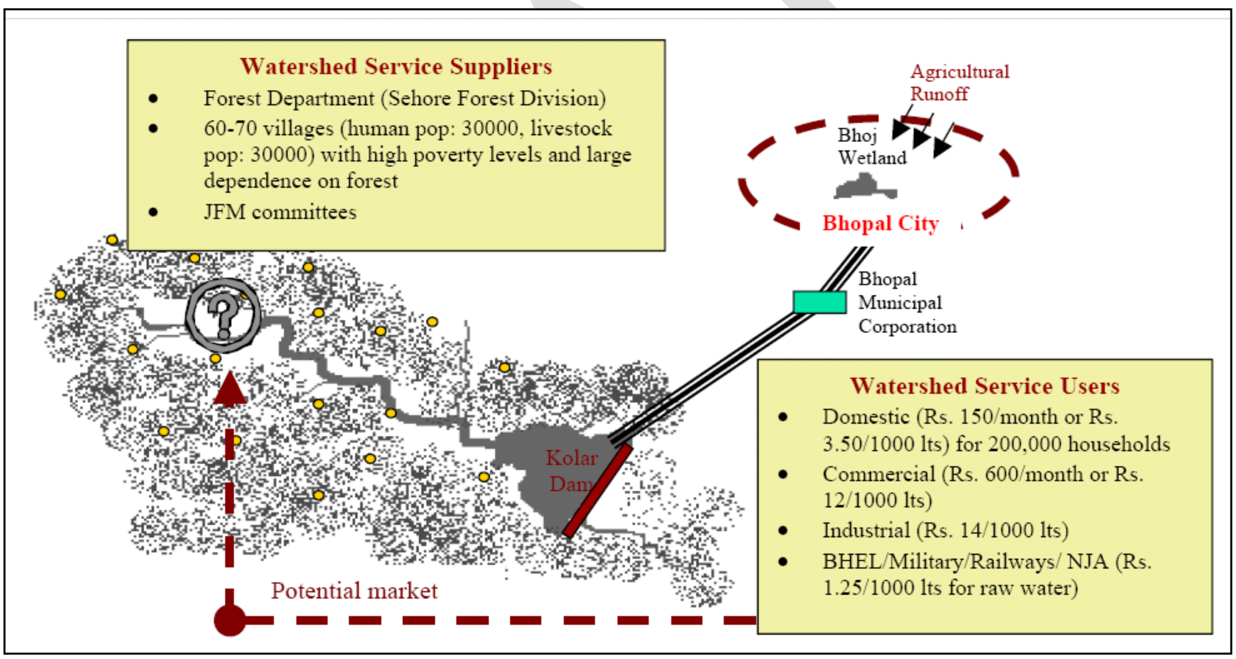


Figure 4.2: Pictorial representation of Bhopal water supply catchments (Sengupta et al., 2003)

Beneficiaries

One set of beneficiaries of the Lake Bhoj watershed management project are people in the City of Bhopal, who get 40 per cent of their drinking water from the Lake. Apart from this, the lake supports tourism development on its shores and is of cultural and religious significance to specific local groups. The public works departments and the department of drinking water for the city of Bhopal are beneficiaries of reduced maintenance and filtration costs and responsibilities through the management of upstream inputs into the watershed. The farming community providing the watershed services gain from the long-term benefits of converting to organic farming. Capacity is built in state prison inmates who learn to provide ecosystem services including cattle-rearing, production and use of manure, and also in demonstrating and training the local communities in organic farming practices.

Financial incentives

While an incentive program already exists to encourage farmers to convert to organic farming practices to reduce nutrient loads on the watershed, a PES scheme between the City of Bhopal and the upstream farers is being considered. Winrock International India (WII), an NGO in the region, conducted a survey to gauge the community's "willingness to pay" for clean water services. It was determined that Bhopal inhabitants were willing to pay a sum of money to an independent, "impartial" lake watershed conservation organization to conduct the transactions of the incentive payments to farmers, but not willing to add a payment to their taxes, or pay government agencies. This survey highlighted the relevance of a trusted intermediary in the success of an effective initiative.

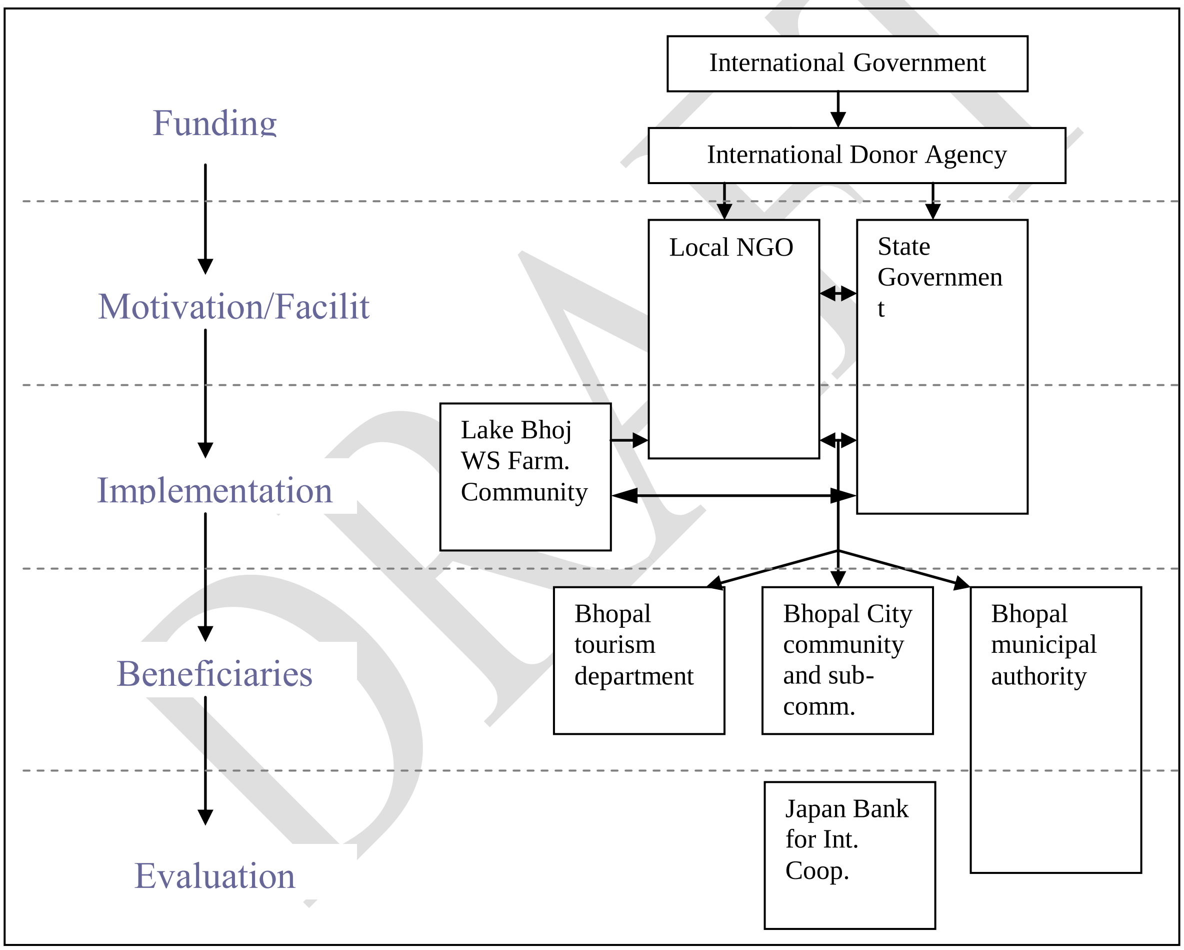


Fig 4.3: Model for Lake Bhoj PES project

A current action learning research project by WII, in partnership with the Lake Conservation Authority, a watershed agency created by the state government of Madhya Pradesh, is focusing on the development of mechanisms through which payments can be generated from the "receivers" of watershed services, and channelled to the "suppliers" in the catchment for improving water quality.

Evaluation
Three evaluation studies are planned by Winrock International India to assess land use management practices, watershed services and impacts on livelihoods. This project is also covered as a documentary as part of the Earth Report on Television Trust for the Environment (TVE).[7] The 5-part documentary titled "Shed Loads" focuses on watershed services and payments for these in different parts of the world.

Relevance to the Lake Winnipeg watershed
The context and values of the Lake Bhoj to the City of Bhopal is similar to the contact and values associated with the Lake Winnipeg. While the city of Bhopal values Lake Bhoj as a lake of cultural and recreational significance, Lake Winnipeg holds a similar iconic position for Manitobans and for the City of Winnipeg. In addition, there are similar stakeholders involved: agricultural lands are the primary source of nutrients into the Lake Bhoj. While the primary responsibility for water quality and watershed management lies with the state government, the largest land use is agricultural. Therefore the onus of best management practices for water quality conservation lies with the large number of farmers in the region. There are very obvious differences as well—the farm units in the Bhoj watershed are very small compared to their North American counterparts, and behaviour change at the farm level is easier to implement and monitor. In addition, the financial resources available are of a different scale. Effective coordination between ecosystem service providers and beneficiaries, the presence of an effective intermediary for coordinating the two sides and the support from government agencies are definitely lessons applicable to the Lake Winnipeg watershed.

[7] http://www.handsontv.info/series6/programme_6.html

4.1.2 Amboro National Park, Bolivia

Watershed Size: 270 km^2
Population: 3,500 (approx.)
Major Watershed Issues: Water quality and quantity.
Total Budget: \$40,000 + \$3,000/annum for last 3 years

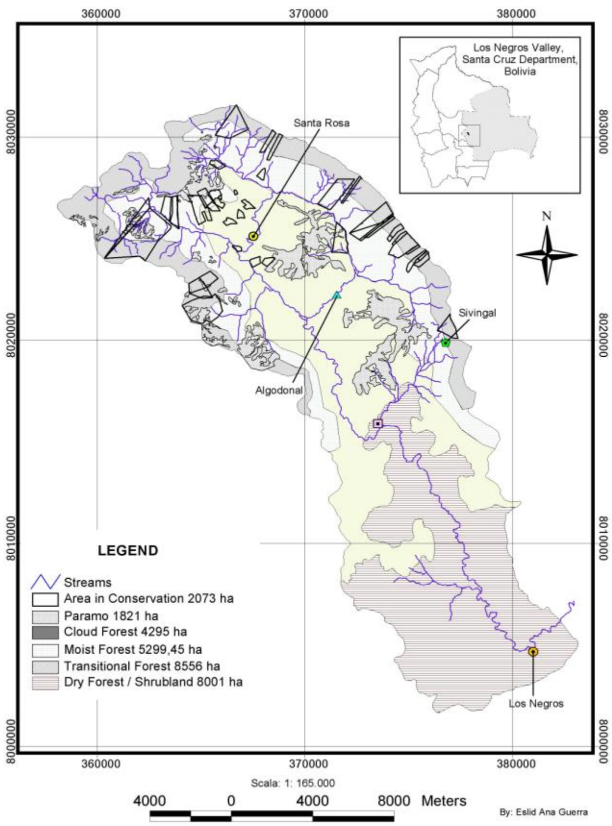


Fig 4.4: Los Negros valley subwatershed

Context and Evolution: Bordering the upper reaches of the Los Negros watershed in Bolivia, is the 637,000-hectare Amboro National Park. It is one of the most biologically diverse areas in the world—712 species of birds have been discovered so far. The national park and its buffer zone are increasingly threatened by illegal land incursions (Asquith, 2006). The valley, with its fertile lands, is most popular amongst vegetable farmers. They have used water from the irrigation channel upstream for the last 70 years. In the last 20–25 years, there has been a substantial drop in water quality and amount of produce in the downstream community of Los Negros as more farmers in the upstream community of Santa Rosa clear land for farming and cattle grazing.

Partnerships: These two agricultural communities in the rainforest areas in Bolivia have come together in the past few years to find ways to protect their watershed and maintain livelihoods. Through facilitation by the local organization, Natura, and funded by international donors, farmers downstream are paying farmers upstream to reduce their land-intensive agricultural practices and take up bee farming. They have built trust between traditionally distrustful communities so that no one loses and everyone can make a decent living.

They all acknowledge the importance of an environmental committee; in this case Natura, the Bolivian Nature Foundation. Natura acted as a mediator for the inter-community discussions and negotiations, provided beekeeping training and now acts as technical experts, assessing forest health using GPS to measure land area covered by rain forest and determine compensation. Natura was funded by the Garfield Foundation, the U. S. Fish and Wildlife Service and the Conservation, Food and Health Foundation and is currently being funded by the Blue Moon fund and Fundacion PUMA. Farmers know that down the line they may have to pay out of their own pockets, but are grateful to have external funding for now.

Beneficiaries: The beneficiaries in the Los Negros valley are the downstream farmers that get cleaner water supply from the Los Negros River, resulting in higher and better crop yield. The upstream farming community also benefits from the less labour-intensive practice of bee farming and do not have to cut down hundreds of acres of rain forest to farm honey bees. Cleaner drinking water and diversified crops are benefits to the entire valley community. The PES initiative facilitates a sustainable agriculture and rural development movement.

Funding and financial incentives: The communities have understood that the rain forests are critical to maintaining the quality of river water. Now farmers downstream are paying farmers upstream to protect the forest, reduce clearing and to convert to bee farming. One PES-enrolled farmer explained in an interview: "If I receive cash, I know I will spend it right away. Instead, I want these payments to create something that lasts" (Asquith, 2006). Beekeeping came up as an interesting alternative two years ago and communities started communicating and negotiating about compensations for water quality. They agreed upon ten hectares of forest preserved for every bee box. The farmers were trained in beekeeping and honey extraction and the originally trained are now training newcomers to the program.

The communities use the honey as a substitute for sugar and the surplus is sold downriver in towns and cities. They are considering future compensation in the form of barbed wire and fruit plants.

Payments for ecosystem services are used in this case to facilitate a transition to sustainable agricultural and rural development (SARD) with long-term social, economic and environmental benefits. It also highlights the potential for using a PES mechanism for the resolution of watershed-based conflicts in similar contexts.

4.1.3 South Tobacco Creek, Manitoba

Watershed Size: 25 km²
Population: Unknown
Major Watershed Issues: Collective desire to know impacts of agricultural practices on the watershed

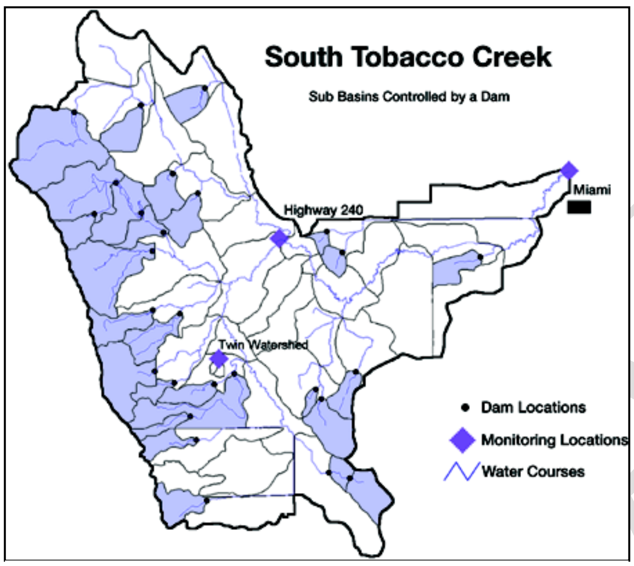


Fig. 4.5: South Tobacco Creek Watershed

Motivations and Evolution

In the early 1990s, a group of farmers in the South Tobacco Creek region joined together to form the Deerwood Soil and Water Management Association. Amongst other functions, this association monitors the environmental impacts of farming practices in their watershed. All 44 agricultural landowners within this 25 square kilometre drainage area are now members of the association and voluntarily provide all of their land use and management data for incorporation into a GIS system managed by Agriculture and Agri-Food Canada. Long-term water quality, flow and land use trends are analyzed and reported by research partners working with the Deerwood Association. Additionally, federal/provincial Equivalent Farm Planning[8] efforts have been initiated within the North Tobacco Creek sub-watershed (Coleman Project, Pembina Valley Conservation District). Both the North and South Tobacco systems consist of mixed farms, including cattle operations. The existing South Tobacco Creek (STC) sub-watershed is one of Canada's most extensively monitored agricultural watersheds, with scientific operations dating to 1991.

Partnerships and support structures

Association members work with several federal, provincial and conservation organizations. All partners appreciate the potential synergistic benefits associated with advancing South Tobacco Creek (STC) watershed plan elements, which could also support government policy directions related to Environmental Farm Planning, Lake Winnipeg water quality improvement and various biodiversity-related activities (e.g. wetland restoration, riparian health, fish habitat). A significant level of partnership assistance in the form of GIS data analysis, watershed mapping, funding and media coverage has been secured from government agencies.

Ecosystem services

[8] Environmental farm plan, or equivalent agri-environmental plans, are part of an Agriculture and Agri-food Canada initiative to help Canada's agricultural producers develop and implement environmental farm plans (EFPs) aimed at helping the agriculture sector better identify its impacts on the environment; and promoting the growth of stewardship activities within the agriculture industry. While Equivalent Farm plans include several farms, environmental farm plans are applied to one farm at a time.

Beneficial management practices in the STC sub-watershed include zero tillage methods, use of small reservoirs and dams for water storage, the use of holding ponds downstream of cattle containment areas, the conversion of crop land to forage and the improvement and enhancement of riparian areas in general. Due to an extensive monitoring network, the STC has developed a growing set of high quality baseline data that includes existing federal program activity and that is fairly representative of the entire Prairie landscape.

This community-driven approach resulted in the early identification of “Farm Income” and “Water Management” as critical local priorities that would need to be prioritized in a STC watershed plan. On-the-ground interventions include the previously mentioned small headwater retention structures, or “small dams.” Between 1985, and 1996, 50 small dams were constructed by the association, primarily on the upland tributaries of the two watersheds: Graham and Tobacco Creek. In the watershed area, there are predominantly three types of small dams:

- **Dry dams/flood control structures** serve to decrease peak flows during spring snow melt and summer run-off events by retaining water for a short period of time;
- **Backflood dams** retain water at a shallow depth over large acreages of annually and/or pasture cropped lands. Water is retained for at least two weeks before being released, thereby greatly increasing soil moisture in the flooded area to the benefit of crops and wildlife; and
- **Multi-purpose dams** are designed to reduce peak flow during spring snow melt and summer rainstorm run-off events by retaining water for a short period of time, and to store water for summer use. Fifty per cent of the dam storage capacity is retained for seasonal use. This includes stock watering, small scale irrigation, wildlife habitat, fish rearing and ground water recharge.

Beneficiaries

Downstream producers are facing a reduced incidence of culverts being washed away heavy flow in peak rain/ run-off seasons. Other beneficiaries of the STC watershed services include the provincial and municipal government agencies that are responsible for water quality, land use planning, habitat conservation, etc. Local communities are beneficiaries of cleaner water, knowledge of the impacts of their agricultural practices, and the larger community benefits from learning from the research and data collection. Since the STC watershed eventually feeds into the Lake Winnipeg watershed, the cottaging community and other beneficiaries of Lake Winnipeg are also indirect beneficiaries of Tobacco Creek management.

Funding

Funding for the STC project comes from a variety of sources, including the federal, provincial and municipal governments, universities, and from private sources including donations and membership fees. It must be noted that a significant section of the management inputs and data research inputs are in-kind donations, of volunteer time, land base for research and other non-quantified contributions.

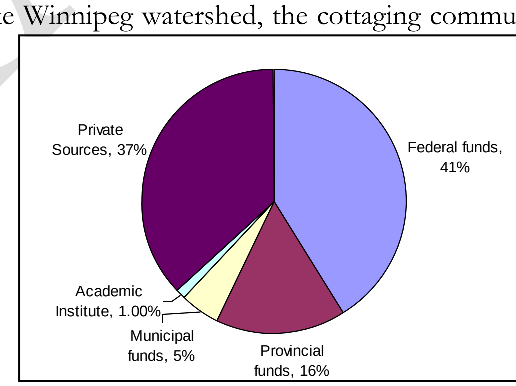


Fig. 4.6: Funding sources for South Tobacco Creek watershed

Evaluation

The effectiveness of the small dams in the South Tobacco Creek watershed have been highlighted through studies evaluating their cost-effectiveness and efficiency in addressing serious land and water management concerns such as flooding and erosion. Small dams in the region have reduced damaging peak storm-water and spring run-off flows by up to 90 per cent at individual sites. Deerwood’s efforts were estimated to be saving two local municipalities in excess of CDN$50,000 per year in reduced costs for the maintenance and repair of roads, bridges and drainage ditches (Oborne, 1995)

Watershed	Water Yield	N Load Inflow kg/yr	P Load Inflow kg/yr	N Export Outflow kg/yr	P Export Outflow kg/yr	N Retention kg/yr
Steppler (mean from 1999-2002)	**113**	**905**	**115**	**733**	**98**	**172**
Madill (mean from 1999-2002)	**121**	**666**	**86**	**507**	**87**	**159**

Table 4.1: Nitrogen and phosphorus reduction in the South Tobacco Creek (Stainton and Turner)

The success of the STC watershed initiative has led to the development of the proposed Tobacco Creek Model Watershed (TCMW) initiative. This proposed initiative aspires to incorporate agricultural beneficial management practices (BMPs) in about 900 km^2 of land adjoining the STC. It has generated interest among its partner municipalities, who have demonstrated a willingness to support it with cash and in-kind contributions if it can help address the inter-related and chronic local issues of farm income and water management.

The success of the STC initiatives is also apparent in the development of the TCMW project and due to the fact that the STC is the site of two major initiatives funded through the Canada-Manitoba Agricultural Policy Framework Implementation Agreement, specifically:

- WEBs (Watershed Evaluation of Beneficial Management Practices), a four year environmental and economic study of most BMPs approved for use by the Agricultural Policy Framework (APF). The Steppler Watershed within the South Tobacco Creek system is one of only seven WEBs sites in Canada and only two on the Prairies; and
- Environmental Farm Plan – Equivalent Planning in the North Tobacco Creek system (Coleman Watershed), in partnership with private landowners and the Pembina Valley Conservation District in which local farmers will be supported in applying a variety of BMPs approved under the APF.

Relevance to the Lake Winnipeg watershed

The South Tobacco Creek watershed lies within the larger Lake Winnipeg watershed and therefore its successes contribute to the management of the Lake Winnipeg watershed as a whole. It is also anticipated that the lessons from this sub-watershed management would be directly applicable to the whole watershed or other parts thereof. While the residents and producers of the South Tobacco Creek watershed are far from being typical, they do embody the challenges faced by watersheds in the region and also the potential for the rest of the Lake watershed. The case context is representative of the bio-physical and policy context that exists in a large part of the lake watershed.

3.1.4 Synthesis at community level

All case summaries at the community level highlight a few main aspects of effective community-based IWRM. In the case of Lake Bhoj, the Los Negros Valley and the South Tobacco Creek the strength of IWRM implementation comes from effective facilitation and a bottom-up approach to IWRM implementation. While all of these cases incorporate some sort of payments for ecosystem service mechanism, a PES-based lesson from these cases is the need for clear articulation and communication of ecosystem services between service providers and beneficiaries.

The cases in India and Bolivia, specifically, also highlight the value of PES initiative in community development and conflict resolution skills. Both cases show the payments facilitating the development of a more sustainable form of agriculture and rural development. In Bolivia, the PES schemes address a typical problem of agricultural extension (cutting of forest land for agriculture). The conflict resolution aspects of PES initiatives is of particular interest to similar contexts with conflict: urban-rural divides, water-based conflicts, livelihood-related conflicts or land-related conflicts. These conflicts are typical to many agro-ecosystems (including prairie Canada) and the PES initiatives offer some financing, as well as institutional, capacity-based solutions to these.

IWRM of the Bhoj Lake in India demonstrates participation from NGOs, government agencies, farming communities, prison inmates and a willingness to pay by the local communities. It is indicated that a non-centralized, participatory approach to integrated lake management has been successful in this context. In addition, the importance of a non-partisan, external organization to facilitate lake management is highlighted through a survey (albeit by an NGO) that indicated that the community of Bhopal would be willing to pay an external agency for the watershed services, but not any government agency. This external organization may play the role of facilitator, as well as the communicator between service providers and beneficiaries in the case of a PES initiative. The importance of education and of involvement of the communities and stakeholders is also highlighted in this case summary.

The South Tobacco Creek case summary is considered a regional model demonstrating extraordinary initiative and stewardship of local farmers. However, it is this uniqueness that makes critiques wonder about the replicability of this model. The single strongest factor contributing to the success of the STC model is the motivation of participating stakeholders combined with timely funding programs that have allowed this enterprising group to realize its stewardship aspirations.

4.2 Regional Level Case Summaries

4.2.1 New York City Watershed

Watershed Size: 5,180 km²
Population: Drinking water for nine million people
Major Watershed Issues: Drinking water quality

Evolution and motivations

The New York City watershed includes 2000 square miles across eight counties north and west of the city. When faced with the challenge of spending US$6 billion on a filtration plant in the early 1990s to provide clean drinking water to the city, the authorities decided to look at alternative means for high standard drinking water. In the early 1990s, the city implemented a comprehensive source water protection program that focused on both protective and corrective initiatives to ensure that the Catskill-Delaware system remained unfiltered and sustained its high quality.

Fig 4.7: New York City Watershed. Source: http://www.nyc.gov/html/dep/gif/map.gif

Partnerships and Support

The New York City Department of Environmental Protection decided to initiate a mutually beneficial urban-rural watershed protection partnership—to benefit the residents of New York City and also provide benefits for the communities of the Catskills and Delaware. While this partnership is currently quoted as one of the all-time successes in integrated water resources management, it did not start out as a success story. There was large-scale opposition from the farming communities to the idea of implementing beneficial management practices directed and funded by the city. The traditional rural-urban divide reared its head and meetings between stakeholders were kept in check with the presence of state troopers and law enforcement officers (Huneke and LaTourette, 2006). A pilot project was started with ten farmers in the region who were selected from a volunteer group on the basis of their standing in the farming community and their influence on their peers.

The partnership had to be a balancing act, providing equality among the farmers and local landowners in the water catchment areas, the environmental regulators and the city ratepayers. A period of constructive discussion and mutual education began in 1991. The environmental regulators set out to explain to the farmers the risks of some of their farming methods from the environmental viewpoint, and the economic consequences in terms of land prices. The farmers, in turn, educated the city about economic pressures they faced and how previous anti-pollution measures did not work. They were concerned about the suggested restrictions and new practices that might prove too costly to implement. In 1993, the stakeholders decided to create the non-profit Watershed Agricultural Council (WAC) to administer the voluntary, incentive-based watershed agricultural program. This council was governed by a Board of Directors (currently 18 directors), of which only one represented the New York City Department of Environment (NYC DEP) and all others represented farming communities and local governments in the Catskills and Delaware regions.[9]

In January 1997, after years of debate, the parties tied all these prior agreements together in a comprehensive Memorandum of Understanding (MOU). The city committed funds of approximately US$350 million, in addition to its agriculture and land acquisition funding to support the economic-environmental partnership

[9] www.nycwatershed.org/index_wachistory.html

programs with upstate communities. This included a water quality investment program, a regional economic development fund and a regional advisory forum for water quality initiatives and watershed concerns. These programs have guaranteed the maintenance of the City's pristine water quality into the foreseeable future.

Programs include infrastructure development, such as the development of new wastewater treatment facilities in watershed communities, land acquisition programs, watershed agricultural programs including nutrient management, education and restoration programs, waterfowl and wetlands management activities and regulatory tools of inspection and enforcement. Farmers in the watershed area participate in the program and are paid incentives to continue beneficial practices to conserve water quality. Voluntary participation in the program may result in thousands of dollars worth of beneficial management practices (BMPs) established on their farms funded by the NYC DEP. On the other hand, non-participation in the program automatically subjects the farmers and communities to water quality regulations.

Ecosystem services

The farmers that sign the voluntary participation agreement with the watershed agricultural council (WAC) agree to develop a Whole Farm Plan in conjunction with a Planning and Implementation Team. As part of the whole farm plan, potential pollutants are categorized and prioritized and farm-level BMPs are identified and implemented accordingly. BMPs are usually categorized for the following issues:

- Parasites and phosphorus: Animal waste
- Pesticides: Mixing and loading areas
- Phosphorus: Fertilizer storage
- Parasites: Animal and manure management
- Nutrient Management
- Nutrients: Concentrated sources
- Sediment: Diffuse
- Pesticides: Field and animal application
- Fuel storage
- Other: Toxic material

BMPs include stream buffers, agricultural easements and other specific waste management practices. In addition to the farm BMPs, the WAC conducts numerous programs for clean water; forest management; land stewardship; economic initiatives, including market development programs and farm to market programs; and education programs including model forests and school tours.

Beneficiaries

The proposed water filtration plant proposed for the city of New York was estimated at approximately US$6 billion for design and construction and US$300 million in annual operating expenses. By saving these large sums of money, the New York City Department of Environmental Protection is one of the primary beneficiaries of the watershed management project. The New York City community benefits from lower impact, more sustainable, high quality drinking water without the extra costs associated with a new filtration plant. The farmers in the area, the providers of the watershed management services, are also benefiting from implementing the agricultural and cattle rearing best management practices from higher crop yield and lower cattle infections. The regulated water quantity and water quality are benefits for all residents in the region, including agricultural producers.

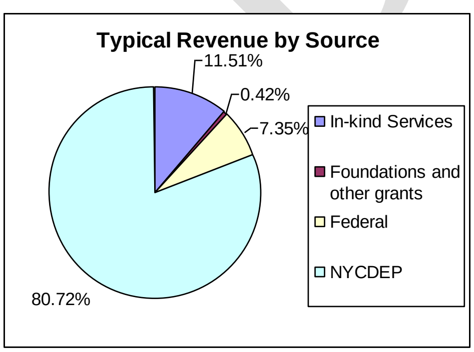


Fig 4.8: Funding sources for NYC watershed

Funding

To date, more than 3,600 best management practices have been installed at a cost of millions of dollars. In addition, the City has augmented the program with the addition of a City/Federal cost-sharing effort known as the Conservation Reserve Enhancement Program (CREP). CREP pays farmers to take sensitive riparian buffer lands, adjacent to water bodies, out of active farm use and re-establish a vegetative buffer. More than 165 miles of farm stream buffers have been enrolled in the program.

Evaluation

New York City's drinking water is monitored and tested on a daily basis by the city's drinking water office and has so far maintained its high quality. In addition, the CREP funding is based on the evaluation of riparian buffers and efficient systems of water conservation. The New York case summary, in addition, has been evaluated and reported by numerous academic and non-academic researchers and has been recognized as a model of watershed management and planning best practice.

Relevance to the Lake Winnipeg Watershed

The New York watershed is considered a leading example of successful implementation of a PES program within the context of watershed management. New York City's watershed management program has succeeded largely due to the initiative of the city to regulate best management practices (BMPs) in the upstream regions, and also due to city-funded incentive programs for the implementation of these BMPs. In addition, the NYC case provides us with insights regarding the urban-rural divide and the lesson that these divides may be breached through careful negotiation and the building of institutional, human and financial capacity. An important lesson for the Lake Winnipeg watershed is also the communication between service providers and beneficiaries that allows both sides to understand the value of ecosystem services.

4.2.2 Grand River Watershed, Ontario, Canada

Watershed Size: 7,000 km^2
Population: ??
Major Watershed Issues: Environmental and water quality problems

In Canada, local organizations, especially municipalities and special purpose water management districts, have long been key players in water management (Ivey *et al.*, 2002). Such organizations exist in Ontario, Canada in the form of the Conservation Authorities (CAs).

Fig 4.9: Grand River watershed. Source: http://www.grandriver.ca/Forestry/images/ForestPlan_Map_Political.jpg

According to the research of Ivey et al. (2002.), the establishment of CAs in Ontario, through the 1946 Conservation Authorities Act, was prompted by a variety of social and environmental concerns. Two of the serious of these concerns was finding employment for armed forces personnel when they returned from the Second World War, and fears that environmental degradation would eventually affect economic growth and development in Ontario. CAs were created as a partnership between municipalities and the Province of Ontario to manage the quality and quantity of surface waters in particular, and natural resources in general. CAs are based on watershed boundaries and have the power to undertake research, acquire land, raise municipal levies, construct works, control surface water flows, create regulations, and prescribe fees and permits. Authorities can manage land that they own and enter into agreements to manage land that they do not own. CAs have responsibilities for construction and operation of flood control structures and regulation of floodplain development. Municipal responsibilities and roles include operation of water supply works, construction and operation of drainage systems and flood control works, and land-use and emergency planning. The overlap in the functions of the CAs and municipalities lead to their close collaboration in many successful project implementations.

Evolution and motivations

The Grand River posed a number of environmental and water quality problems in the early to mid 1900s. To deal with these issues, a group of eight municipalities banded together to form the Grand River Conservation Commission in 1932. In 1942, the commission completed the Shand Dam, the first multi-purpose dam in Canada, built for flood control and low flow augmentation to improve water quality in the dry summer months. The Conservation Authorities Act in 1946 gave rise to the Grand Valley Conservation Authority in 1948. After some debate about the practicality of two conservation organizations in the same watershed, to avoid potential conflict over roles and responsibilities and to eliminate duplication, the Grand River Conservation Authority (GRCA) was established in 1966 through the amalgamation of the two organizations. The GRCA was created to enable municipalities to jointly undertake water and natural resource management on a watershed basis. Senecal and Madramootoo (2005) explain that the GRCA management evolved from single-use planning in its infancy—essentially river channel improvement for transportation—to ecosystem-based multiple-use planning on a watershed scale that entailed the diversification of activities from primarily structural functions to the current mix of structural and non-structural.

Partnerships and structure

The GRCA currently has 26 members directly appointed by 22 municipal councils representing 34 upper and lower tier municipalities. Member municipalities participate in the administration and operation of the GRCA through their appointed representatives and support it financially through general municipal levies and special project levies that directly benefit a municipality or group of municipalities. This governance model has proved successful and many international delegations have considered implementing a similar approach.

Ecosystem Services

The GRCA is involved in water quality management both directly and indirectly. Its key activities include land and water management, low flow augmentation through controlled reservoir releases, moderating low flows during the summer and early fall and ensuring adequate dilution of waste water entering the Grand River system. In addition, they also conduct monitoring and modelling of water quality, water temperatures, pH, conductivity and dissolved oxygen. The GRCA provides water supplies at its conservation areas and nature centers, most of which are not connected to the municipal water systems.

Beneficiaries

Since the main functions of the GRCA include watershed management, recreation and environmental education, the beneficiaries include watershed communities, educational institutions and municipalities. Watershed management functions of the GRCA focus on reducing flood damage, improving water quality, providing adequate water supply, protecting natural areas and watershed planning. The Grand River watershed is partially responsible for providing drinking water to a number of cities and counties in the region including Waterloo, Brantford, Guelph, and the Six Nations of the Grand River Territory.

Funding

According to the GRCA annual report, the organization's annual budget averages between $15 million and $20 million. As an agency established under the *Conservation Authorities Act*, the GRCA forms a partnership with the Province, watershed municipalities and others to fund conservation programs. Sources of revenue for conservation programs include watershed municipal levies, provincial and federal grants, conservation area and nature centre user fees, property rental income, hydro-electric production, tree-planting user fees and tree sales, financial support from partners and funds generated by the Grand River Conservation Foundation. It is estimated that of the average total, 10 per cent is government grants, 55 per cent is self-generated revenue and about 35% is municipal revenues[10]. General municipal levies are collected for watershed management activities and special levies are collected for projects that directly benefit a municipality or a group of municipalities. Self-generated revenue sources include: conservation area and nature centre user fees; property rental income; hydroelectric production; tree planting user fees and tree sales; financial support from partners; and the Grand River Conservation Foundation.

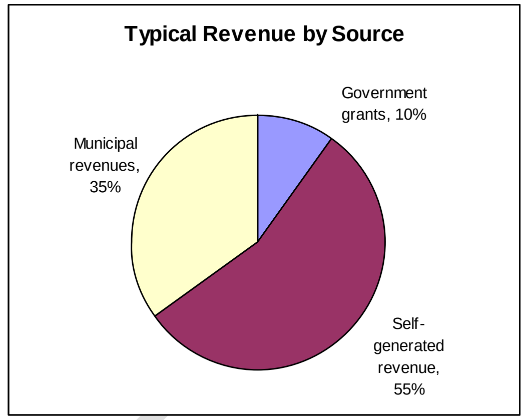


Fig 4.10: Funding sources for GRCA watershed

Evaluation

The GRCA has its own monitoring system that consists of real-time water levels, water flow, rainfall, reservoir and water quality monitoring stations. The role of the monitoring system is to provide information to support water management decisions related to flood emergencies and day to day operations of the water control structures. The GRCA is also part of the provincial flood warning system and works in collaboration with the Province of Ontario and Environment Canada. Environment Canada also operates a portion of the stream gauges in the data collection network. Senecal and Madramootoo (2005) indicate that the success of the GRCA can be partly attributed to the relatively high level of direct control over water management and watershed resources. They also highlight the relative affluence of the CA and its capacity to generate revenue through activities such as hydroelectric production and property rental as contributors to its success.

Relevance to the Lake Winnipeg watershed

The Conservation authorities in Ontario are similar to the Conservation Districts mandated by the Manitoba provincial government and have the same sorts of overall duties. While the Manitoba Department of Water Stewardship is initiating watershed planning through the existing conservation districts, the conservation authorities in Ontario are based on a watershed model since their inception. The authority to collect watershed-related taxes and tariffs, and generate project related funds is a significant advantage that the Ontario conservation authorities have over the Manitoba Conservation Districts and proposed watershed authorities.

[10] Typical Revenues by Source. www.grandriver.ca/Grca/pdf/GRCABrochure.pdf

4.2.3 Lower Souris River Watershed, Saskatchewan

Watershed Size: 8,400 km²
Population: 14,300 (2001)
Major Watershed Issues: Land use changes and nutrient loading

Motivation and evolution: The Four Creeks Watershed Advisory Committee was originally developed independently of government and worked towards the management of the Four4 Creeks watershed. With a growing interest of government agencies in the workings of local watershed management, the committee gave way to the Lower Souris Watershed Committee in 2006. The Lower Souris Committee now works with representatives from the 4 Creeks, Pipestone and Antler River Committees to manage the Souris River watershed.

The land-use shift from grasslands to agriculture resulted in an increase in nutrient loading to the watershed. In 2001, at least 5,800 people were affected by a serious outbreak of gastrointestinal illness in the North Battleford area. In response to this outbreak and the findings of an inquiry, Saskatchewan Environment initiated a sweeping Safe Drinking Water Strategy. A key element of the strategy was the creation of the Saskatchewan Watershed Authority (SWA), to better coordinate water source protection across the province by merging the existing watershed management responsibilities of SaskWater, Saskatchewan Environment and the Saskatchewan Wetland Conservation Corporation. SWA formally started the watershed-based planning process, although basin-level management activity had already existed in basins such as that of the Souris River.

Implementation: The Lower Souris Committee actively promotes beneficial management practices (BMPs) throughout the watershed through workshops, tours and on-farm visits. BMPs are implemented to improve the quality of local land and water resources. The Lower Souris Agri-Environmental Group Plan offers incentives for two BMPs including wintering site management and riparian area management. The Lower Souris River Watershed Source Water Protection Plan was developed by the local advisory committees in each watershed planning area with critical support from the Lower Souris River Watershed Technical Committee.

Partnerships and structure: The Souris River Watershed Source Water Protection Plan is being developed at sub-watershed levels by the local advisory committees with help from the Lower Souris River watershed Technical Committee. The membership of the Watershed Advisory Committee includes representatives from local municipalities, First Nations, industry, environmental and agricultural interest groups. Technical support is provided by government agencies and by Ducks Unlimited Canada. The SWA supports this IWRM initiative by committing at least one planning team member to be involved with the Watershed Advisory Committees.

Funding and financial tools: Funding for farm-level BMPs comes from a variety of sources; 12 municipalities contribute $1,500 each, and have been since the beginning of the program and before provincial government involvement. The provincial watershed authority (SWA) contributes $25,000 annually and makes in-kind contributions of staff time. Ducks Unlimited Canada also makes an annual contribution of $15,000 and in-kind contributions of staff time. The committee seeks federal funding for specific programs.

The SWA is currently in the process of applying for federal funding for a pilot project to examine how ecosystem goods and services (EGS) policy tools could be used in a real working landscape to achieve desired environmental endpoints. The project will determine the net costs (or lack thereof) borne by agricultural producers in the Lower Souris to provide target quality and quantity of appropriate habitat in the Lower Souris Watershed using actual on-farm data. Combined with farm economic data, a model will generate actual costs borne by producers to generate wildlife habitat. A provincial watershed authority's interest in PES for watershed management is indicative of its potential for policy-makers at various levels.

Evaluation: The SWA currently monitors water quality in the Lower Souris River Watershed. Local concerns over water quality in the Moosomin Reservoir led to the formation of a lake stewardship group that included local residents, stakeholders and the Saskatchewan Watershed Authority, previously Sask Water, in 2001. Since then, Saskatchewan Watershed Authority staff, with the assistance of the local stewards, have conducted annual sampling on the reservoir. A water quality report of the results is produced by the Saskatchewan Watershed Authority each year. The SWA released the State of the Watershed Reporting Framework in January, 2006. This indicator-based report card will provide information about the human activities (environmental stresses), and the health of the watershed (conditions), and it will report on the effectiveness of the management activities (responses) designed to address change within the watershed.

4.2.4 Synthesis of regional-level case summaries

Both the New York and Grand River case summaries demonstrate success in regional level watershed protection. A key element of the success in both regions is the involvement and participation of various levels of government and communities. In both areas, a large scale program that included the various stakeholders was affected and the collective action of the stakeholders, with the overseeing of a municipal government in the New York case, and a collective board in the Grand River case was key to collective action and successful implementation. Institutional capacity and effective coordination between the various levels of government and watershed level organizations emerges as a key component of success.

In the New York case, a combination of incentives, persistence and adequate financial resources were instrumental in overriding the mistrust and urban-rural divide. Financial resources are contributed by the municipal authority and are justified by the savings from a new water treatment facility. The Grand River case summary relies on a number of different sources of financing. These include government grants, self-generated funds and municipal sources. In both the NYC and the GRCA cases, the financial resources play a significant role in their success as a watershed management authority. The GRCA is a corporate body born of a municipal government initiative (Senecal and Madramootoo, 2005). Similar to the New York case summary model, the GRCA enjoys a great deal of power over water management through structural (levies, hydroelectric production) and non-structural (stakeholder representation) means. The NYC watershed case summary indicates that water-related conflicts must be dealt with effectively and pre-emptively for effective implementation.

The Lower Souris case reinforces the concepts of coordinated action through local watershed agencies. While the onus for implementation is localized, a large part of the planning and funding is centralized. This participative model has been repeated through the regional case studies.

4.3 *Provincial/National Level Case Summaries*

4.3.1 The Guadalquivir River Basin, Spain

Fig. 4.11: Guadalquivir river watershed. Source: http://www.grid.unep.ch/product/publication/freshwater_europe/images/map14.jpg

Watershed Size: 57,017 km²
Population: 4 million
Major Watershed Issues: Floods, droughts, water use conflicts and water quality degradation

Spain has perhaps the longest history of any country in developing formal governmental authorities on the river basin scale, with the earliest ones dating from 1926. Although the river basin authorities in Spain (Confederaciones hidrograficas, or CHs) have changed responsibilities and participatory structures over the years, they represent a notably long-lived set of basin management institutions. The CH for the Guadalquivir River is one of the oldest in Spain, and the river basin faces floods as well as drought, tensions between urban and agricultural water uses and water quality degradation. It is situated almost entirely within the Spanish region of Andalusia.

Partnerships and structure

The CH structure is under the direction of the central government or regional governments depending on whether they cover an inter-regional river basin or an intra-regional one. In addition, irrigation water communities and users, urban water suppliers, government agencies at all levels of government, and other minor stakeholders such as hydropower generators and other energy groups are also stakeholders for management of the river basin.

Spain has had a water law since 1879, which was updated with the need for a law that would include more current priorities and circumstances. The water law of 1985 represented a major reform of water policy in Spain. The purposes of the new law included a more integrated water planning approach, the incorporation of economic techniques of water management and implementation of greater recovery of water costs from water users.

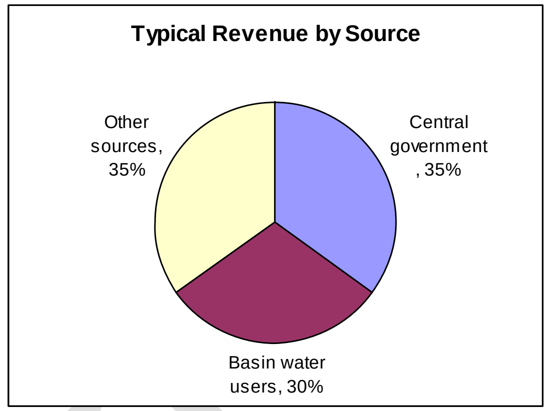
The CHs were created by the central government for its own purposes, neither because of local-level demands for greater autonomy nor because of central-government desire to shed water management responsibilities, but as an organizational device for executing central government policy one river basin at a time.

Implementation

Internally, CH Guadalquivir is organized into staff offices plus a set of boards, councils and commissions composed of basin stakeholder representatives and CH staff. The CH president serves as head of the CH staff, chairs the advisory bodies and has a strong role in guiding the CH's activities. The president is appointed by the Council of Ministers and is effectively an official of the central government. The governing board is in charge of financial matters, approves action plans and defines aquifer depletion and groundwater protection areas.

Funding

While, legally, CHs must cover their expenditure, CH administration and operations are funded by a combination of revenue from the central government and revenue generated by the CH itself. CH Guadalquivir reported a 2001 annual budget of US$115,800,000, with 35 per cent coming from the central government, 30 per cent from basin water users and 35 per cent coming from other sources.



An important income is tariffs and taxes on water users and residents within the basin. CH Guadalquivir retains all of these locally-generated revenues for use in the basin. CHs also receive an annual appropriation from the central government. This is meant to cover some costs incurred in implementing and enforcing national laws and regulations. The national government also passes some EU structural funds through to the CHs to assist in economic development of poorer member states.

Evaluation

The Guadalquivir case has been analyzed by the World Bank in an Institutional and Policy analysis context. The analysis report (Kemper et al., 2005) highlights that while the existence of a central government-based; basin-level organization emphasizes the priority given to river basin management, literature on this case summary (Blomquist et al., 2005) indicates that while it has maintained some level of autonomy and generated a large part of its own finances, the focus of this organization has been largely on supply augmentation rather than a broader range of concerns. It is also perceived to be catering to irrigators' interests and is critiqued as being non-participatory in nature. Although stakeholder representation on the CH boards and councils was expanded in 1987 and 1989 central government decrees, the management structure and internal culture of CH Guadalquivir has been slow to change, and the formal decision-making authority remains concentrated in the hands of the CH president and board. Guadalquivir's "water deficit" has not been erased and exposure to droughts remains a problem. Drought problems have been dealt with through structural solutions, such as the building of dams that have not proved successful.

Decentralization reforms and the establishment of river basin management with active stakeholder involvement are processes that take time, sometimes even decades. In order to sustain the reform process, consistent support is vital, as is the ability to adapt and modify basin management arrangements in response to changed conditions. To incorporate a payment scheme for ecosystem services in the CH Guadalquivir case, beneficiaries (local communities, farmers, municipalities) would have to be identified and made aware of the watershed benefits that they get as a result of CH project implementation and management.

Relevance to the Lake Winnipeg watershed

The management of watersheds in Spain has been implemented through central government agencies at the watershed level. While a significant section of literature on effective IWRM implementation has stressed on a more "bottom-up" approach and the presence of a non-partisan watershed level organization, the Spain case summary shows another model for IWRM implementation. While this model has been criticized, including the fact that the CH structures are irrigation biased, there are definitely studies that identify the CH organizations in Spain as being effective and centrally-managed, but operationally decentralized, tools for watershed management.

4.3.2 Fraser Basin Council

Watershed Size: 238,000 km²
Population: 2.7 million
Major Watershed Issues: Water quality and quantity, flood control, hydropower production and wetlands management.

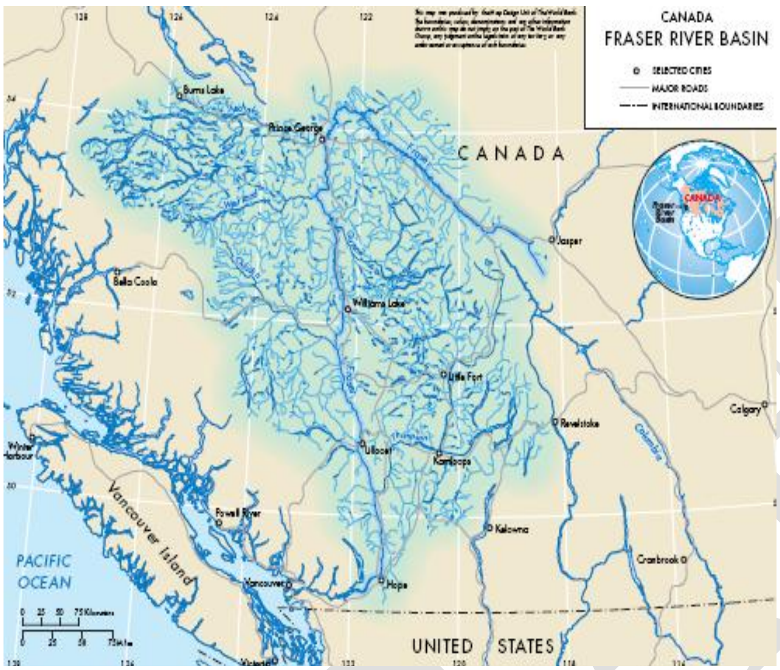


Fig 4.12: Fraser Basin watershed (Source: Kemper et al., 2005)

Evolution and motivations

The Fraser Basin contains an extraordinary range of ecosystems and spectacular natural beauty, and is considered one of the most productive areas of British Columbia. Activities in the basin contribute 80 per cent of the province's gross domestic product and 10 per cent of Canada's gross domestic product. During the 1980s it became evident that industrial and agricultural pollutants, over-fishing and rapid urbanization were compromising the environmental health of the basin. As a result, challenges related to water management began to surface, including: water supply, pollution control, fisheries management, flood control, hydropower production, navigation and wetlands management.

Partnerships and structure

The Fraser Basin Council (FBC), a non-governmental, not-for-profit organization has adopted four "directions for sustainability." These include understanding sustainability, caring for ecosystems, strengthening communities and improved decision-making. These four directions facilitate problem solving among the council and its partners. By bringing together the necessary people to make decisions and create solutions balancing social, economic and environmental considerations, engineered solutions are based on the needs of the entire basin. The council acts as a catalyst for solving inter-jurisdictional issues, as a conflict resolution agent, and as a sustainability educator. It therefore aims at a governance model that "brings together multiple sectors and interests in a collaborative, sustainability-centered context, to promote the common good" (Alexander et al., 2006) To ensure that a broad diversity of perspectives is heard with respect to any sustainability issue, the Council's Board of Directors consists of representatives of four orders of Canadian government (federal, provincial, local and First Nations), the private sector and civil society.

Implementation

In all of its work, the FBC remains impartial, trans-partisan, independent and non-political in its primary role as an advocate for a sustainable basin (Alexander et al., 2006). This consensus-based governance model provides a means to overcome the limitations of the traditional hierarchy of multiple jurisdictions operating independently in a common bioregion and "top-down" approaches to governing.

Primarily, the council conducts its business through the work of five standing committees: operations; staffing/financial operations/audit; constitution and council director recruitment; sustainability fund; and communications. Specific projects are overseen by five regional committees, and also by issue-specific task committees. These committees provide the implementation structure and decisions are by consensus.

Funding

The Fraser Basin Council generated an income of CDN$2.8 million in 2005 and CDN$2.2 million in 2004, while corresponding expenses were CDN$2.5 million and CDN$1.8 million respectively in those years. The funding for this council comes from a combination of federal, provincial and municipal governments. Revenue is also generated through project-based work and through events such as the State of the Fraser Basin conference. In addition, there is investment income and income from donations.

Evaluation

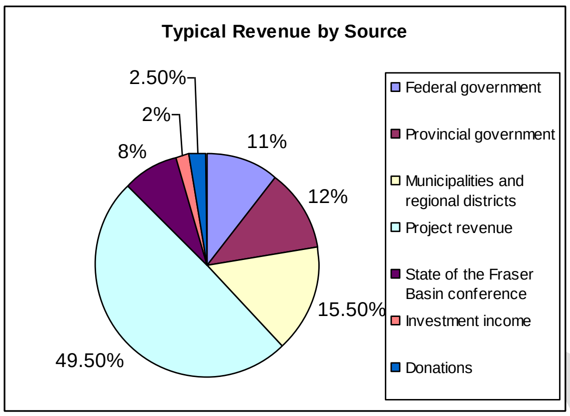


Fig 4.13: Funding sources for FBC

The Fraser Basin Council evaluates the sustainability of the river valley and its own performance in the State of the Fraser Basin Report every two years. The 2006 report, the third of its kind, addresses sustainability issues in 18 key areas, from air quality to business sustainability, health, energy and forestry. The last report is also undergoing a long-term evaluation of its own and the website invites participants to a three, six and twelve month review of the report.

The World Bank has reported on the Fraser Basin council governance model and highlighted its strengths and weaknesses from an institutional and policy perspective. The report (Blomquist et al., 2005) states that the NGO approach has provided "a means of crossing jurisdictional boundaries among levels of government." The report also claims that it has allowed the integration of First Nations communities and private stakeholders in ways that more traditional governmental programs have found difficult or impossible. In addition, it has provided a good forum for information generation and sharing, since there is less concern over who "owns" the information. It has preserved a reputation for objectivity and for building a more diverse financial base. One key to this success has been the ability of the council to promote the concept of interdependency among stakeholders. The Fraser Basin Council, as an NGO, is able to take on a broad range of issues and, in a way, provide political cover for participating agencies.

The NGO approach epitomized by the Fraser Basin Council also has its weaknesses. The council is generally unable to implement the plans and programs it agrees upon, and must hand them off to others—usually governmental agencies—for implementation. Other vulnerabilities include the fact that the council's consensus decision-making approach, though helpful in a number of respects, can at times be inefficient. Also, as an NGO reliant upon contributions and funded projects, the council is vulnerable to "mission creep," the temptation to move beyond its primary concerns and interests to follow the money.

According to Kemper et al. (2005) the Fraser Basin experience has demonstrated that establishing effective multi-stakeholder processes requires time and commitment, key interests should be involved at the earliest possible point and multi-interest processes can effectively provide a forum for addressing the joint management of land and water for more sustainable watersheds.

Relevance to Lake Winnipeg Watershed

While the complexity of issues and the number of stakeholders is higher in the case of the Lake Winnipeg watershed than in the Fraser Basin, the Fraser Basin Council provides us with an existing model of multi-jurisdictional watershed governance. A forum for stakeholders to come together and address their different points of view and agree on a vision for the basin and work together towards its fulfillment is a useful lesson of the Fraser Basin Council model. While the Fraser Basin Council has not been granted official power to regulate and legislate change, and nor is it funded generously by government sources, it has managed a diverse funding base, some degree of autonomy and is a respected quasi-governmental watershed agency. A similar forum for the Lake Winnipeg watershed may be used to determine an integrated vision and coordinate watershed level planning.

4.3.3 Seine-Normandy Basin, Water Parliament System, France

Watershed Size: 97,000 km^2
Population density: 17.5 million
Major Watershed Issues: Water quality and land use.

The 1964 Water Law in France created the novel concept of Water Agencies, each with its own "water parliament," or basin committee. France and its river network are divided into six geographical zones called catchment basins. Since 1965, each major catchment basin has a river basin committee and a corresponding executing authority called the Water Agency. The decentralization of water management was reinforced by the second Water Law, which, in 1992 increased the role of the water agencies and created a Master Plan for Water Management (SDAGE, Schéma directeur d'aménagement et de gestion des eaux), guidelines for balanced water management on a river basin scale, to be drawn up by a Basin Committee.

In 2000, the EU issued its Water Framework Directive (WFD), which outlines the principles for IWRM at the river basin level and requires that member states achieve "good status'" for all of its water bodies by 2015, using any methods they should choose. From an institutional point of view, the new French Water Law, which came into force in 2003, translates the WFD into French law.

The role of the Water Agency at the river basin level is to promote measures undertaken to ensure a balance between water resources and needs. Its role is mainly financial. It allocates funds— in the form of loans or subsidies—for projects that correspond to the objective of the Water Agency program. Thus, by evaluating proposals and monitoring funded projects, it also plays an advisory and consultant role that is widely recognized. The water bill paid by domestic and industrial users hooked up to the municipal water supply network covers the cost of drinking water distribution and wastewater collection and treatment. The price of water varies according to its treatment, management, supply conditions and wastewater discharge. The bill also includes a pollution tax and a resource withdrawal tax levied by the Water Agency. These taxes represent only a small proportion of the total water bill. Their revenues are redistributed by the Water Agency in the form of interest-free loans or subsidies, in accordance with a five-year program drawn up jointly by representatives of water users within the framework of the basin's SDAGE. This financial aid is meant to incite users to reduce the impact they have on the resource through investments or improved techniques. The amount of financial aid allocated to various categories of users is equivalent to the taxes they pay.

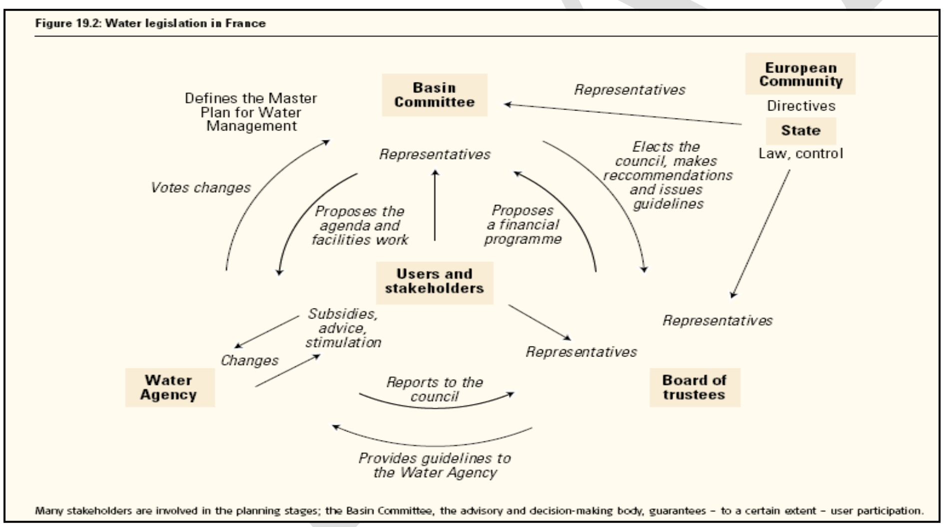


Fig 4.15: Water legislation in France. (Source: UNESCO-WWAP, 2003)

The calculation of the Water Agency pollution tax is based on the actual quantity of polluted water. For instance, a water treatment allocation has been set up for industries, based on water treatment efficiency and the wastewater destination, so that they are taxed for the actual amount of pollution that they release into the environment and into the local sewage systems. Water management in the Seine-Normandy basin is, therefore, in accordance with the polluter pays principle. All Water Agency revenues are spent on supporting pollution reduction and clean-up actions.

The French water management system incorporates a high degree of local responsibility, public-private sector partnerships, coordination on a river basin level and a consideration of all water uses. The river basin water agencies promote measures to ensure a balance between water resources and needs. While its role is mainly financial, it also plays an advisory and consultant role that is widely recognized by its partners. The acknowledged neutrality of the Water Agency also allows it be act as mediator in the case of water-related disputes. Water Parliament members include all basin level stakeholders and the six regional water agencies work in close collaboration with the federal and regional government agencies, relevant advisory boards and the watershed communities.

Load-Based Licensing in New South Wales, Australia

Based on the understanding that traditional approaches of pollution regulation no longer guarantee the best outcomes for the environment, the government of New South Wales initiated a load-based licensing (LBL) approach that applies the “polluter pays” principle to reduce air and water pollution.

Environmental protection licenses are a central means to control the localized, cumulative and acute impacts of pollution in NSW under the “Protection of the Environmental Operations Act 1997.” The LBL scheme, which commenced on July 1, 1999, sets limits on the pollutant loads emitted by holders of environmental protection licenses, and links license fees to pollutant emissions. LBL is a powerful tool for controlling, reducing and preventing air and water pollution in NSW. LBL combines the strengths of several regulatory instruments to achieve better environmental and economic outcomes. In particular, it:

- sets clear minimum standards for environmental performance
- incorporates powerful incentives for ongoing pollution reduction
- gives licensees flexibility to implement cost-effective pollution abatement methods
- increases regulatory transparency
- provides the infrastructure for emissions trading schemes
- enables the long-term tracking of emissions reductions.

Traditional systems of licensing allowed licensees to dilute pollutant concentrations, such that total emissions at any given time would be below permissible limits, without reducing cumulative effects. Also, a licensee would be penalized for exceeding the limit on just one occasion, even though its overall emissions may be significantly less than cumulative permissible limits. In addition, there was no incentive to do any better than the minimum required emissions.

4.3.4 Synthesis of provincial- or national-level case summaries

The case summaries at a provincial or national level demonstrate different methodologies for large-scale watershed management. While the CH structure in Spain is based on a national government regulatory structure, the Fraser Basin Council is a model of non-governmental organizational leadership coordinating government and non-government stakeholders for the management of a river basin. The CH structure is critiqued in the literature as being an organization that fulfills the mandate of the national government, including infrastructure development and fulfilling irrigation requirements. The Fraser Basin Council, on the other hand, attempts at IWRM with its participatory nature and with its diversity in funding sources and the willingness of all the stakeholders to work together to manage and protect their common watershed, but lacks any significant implementation authority. The sense of a common goal combined with a climate of information sharing and interdependency amongst stakeholders has contributed to its success.

The presence of an independent organization facilitating mediators and reinforcing the common purpose is attributed the success of the Fraser Basin Council case. The CH structure in Guadalquivir is attempting the move towards participatory development, but has a tradition of being central–government-driven and infrastructure-focused. The development of a common purpose and the trust among stakeholders working together towards this common goal is described as key to the FBC success and is markedly missing from the national government-driven CH structure in Spain.

4.4 *International-level case summaries*

4.4.1 Lower Danube Basin

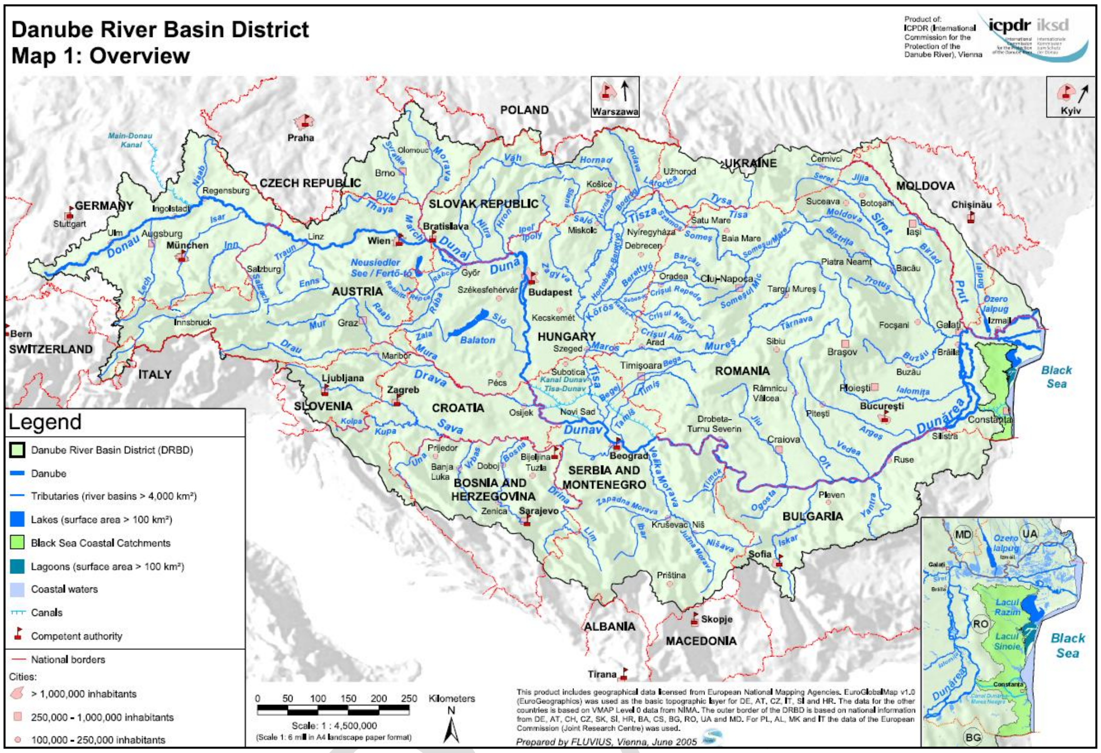


Fig 4.16: Danube River watershed. (Source: ICPDR, 2005)

Watershed Size: 801,463 km² (ICPDR, 2004)
Population: 81 million (ICPDR, 2006b)
Major Watershed Issues: Biodiversity conservation and invasive species, international water management, new infrastructure for shipping, eight proposed large dams, pollution

Evolution and motivations

The Lower Danube basin remains relatively untouched and features a biodiversity unparalleled in the rest of the basin, making it a great environmental asset. It is home to over 100 different types of fish and many rare bird species, and is also the largest reed bed in the world. In the last few decades, drastic interventions especially canalization, resulted in a severe reduction in habitats and biodiversity.

The Danube River drains into the Black sea—an inland sea with a drainage basin that covers about a third of the area of continental Europe. The northwest shelf of the Black Sea has been converted from a system based on rich and extensive beds of red algae and bivalves to an anoxic "dead zone." Studies by the Danube Basin Environmental Program suggest that about half of the nitrogen and phosphorus compounds found, which trigger the eutrophication process, are from agriculture, one quarter from industry and a similar proportion from domestic sources. The management of nutrients in the Danube Basin—a large contributor to the water in the Black Sea—is therefore important for the control of eutrophication in the Black Sea.[11]

[11] International Commission for the Protection of the Danube River http://www.icpdr.org/icpdr-pages/black_sea_trend.htm

Partnerships and support

The Danube River Basin (DRB) covers a vast area of over 800 million km², and covers the greatest number of countries in the world (for a river basin) with a total of eighteen states. Some countries, such as Austria, Hungary, Romania, Serbia and Montenegro and the Slovak Republic, are completely situated within the DRB, whereas less than 5 per cent of the territories of Albania, Italy, Macedonia, Poland and Switzerland lie in the basin.

The International Commission of the Protection of the Danube River (ICPDR) was established in 1998 to promote and coordinate sustainable and equitable water management practices, including conservation, improvement and rational water use. The ICPDR, with thirteen cooperating states, ensures that the measures to improve water management are reflected in the contracting Parties' national legislations and applied in their policies.

The ICPDR serves as the platform for coordinating the development of the Danube River Basin Management Plan, which is to be implemented by 2009. Preparation of basin management plans by this date is compulsory for all European Union (EU) countries as per the requirements of the Water Framework Directive (WFD).

Financial incentives

"The lack of appropriate financing mechanisms at the national as well as the regional level is perhaps the largest deterrent to the implementation of pollution reduction measures" (UNDP/GEF, 1999). While numerous initiatives are in place to address these threats, the lack of finances (for the reduction of nutrient overloading and biodiversity conservation programs) put them at risk in the longer term.

The need for sustainable financial resources to resolve watershed level threats to the lower Danube basin led to the development of payments for ecosystem services (PES) for sustainable financing. The support for the development for a PES system of the lower Danube was also provided by the large scale of the project, the Danube countries' commitment to the conservation of the Danube basin, the Eastern-bound enlargement of the EU, the recent EU Water Framework Directive, plus the ongoing greening of the EU Common Agricultural Policy. This effort was also conceived to provide a model of watershed management applicable elsewhere in the world.

While collaborative work in the Lower Danube is ongoing, the preparation of the river basin management plan is due in 2009, followed by the introduction of pricing policies for payments for ecosystems services to finance the watershed management and conservation. The timeline for the implementation of the Danube management is approximately 25 years, indicating the challenges anticipated in its formalization.

Beneficiaries

All member countries are potential beneficiaries of any integrated river basin management plan for the Danube. Improved agricultural systems, wildlife habitat and water quality benefits are anticipated from the management efforts. The eutrophication of the Black Sea will potentially slow down and even be reversed, potentially improving fishery, tourism, recreation and other coastal concerns.

Relevance to Lake Winnipeg Watershed

The Danube Basin watershed is one of the few international watersheds that the Lake Winnipeg watershed can learn from. The Danube Basin has initiated a multi-stakeholder process to implement and enforce a watershed management plan with a clear timeline. While the goals are to improve inter-jurisdictional cooperation and reduction of eutrophication in the Black Sea, the inter-jurisdictional organization in the form of ICDPR provides, once again, the value of a facilitating agency with the backing of government(s) for the management and implementation of basin-level plans. Funding for this organization is shared by member stakeholders.

4.4.2 Red River Basin Commission

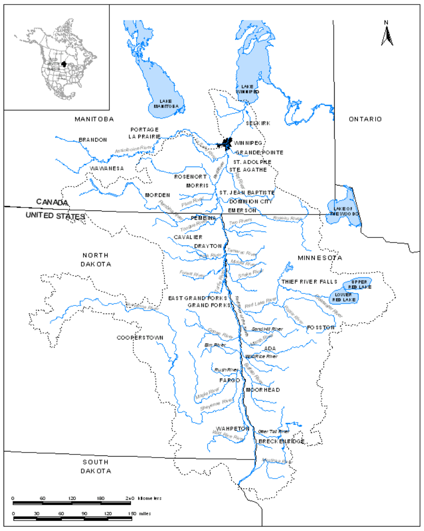


Fig 4.17: Red River Basin. (Source: RRBC, Winnipeg)

Watershed Size: 116,500 km²
Population: Unknown
Major Watershed Issues: International water management, floods, quality and nutrient management.

The Red River of the North flows north from its headwaters in Minnesota, across the Canada-United States international boundary, to its outlet at Lake Winnipeg in Manitoba.

The Lake Winnipeg watershed is the second largest watershed in Canada, spanning multiple governance structures. This watershed drains about 950,000 km² so that every square metre of the lake represents a drainage area of 40 m², the largest surface-to-drainage ratio of any major lake in the world (Casey, 2006).

Evolution and motivations

Lake Winnipeg is currently under scrutiny by a large number of government and research organizations for its increased frequency and severity of algal blooms. This may lead to reduced recreational appeal, degraded aquatic habitat, drinking water quality problems, clogged fishing nets and toxic algae. The Red River is the largest contributor of nutrients to the waters of the Lake Winnipeg (Manitoba Water Stewardship, 2006) and its management is a high priority for management of the lake. The city of Winnipeg is proposing a waste water treatment plant to treat the growing amount of waste water and sewage from the city of Winnipeg: this treatment facility is anticipated to cost about CDN$243 million.

The hydrologic system of the Red River Basin is complex and influenced by many natural and human forces. While floods have frequented the basin, the 1997 flood caused more property damage, loss of life and disruption than any of the preceding floods. Catastrophic damage occurred in Grand Forks, North Dakota, East Grand Forks, Minnesota, and Ada, Minnesota as these communities substantially or completely flooded. Although literally within a few inches of complete overtopping of protective levees and dikes, Winnipeg, Manitoba successfully repelled this flood, but feels a similar or larger future flood is a certainty.

The realization that actions by either the United States or Canada could directly influence the water resources of the other resulted in the 1909 Boundary Waters Treaty Act and the creation of the International Joint Commission (IJC), comprised of six members. Three of these members are appointed by the Governor in Council of Canada, and three by the President of the United States.

Water quality monitoring recommendations of the IJC led to the formation of the International Red River Pollution Board in 1969. In 2001, the International Red River Pollution Board and the Red River portion of the International Souris-Red River Engineering Board were combined to form the International Red River Board (IRRB). The mandate of the IIRB is to assist the commission in preventing and resolving transboundary disputes regarding the waters and aquatic ecosystem of the Red River and its tributaries and aquifers. Its geographical scope includes the Red River Basin, including the Assiniboine and Souris Rivers.

On the other side of the spectrum, a group of concerned citizens organized the International Coalition for Land and Water Stewardship in the Red River Basin. This group, organized as a tax-exempt non-profit in the United States and registered charity in Canada and brought together parties involved in land and water use to come to agreements on those issues. In addition, in 1981 a non-profit corporation was formed to provide a formal coordination between Minnesota and North Dakota. The impetus to form the Red River Water Resources Council came from the U. S. federal budget cuts, which terminated the Souris-Red Rainy River Basin commissions. In 2002, the International Coalition, the Red River Basin Board and the Red River

Water Resources Council merged to form the Red River Basin Commission, which was charged with the task of producing the Red River Water Management Plan.

Partnerships and structure

The Red River Basin Commission (RRBC) is a chartered, not-for-profit corporation at the river basin level attempting to work towards an integrated water resources and natural resources management plan. The existence of multiple political jurisdictions at the federal, state, provincial and local levels poses challenges to an integrated approach and the presence of a basin-level organization, contributes to alleviating these challenges. The RRBC has been structured to reflect the complexity of its watershed. Two federal governments, three states, one province, multiple counties and rural municipalities, cities, towns, First Nations and tribes are represented by 41 board members. Further subdivisions of local governments including soil and/or water conservation districts, watershed districts, county and city associations are all active participants in the Board and its committees.

Implementation

The Red River Basin Commission published the Red River Basin Natural Resources Framework Plan in 2005. The Plan Implementation Committee, including members of the Board of Directors and planning experts from all levels of government and the private sector, will oversee the framework's implementation. In addition, special task force groups were created to focus on specific problem areas. The RRBC also has a number of staff persons to assist in the coordination and implementation of RRB management implementation.

Funding

The Red River Basin Commission is financially supported by federal and state/provincial governments of both United States and Canada. The two federal governments provide funding through the International Joint Commission. In addition, the states of Minnesota and North Dakota, and the province of Manitoba provide substantial funding for the research, education and management of the Red River Basin. Local and county-level government agencies are responsible for over a third of the RRBC funding and the remainder is raised through private donations and through fees for projects.

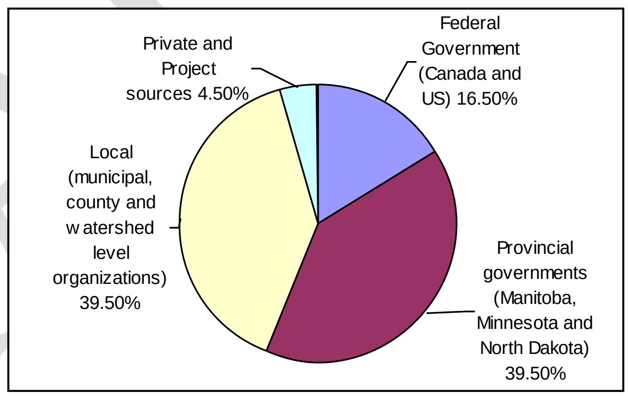


Figure 4.16: Funding sources for the RRBC

A larger issue for the Red River Basin is the Lake Winnipeg watershed and its issues. While the proposed city of Winnipeg Wastewater treatment facility might cost millions of dollars, the cost of implementing a watershed management and nutrient management project with a PES incentive program may be worth exploring.

Ecosystem services

The Red River Basin Natural Resources Framework Plan contains goals and implementation plans for the management of water quality and supply, soil conservation, drainage, fish and wildlife and outdoor recreation. The plan is aimed at:

- Encouraging a basin-wide approach to the management of natural resources; managing within watershed boundaries.
- Integration of diverse challenges such as flooding, water quality and supply, fragmentation of native prairie habitats, land use, and soil loss in natural resources management
- Overcoming jurisdictional fragmentation and political barriers.

Beneficiaries

While the habitants of the Red River Basin are the immediate and obvious beneficiaries of the management and ecosystem services, the Lake Winnipeg watershed-related communities benefit from the ecosystem services as well. Clean water for agriculture in downstream communities, clean water in downstream lakes—affecting cottaging communities and tourism—and more efficient riparian systems benefit municipalities and provinces alike.

Relevance to Lake Winnipeg Watershed

The Red River Basin is a primary part of the Lake Winnipeg watershed and also a primary contributor to its nutrient loading issue (see nutrient load graphs on page 7). While systems in place for the Red River Basin are systems that can be used for the management of the larger Lake Winnipeg watershed, it is also important to learn lessons from those aspects that do not work in the context of the Red River Basin. While the RRBC is an effective watershed coordination agency, it lacks implementation authority and financial autonomy—problems that carry through to management implementation at any larger scale.

4.4.3 Synthesis of international-level case summaries

The presence of a non-governmental, external agency acting as facilitator for watershed management seems key to the success of transboundary watershed management implementation irrespective of scale. An independent organization is able to work more effectively in the interest of the watershed and might help effectively coordinate basin-level activities, while the various stakeholders may think in terms of their own specific mandate. Both the Lower Danube and Red River case summaries are driven by an independent agency comprising the stakeholders for basin management. While one of the case summaries described is in the formative stages of a PES mechanism, the other has only just developed a framework plan for the river basin and has no economic instruments in place therein.

A common lesson from both cases seems to be the effective and ongoing participation of stakeholders in the successful management of the watershed. In the case of the Lower Danube, the introduction of payments for ecosystem services seems to be the proposed way to recover funds for the management of the river basin. This will ensure sustainability of the project and move the basin communities towards a better understanding of the value of the basin and its services. The Red River Basin Commission, on the other hand, funds the management of the basin by a combination of government grants and project-based funds and would very much benefit from the inclusion of a PES scheme to manage nutrient loading in the Red River and Lake Winnipeg.

5. Synthesis and Salient Features in Case Summaries

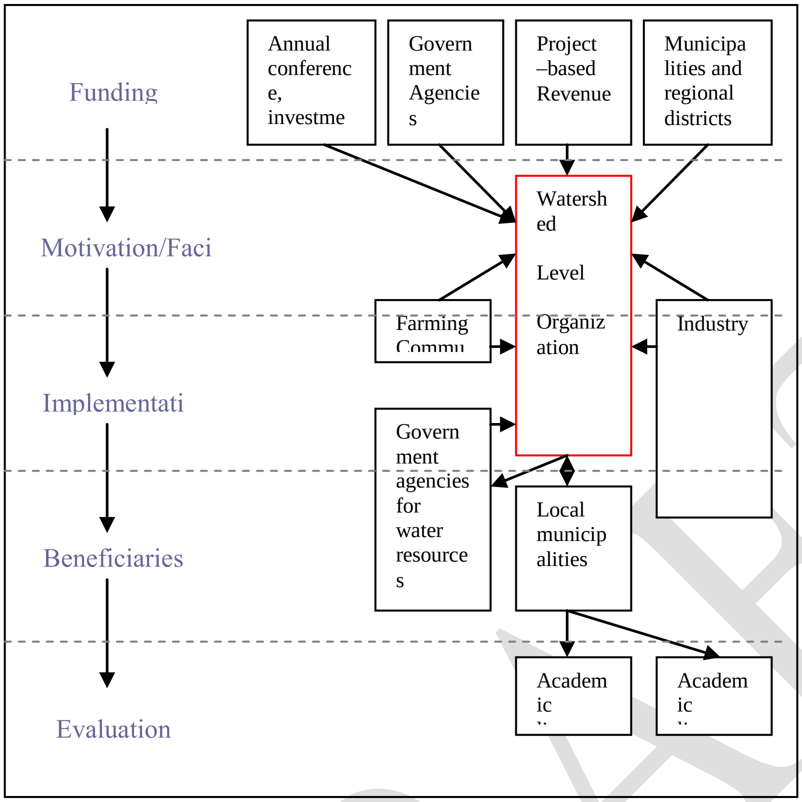


Fig 5.1: Model for PES in the context of IWRM

Successful, sustainable, cooperative river basin management is clearly a challenge (Blomquist et al., 2005). The case summaries demonstrate integrated water resources management responses to a variety of basin-level challenges using a variety of methodologies and instruments. The challenges are predominantly water quality-related, but also include pollution, urban development, flooding, seasonal water scarcity, water storage and erosion. The cases also differ on whether the development of institutional arrangements for water management at the basin level originates as a central government reform effort (as in the case of the CHs in Spain) or as an effort initiated by stakeholders within the basin (as in the case of the Fraser Basin Council).

Because IWRM at the river-basin level could involve a range of responsibilities and activities, it is not surprising that the cases differed in the manner in which IWRM was implemented. Some watershed managers had authority to allocate water to users and others did not. Many but not all were responsible for water quality. A few were engaged in setting and/or collecting water tariffs. Some operated dams, reservoirs and other physical facilities. A common function, however, was the watershed-level planning and coordination, such as the development of basin management plans and coordination of stakeholder activities at the watershed level.

With respect to reducing exposure to flooding and the management of water storage reservoirs, stakeholder involvement and performance improvements in the Guadalquivir case have gone hand-in-hand. For instance, according to Kemper et al. (2005), despite the fact that irrigation communities and basin agency personnel in the Guadalquivir basin have devoted decades to lobby for the construction of additional dams and reservoirs, the basin's annual "water deficit" remains in place. The report also claims that improvements to the efficiency of agricultural water use there have been piecemeal, unlicensed users of irrigation water continue to grow, and the issue of agricultural contributions to water pollution have only been addressed recently and partially. They attribute this to the fact that traditionally CHs have been irrigation-focused and only recently are shifting to a more integrated approach to basin management.

Blomquist et al. (2005) attribute successful IWRM implementation to a combination of factors that include, at minimum "the incentives of central government officials to participate in and support the devolution of authority to basin- and sub basin-scale organization, the incentives of stakeholders within the basin to assume and maintain responsibilities for participating in decision making and the implementation of management activities and enabling conditions such as a legal framework and the economic resources to make the intended management improvements possible in the first place, and then sustainable over time" (p. 6). The authors go on to identify four sets of variables under following major headings that influence incentives and conditions that are believed to be linked to basin management success or failure:

- Contextual factors and initial conditions
- Characteristics of the decentralized process
- Characteristics of central government and basin-level relationships and capacities
- The internal configuration of basin-level institutional arrangements

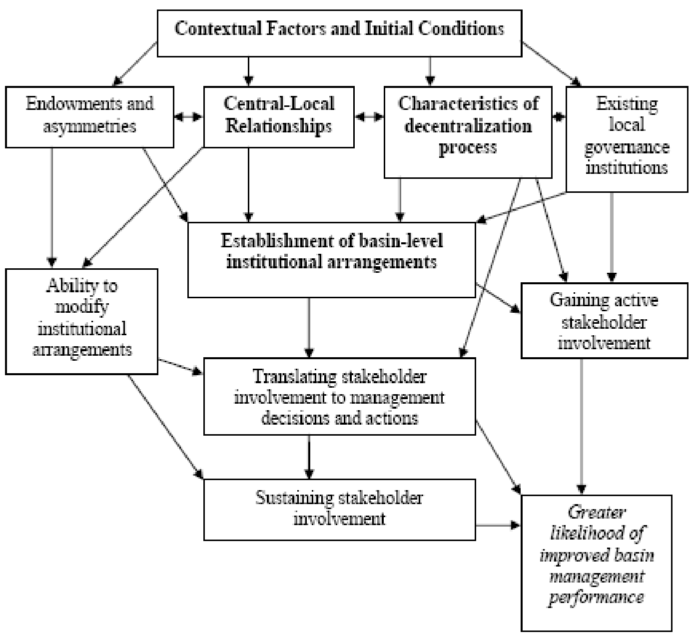


Figure 5.2: Theoretical framework of study (Blomquist et al., 2005)

Consistency of government support for basin management, stakeholder involvement, and water policy reform has emerged as the most important factors distinguishing cases we studied with greater levels of success and stakeholder participation from those with less. Related variables concerning financial resources mattered to longevity as well. Financial autonomy, and the ability to generate and retain revenue generated for improvements and operations at the river basin scale acts are also important determinants of IWRM success.

Some highlights of the case summaries are enumerated below:

a. **Stakeholder participation** in river basin-level management emerged as an important contributor to success in these case summaries. Since this is an inherent part of integrated water resources management, it may be the nature of the case summaries selected as well. While the most effective tool to initiate stakeholder participation seems to be education/awareness/outreach programs to ensure that watershed communities and other stakeholders realize the value of the watershed services, another aspect is that if stakeholders of a watershed share the goal of watershed management, the watershed management program is more effective than if it is imposed solely as a regulation or legislation. Building institutional capacity at the local watershed level through the policy support from central and regional governments is key to ensuring effective and high quality participation in decision-making and coordinated implementation of any watershed-level plan.

b. The presence of a **non-governmental organization/agency** or local watershed-level organization working in the interest of the watershed and its communities (human and ecosystem), implementing the project and mediating communications among the basin-level stakeholders is also emerging as a key component of the project success. This organization may resolve conflicts, organize meetings and events to bring stakeholders together, manage the financial aspects of the project or be the force that initiates collective action. The role of this independent organization spans a variety of tasks. Of the studied cases, the Lake Bhoj, Los Negros Valley, New York City watershed, Grand River, CH Gualdalquivir, Seine-Normandy Basin Committee, the Fraser Basin Council, the ICDPR for the Danube River and the Red River Basin Commission are non-government or quasi government agencies implementing or affecting the bulk of the IWRM implementation at the basin level. The efficacy of the organization seems often to be proportionate to its capacity (institutional, financial and technical). Some additional factors for the efficiency of a basin-level organization may be the representation of stakeholders. Another clear role of this basin-level organization is an identification of watershed-level ecosystem services and the communication of their value to watershed beneficiaries for an effective IWRM-PES linkage. Coordination capacity, therefore, seems a primary necessity for such an organization.

The argument supporting the presence of an NGO-driven river basin management organization is made by a policy analysis paper by the World Bank (Kemper et al., 2005), which claims that the NGO approach reduces some of the bureaucratic "turf battles" that one would expect to be associated with placing basin management responsibility in an existing agency, or creating an agency that would have authority transferred from, or overlapped with, existing agencies. Furthermore, the NGO approach, such as in the case summary of the Fraser Basin Council, has allowed for the integration of First Nations communities and private stakeholders in ways that more traditional inter-governmental programs have often been found difficult if not impossible. It has provided a good forum for information generation and sharing, since there is less concern over who "owns" the information.

The paper goes on to critique the approach as well, focusing on the Fraser Basin. It states that the [Fraser Basin] council is generally unable to implement the plans and programs it agrees upon, and must hand them off to others—usually governmental agencies—for implementation. Other vulnerabilities include the fact that the council's consensus decision-making approach, though helpful in a number of respects, can at times be inefficient. Also, as an NGO reliant upon contributions and funded projects, the council is vulnerable to "mission creep," the temptation to move beyond its primary concerns and interests to follow the money.

c. **Sustainability of funding** is another component of the success or failure of these watershed management projects. While some successes are dependent on external sources such as international aid agencies, many successful and sustainable watershed management programs are based on diverse funding sources, including government agencies, project finances and community-based funding. The diversity of funding reduces the financial vulnerability of an initiative or organization to political changes or resource re-allocation.

d. While funding for integrated water resources management is always a challenge, some successful case summaries are developing mechanisms for **payments for ecosystems services**. The sources of these payments vary from government tax incentives and subsidies to user payments by communities that benefit watershed conservation, including better water quality. The sustainability of an IWRM initiative may be enhanced by diversity of payment, valuation of watershed services and by the payment of incentives to watershed stewards for the management of the watershed and its services. For the success of such an initiative, it is important that the ecosystem services be specifically identified for the given context and clearly communicated to the beneficiaries. The role of a facilitation organization has been clearly identified for this purpose in a number of cases that we summarized. PES programs, as shown in the Bolivia case study, can act as effective mechanisms for conflict management and closing gaps between traditionally disparate values.

PES as a viable IWRM tool

In economics terms, watersheds are natural assets that deliver a stream of goods and services to society. Commercial markets, however, value these services only partially, if at all (Postel and Thompson, 2005). The failure to adequately incorporate the value of natural services into decisions about the use and management of watershed lands is reducing the net benefits that societies derive from watersheds.

The Millennium Ecosystem Assessment (MA) has identified payments for ecosystem services as a primary tool for the integrated management of water resources. In the context of freshwater ecosystem services, the specific tools of market-based approaches, payments and incentives for water conservation and payments for watershed services initiatives were reinforced. The MA stresses that payments for water conservation can increase water availability, but cautions that payments for watershed-based services that have been narrowly focused on the role of forests in the hydrological regime should be developed in the context of the entire flow regime, including land cover, land use and management practices. The MA recommendations stress that the value placed on watershed services would depend on stakeholder confidence in the effectiveness of proposed management of actions for ensuring that the service continues to be delivered.

The well-known success of the New York City watershed management plan is at least partly attributed to the success of the incentive programs that helped watershed farmers make the transition to beneficial management practices (BMPs) that promoted land and water stewardship. These incentives, or payments for ecosystem services, are therefore the tools largely responsible for one of the largest schemes in the world to offer direct payments by a beneficiary of hydrological services to the providers of those services. The New York case summary demonstrates that watershed protection through payments for ecosystem services can be a highly cost-effective alternative to technological treatment in meeting specific water quality standards. It also demonstrates that an inclusive negotiated partnership between upstream and downstream parties can result in expanded benefits for both (Postel and Thompson, 2005).

According to Kiersch et al. (2005), watershed-based PES can be divided into two main categories:

- *Local schemes* involve the service providers and beneficiaries of one watershed. Downstream beneficiaries may include municipal or private water supply, hydroelectric and other companies, such as beverage manufacturers. Providers may include individual landholders or groups of landholders, such as agricultural cooperatives.
- *National-level programs* finance incentives for land users through cross sectoral subsidies such as taxes on fuel or energy production. The funds are channelled through government programs, and there is not always a direct link between service providers and beneficiaries.

While the New York case summary is possibly the best demonstration of an effective, synergistic and mutually enforcing partnership between watershed service providers and beneficiaries, the Lake Bhoj, Los Negros Valley, Lower Souris River and the Lower Danube are all aspiring towards PES solutions to their watershed management issues in some respect. Some have piloted PES processes on some scale and are awaiting the long-term stability of these processes, and some, like the Lower Danube case, are aspiring towards a long-term planning of PES methodologies towards effective watershed management in an international context. The reiteration of the use (or aspirational use) of PES systems in IWRM in a number of IWRM implementation projects leads to our hypothesis that IWRM and PES are synergistic tools that enhance IWRM implementation.

The case summaries utilizing PES systems also reinforce the theory that PES is a viable tool that allows watershed beneficiaries to realize the value of watershed-based services, and that PES systems can allow for the building of institutional and inter-agency capacity that is an integral part of integrated water resources management implementation.

6. Instruments for Watershed Management

With some lessons for integrated water resources management implementation derived from the international best practice case studies, the next section of our research endeavours to identify specific instruments for integrated water resources management; tools that make nutrient management within a watershed easier.

The problems faced by water resources managers are many and diverse. The Global Water Partnership's IWRM Toolbox (2003) alludes to this contextual range and provides a "toolbox" for water resource management that includes regulatory, economic and social change instruments. According to the authors, these tools may be appropriately used according to the priority of the watershed context, policy context and the management plan adopted.

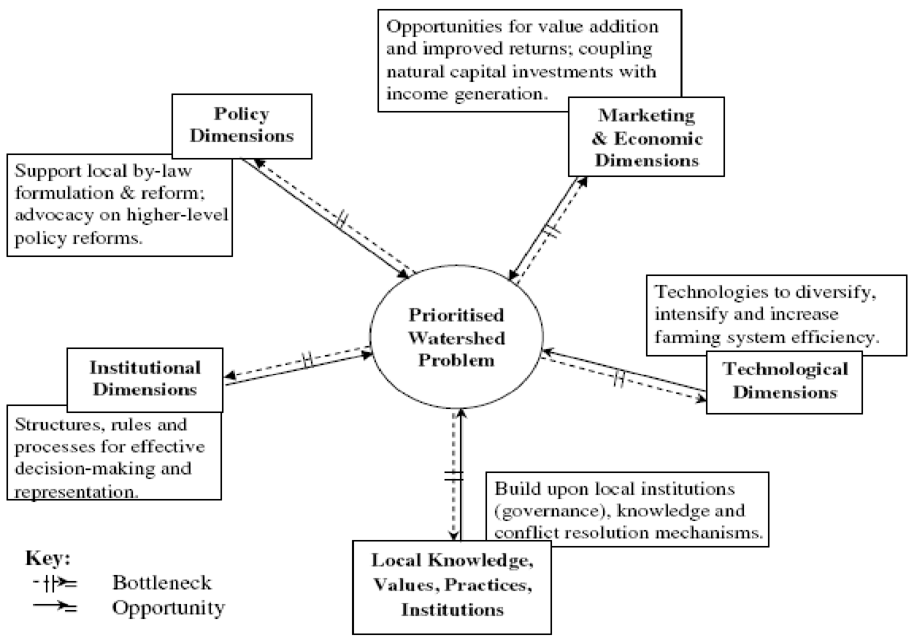


Fig. 6.1: Multi-disciplinary and multi-sectoral integration in watershed management (German et al., 2006)

While integrated watershed management may mean different things to different people, the above diagram demonstrates some aspects of multi-sectoral and interdisciplinary watershed management. According to German et al. (2006), this form of integration is required to address priority watershed problems through the integration and sequencing of technical solutions with social, policy and market interventions. The above figure gives one scenario of multi-sectoral approaches to addressing watershed problems, illustrating the many angles through which presumably "biophysical" problems can be addressed. The authors use the diagram to demonstrate the diversity of strategies to be considered when supporting local communities to address identified watershed problems. It is our opinion that this diagram may also apply generally to a range of options available for watershed management generally. Often, in practice, the solutions are some combination of these strategies, involving a range of policy, institutional, social and technical solutions.

For the purpose of this research, we have selected a categorization of instruments or tools potentially applicable to nutrient management in the Lake Winnipeg watershed.

Table 6.1: Categorization of policy instruments (Adapted from IISD and TERI, 2003)

Instrument Category	Instrument	Description
Market-based (Economic)		Market-based instruments— also referred to as economic instruments or financial instruments — are measures that directly influence the price that a producer or consumer pays for a product, behaviour, or activity.
	Tradable permits	**Market creation instruments**: A system of direct regulations can be used to create a tradable good or service and a market in which it can be traded. Previous to the establishment of the market, the use of this good may have been implicitly appropriated by polluters. Examples include emission permits (i.e., CO_2); development quotas (i.e. for tourism construction); water shares (where resource is indivisible in space, but divisible in use [Panaytou ,1998]). Conservation banking and wetland banking described later in this section are examples of tradable permits.
	Deposit refund	**Revenue generating instruments:** Instruments such as taxes, charges, user fees and deposit-refund schemes that require that money be paid to government in return for engaging in some behaviour. These economic instruments discourage undesired behaviour by raising their prices. To induce a significant degree of behavioural change, a tax or fee may have to be imposed at a level that raises the price of an undesired behaviour above that of an alternative behaviour, in order to achieve the correct relative pricing between the two options. The general principle to applying revenue generating instruments is to tax activities or behaviours that are to be discouraged or reduced (Barg et al., 2000).
	Performance bonds	
	Taxes	
	Earmark taxes & funds	
	User fees	
	Subsidies	**Subsidies:** Instruments such as cash subsidies, tax breaks and grants induce behavioural change by making the more desired behavioural option cheaper, thereby increasing its attractiveness to the producer or consumer (Barg et al., 2000) Conservation easements are examples of tax breaks.
	Tax breaks	
	Administered prices	Price control by governments via a regulated market.
Direct Expenditure		Governments influence producer and consumer by channelling expenditures directly at the behaviour they want to encourage. Direct expenditures differ from subsidies in that they are typically broad programs of expenditures targeted at a macro-level to foster activities like technological innovation, whereas subsidies reward incremental changes in individuals' behaviour. (Barg et al., 2000).
	Program/project operation	Governments may direct their budget toward programs that work directly on the environment to carry out ecosystem protection and/or restoration
	Green procurement	Governments can opt to spend their routine procurement budgets on goods and services that support environmental improvement goals.
	Research and development	Governments can allocate budget expenditures to R&D directed at specific economic, social and environmental goals.
	Moral suasion	Governments can encourage behavioural changes consistent with ecological goals by funding programs designed to provide information, education and awareness. These moral suasion and education programs are based on the premise that people behave in environmentally harmful ways because they lack information and knowledge, and that if they have good information, they will do the right thing. (Barg et al. , 2000)
Regulatory		Creating change via legal avenues
	Legislative instruments	Acts and regulations passed to carry out legal mandate for change
	Enforcement activity	The enforcement of legislative instruments
	Liability	Aims to induce socially responsible behaviour by establishing legal liability for certain activities such as natural resource damage, environmental damage, property damage, damage to human health, non-compliance to environmental laws and regulations, and non-payment of due taxes, fees or charges (Panayotou, 1998).
	Competition and deregulation policy	Government policy initiatives directed at orienting markets such that "prices are established and investments are made in competitive and freely functioning competitive markets" (NRCAN).
Institutional		Affect the workings of the government itself in an effort to promote change.
	Internal education	Internal efforts to educate technical officers and policy-makers on sustainable development topics (i.e., a national round table on the environment and the economy).
	Internal policies and procedures	Governmental institutional changes (i.e., the Canadian Commissioner's Office on Sustainable Development and Environment) or procedural changes (requiring drafting of a sectoral sustainable development strategy).

A report by IISD and TERI (2003) gives the four broad categories of policy instruments:

- Market-based (economic) instruments
- Direct expenditure instruments
- Regulatory instruments; and
- Institutional instruments

Market-based or economic instruments refer to measures that directly influence the price that a producer on consumer pays for a product, behaviour, or activity. Market-based instruments are also referred to as economic or financial instruments.

Direct expenditure instruments are those measures taken by governments to influence producer and consumer behaviour through channelling expenditures directly at the behaviour they want to encourage. This category of instruments is characterized by broad programs of expenditures targeted at a macro level to foster activities such as technological innovation.

Regulatory instruments describe efforts to create change via legal avenues. These include legislative, liability, enforcement activity and competition and deregulation policy instruments.

Institutional instruments affect the workings of the government itself in an effort to promote change. Included in this category are internal education efforts and internal policies and procedures. The development of conservation districts for watershed planning in Manitoba would be an example of an institutional arrangement.

6.1 Market-based instruments

While a few specific instruments are described in some detail in the sections below, numerous other market-based instruments exist for trading and compensating watershed services in the international context. Perrot Maitre and Davis (2001) give an overview and case studies of markets and innovative financial mechanisms for water services specifically from forests, while other researchers have focused on specific aspects of market based instruments, such as a study on reference levels by Eco-Ressources Consultants (2006) using international case studies of compensation programs for agricultural producers.

Bio-physical and social contexts are important components of finding solutions within the scope of IWRM. A World Bank study (December, 2005) on managing lake basins for sustainable use found that the principle of payments for the use of local lake basin resources was widely supported but applied inconsistently. Resource-user charges were most common in lakes with relatively wealthy users, although not in all cases. While lakes with poorer resource users tended to regard user fees for resources such as biodiversity as too difficult to implement, cases like the Tanzanian part of Lake Victoria in Africa showed that, when combined with legal backing, local autonomy and local retention of funds, even poor fisher-folk were willing to pay resource-use fees.

6.1.1 Load-based licensing

Load-based licensing focuses on the total amount of pollution emitted each year. The annual license fee is calculated on the potential environmental impact for a pollutant, and not on pollutant concentration. The premise behind load-based licensing is, "the lower the potential for environmental impact, the lower the fee.[12] This approach gives polluters a financial incentive to reduce the pollution they produce, and to keep on reducing it. It also encourages industry to invest in pollution reduction in those areas where it will most reduce fees, and so most improve the environment.

[12] www.epa.nsw.gov.au/resources/lblbooklet.pdf

Load-based licensing in New South Wales, Australia incorporates all aspects of pollution into a single license. According to the EPA, NSW, "a single license reduces the potential to shift pollution between air, water and the land"[13].

Under this system, not all license holders pay a pollutant load fee. Many licensed activities do not emit prescribed pollutants and are therefore exempt from such fees. The fees charged are based on the load (or amount of pollution), how harmful it is and where it is released.

An emission threshold is set for each industry type at a level that can be reasonably achieved with modern technology. The threshold should only be exceeded if an operator is not using modern technology. The load fees beyond this threshold are doubled to provide a strong incentive for industry to reduce high levels of pollution promptly. Beneath the thresholds, the incentive of further fee reductions encourages continuing improvements in performance.

To ensure that pollutant loads are measured accurately, the EPA has developed a Load Calculation Protocol that sets out acceptable methods for calculating the emission of the various pollutants covered under the scheme. A technical Review Panel advises the EPA on the protocol and comprises representatives of licensees, local government, environmental groups and the EPA, as well as having an independent advisor.

6.1.2 Taxing Nutrient Loads

Taxation of nutrient loads to reduce eutrophication is being considered in places like the Chesapeake Bay in the United States. Elevated nitrogen and phosphorus loads are the primary cause of poor water quality and aquatic habitat loss in the Chesapeake Bay. Hoffman et al. (2006) offer environmental service fees as one option to control nutrient loading on the Chesapeake Bay. They describe environmental fees as payments made for emitting pollution where every "unit" of pollution released triggers a corresponding "unit fee" that the polluter must pay. More pollution corresponds to larger payments.

Hoffman et al. (2006) also offer some comparison between nutrient standards and environmental fees and describe contexts in which environmental fees may be preferable to imposing nutrient standards. They indicate that taxes are particularly desirable when pollution control costs vary across sources and are difficult for regulators to measure. Taxes also shift the costs of pollution to the polluters. With standards, polluters only pay the cost of meeting the standard, not the taxable cost to the environment and society of the remaining pollution. In other words, taxes require polluters to both pay control costs and taxes on emissions that are not controlled.

6.1.2.1 Case study of the Dutch Farm Nutrient Tax

The Netherlands, with the highest density of livestock pollution in Europe, faces intensive nutrient loading problems into its groundwater and the North Sea. From 1998 through the end of 2005, The Netherlands relied on an innovative tax program, MINAS, to control agricultural nutrient pollution. The principle behind MINAS was that farmers were taxed on the amount of nutrient discharged into the environment. The Dutch used an inoovative nutrient accounting system to measure this discharge. Nitrogen and Phosphorus comes into the farm in many forms including feed, livestock, fodder, manure and chemical fertilizer. It leaves the farm in the form of livestock, forage manure, grain, milk and eggs. Under MINAS, the difference was called the farm's mineral loss. Dutch farmers were taxed on mineral loss in excess of an allowable amount of kilograms of nitrogen and phosphorus per hectare of land on the farm. Like most income tax systems, the Dutch mineral tax relied on self-reporting and reporting from off-farm sources. Feed suppliers reports, receipts for livestock and manure shipments and laboratory tests of nutrient content were to be attached to tax returns.

Evaluation of MINAS proved that it was effective in decreasing nitrogen and phosphorus surplus in dairy farming, but not in hog or row crop farming (Mallia and Wright, 2004; RIVM, 2004). While MINAS did

[13] www.epa.nsw.gov.au/resources/lblbooklet.pdf

have successes in being associated with substantial concurrent decreases in groundwater nitrate concentrations (RIVM, 2004) political opposition to environmental taxes led to the downfall of MINAS and its replacement in early 2006 by a complex system of limits on use of animal manure and fertilizers.

6.1.2.2 Nitrate-sensitive areas in the United Kingdom

In the United Kingdom, nitrate contamination has significantly impacted in the costs of supplying drinking water. Moreover, under the European Union's Nitrate Directive, member states must:

a) identify surface and groundwater sources polluted by nitrates,

b) identify nitrate vulnerable zones (NVZs) (watersheds),

c) devise action plans for meeting the requirements of the Directive, and

d) implement them (Eco-Resources Consultants, 2006).

The United Kingdom has implemented a program to meet this Directive under which vulnerable zones are identified, and additional mandatory farming practices are defined for these zones. While there is no compensation for these practices, there are payment schemes that accommodate practices that go beyond the scope of the mandatory practices.

6.1.3 Payments for Ecosystem Services

Ecosystem services are, simply, the benefits that people receive from ecosystems (Millennium Ecosystem Assessment 2003; Kumar 2005). Various systems of categorization of these services have been put forward.

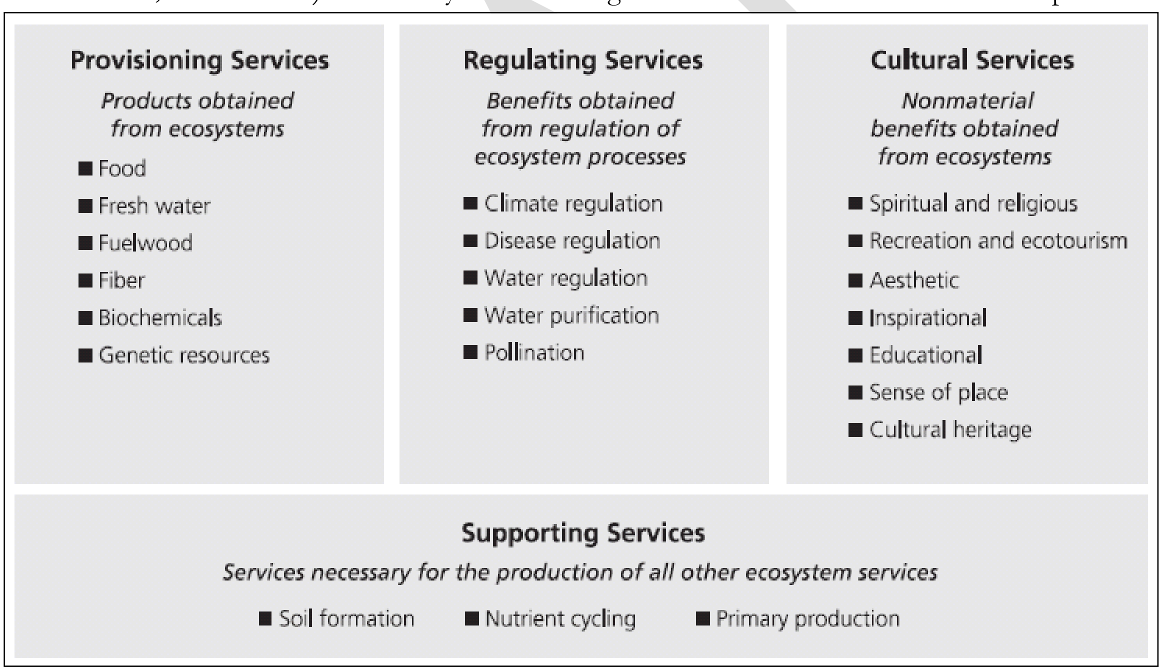


Figure 6.2 - Ecosystem services are the benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2003).

The Millennium Assessment (2003) suggests four categories: provisioning services, regulating services, cultural services and supporting services.

- Provisioning services include the basic necessities we consume and require for our survival and well-being, such as water, food, fibre, fuel, biochemicals and medicines, ornamental and genetic resources (Millennium Ecosystem Assessment, 2003).

- Regulating services provide us with a habitable environment. Air quality maintenance, climate, water and human disease regulation, water purification and waste treatment, erosion control, biological control, pollination and storm protection are examples of regulating services (Millennium Ecosystem Assessment, 2003).

- Cultural ecosystem services benefit people in a nonmaterial manner. They provide us with inspiration, knowledge systems, educational opportunities, spiritual and religious enrichment as well as ecotourism and recreational opportunities (Chiesura and de Groot, 2003; Millennium Ecosystem Assessment, 2003). Additionally, these services also foster cultural diversity, social relations, cultural heritage values and a sense of place (Chiesura and de Groot, 2003; Millennium Ecosystem Assessment, 2003).

- The supporting ecosystem services are necessary for the continuation of the other three types of ecosystem services (Millennium Ecosystem Assessment, 2003). They have either indirect impacts or effects over extended periods of time (Millennium Ecosystem Assessment, 2003). Examples of supporting services are primary production, atmospheric oxygen production, nutrient and water cycling as well as habitat provisioning (Millennium Ecosystem Assessment, 2003).

According to the Millennium Ecosystem Assessment over half of the world's ecosystem services have been degraded and are threatened (Tallis and Kareiva, 2005). In order to avert the degradation of ecosystems, payments for their services are being contemplated by conservation organizations, private land owners, corporations and governments. As the interest for establishing payments for ecosystem services has been growing, the body of knowledge and methodologies for the valuation and offset trading schemes of ecosystems services has expanded rapidly. Although a number of methodologies for valuating ecosystem services have been devised there is no standard method (Carpenter et al., 2006). Conservation banking is currently being used in the United States to offset impacts to biodiversity and wetlands. BioBanking, a biodiversity offset trading scheme, is being fine tuned in Australia to preserve natural ecosystems. Within the Canadian context, Alberta has adopted wetland restoration/compensation guidelines to offset development impacts to wetlands (Alberta Environment, 2005) and the Department of Fisheries and Oceans has in place mechanisms to offset impacts to fish habitat (Minns, 1997). A number of carbon trading schemes are being established under the Kyoto protocol, and ecosystem carbon sequestration may play an important role.

The ecosystems services in question can be watershed protection, forest conservation, biodiversity conservation, carbon sequestration, landscape beauty and wildlife husbandry and more. Postel and Thompson (2005) clarify that ecosystem services provided by healthy watersheds include:

- Water supplies for agricultural, industrial, and urban-domestic uses
- Water filtration/purification
- Flow regulation
- Flood control
- Erosion and sedimentation control
- Fisheries
- Timber and other forest products
- Recreation/tourism
- Habitat for biodiversity preservation
- Aesthetic enjoyment
- Climate Stabilization
- Cultural, religious, inspirational values

Ecosystem services may be present at any scale, from local to national or international (the latter sometimes called "global commons"). A PES approach could work at any of these scales. A global PES scheme that is becoming increasingly popular is the Clean Development Mechanism (CDM). The Clean Development

Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment (so-called Annex 1 countries) to invest in emission reducing projects in developing countries as an alternative to what is generally considered more costly emission reductions in their own countries.

An effective causal link between improving or avoiding degradation of a watershed services and direct outcomes related to water security are essential for an effective PES scheme (Smith et al., 2006). According to Postel and Thompson (2005), a variety of institutional mechanisms exist to encourage higher levels of protection of watershed hydrological services. There is no "right" approach: successful arrangements will be contoured to the needs and characteristics of individual watersheds. Options that make sense for small watersheds may differ from those suitable for very large ones. Similarly, measures appropriate for relatively pristine watersheds may not be applicable to watersheds in which substantial population and economic activity already exists. The menu of institutional options given by Postel and Thompson (2005) is organized into four broad categories:

- governmental ownership and control of watershed lands;
- broad-based government incentive payments to encourage ecologically sound land-use choices;
- government regulations to protect watershed health (including market-based cap-and-trade schemes); and
- negotiated payments by the (usually downstream) beneficiaries of natural water supply services to the (usually upstream) providers of those services.

For the most part, the value of ecosystem services to human beings is not captured in markets or in national accounts, and typically, they end up being undervalued or even completely ignored. It has been estimated that the total global value of ecosystem services, most of which are outside any markets, is between US $ 16 trillion and US $ 54 trillion (Costanza et al., 1997). Payments for ecosystems services, in the context of freshwater, are identified as a primary policy tool within the Millennium Ecosystem Assessment recommendations.

> *Economic incentives have the potential to unlock significant supply-and-demand-side efficiencies while providing cost-effective reallocation between old (largely irrigation) and new (largely municipal and instream) uses. Payments and incentives for water conservation can increase water availability, just as pricing water at its full marginal cost can reduce demand. Functioning water markets can provide price signals for reallocation between different uses and also signals to guide conservation activities.*[14]

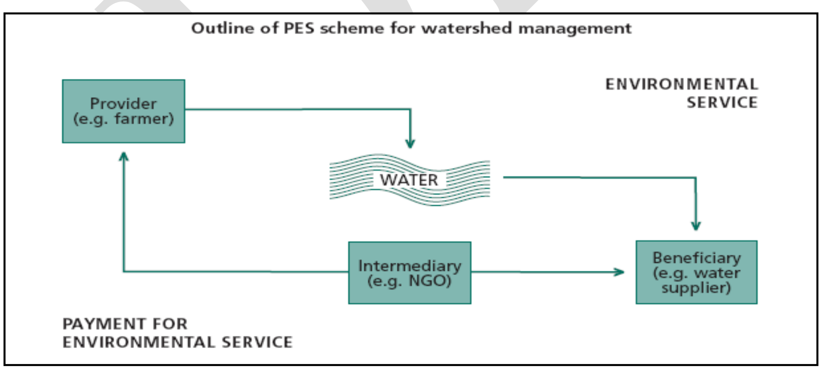


Fig 6.3: Outline of PES scheme for watershed management (Source: FAO, 2006)

The Millennium Ecosystem Assessment (MA) identified the existing gap and the need for linkages between PES and IWRM and provided two relevant critical policy insights: firstly, that a future scenario consistent with improved provision of ecosystem goods and services (EG&S) is one in which "regional watershed-scale ecosystems are the focus of political and economic activity". This requires that local institutions are strengthened and local ecosystem management strategies

[14] Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well Being. Volume 3: Policy Responses, Findings of the Responses Working Group. Island Press, New York

are common. The second major insight of the MA is the need for greatly increased use of market-based instruments based on ecological goods and services that mitigate or reverse serious ecosystem degradation, such as:

- Payments to landowners in return for managing their lands in ways that protect ecosystem services, such as water quality and carbon storage, that are of value to society
- Market mechanisms to reduce nutrient releases and carbon emissions in the most cost-effective way.[15]

The MA stresses that payments for water conservation can increase water availability but cautions that payments for watershed-based services that have been narrowly focused on the role of forests in the hydrological regime, should be developed in the context of the entire flow regime, including land cover, land use and management practices. The recommendations stress that the value placed on watershed services would depend on stakeholder confidence in the effectiveness of proposed management of actions for ensuring that the service continues to be delivered.

The PES approach is a useful innovative concept for watershed management. Most PES schemes recognize that the environmental services provided by watershed systems will become increasingly scarce, depending on the willingness of beneficiaries to invest in their continued provision.

The adjoining diagram (FAO, 2006) illustrates a typical PES scheme for watersheds. Upstream *providers* supply a well-defined water-related environmental service to downstream *beneficiaries*, who *compensate* the providers through the payment scheme, either directly or through an *intermediary*.

Payments for ecosystem services in Canada

Projects incorporating payments for ecosystem services (PES) are being initiated in different parts of the country. Many of these are proposals, while some are being implemented and evaluated. A few examples illustrating the different PES initiatives on the Canadian landscape help illustrate the breadth of scope for incorporating PES as a financing mechanism for a variety of conservation activity.

The City of Camrose sits in a largely agricultural part of central Alberta, within the County of Camrose. The city is surrounded by a typical aspen parkland landscape with numerous prairie pothole sloughs, small creeks and larger drainages. The Battle River flows just south of Camrose into Driedmeat Lake, the water supply for more than 15,000 residents of Camrose and Bittern Lake. Driedmeat Lake is a large prairie slough and is hypereutrophic, meaning that it contains a very high nutrient load. This results in a complex water treatment system with water quality issues such as high levels of organic materials, nitrogen, phosphorus, algae, and bacteria like Giardia and Cryptosporidia.

Recognizing the extent of the problem, the City of Camrose and the County formed a partnership to work on watershed-level issues, including reducing the urban-rural divide and building trust towards cooperation.

A highlight of this partnership has been access to dollars for funding watershed initiatives and the exchange of information between rural and urban residents. Payments have been made available to the county from various sources for protection of source water, watershed health education, riparian management, water quality monitoring, etc.

The Alternative Land Use Services (ALUS) project is another PES project that is being currently implemented in the Rural Municipality of Blanshard in Manitoba. This pilot project is based on the fact that producers are facing an increasing demand to provide environmental services that provide benefits such as clean air, clean water, soil health, etc. that are enjoyed and relied on by society at large. Producers are also facing economic stress resulting from low commodity prices, the after-effects of BSE, and other trade and economic issues. The costs of these additional land stewardship services, the benefits from which are

[15] www.millenniumassessment.org/proxy/document.429.aspx

enjoyed by a larger societal beneficiary group, must therefore be made available to producers for these alternative land services.

Hamm (2006) described ALUS as a voluntary, incentive-based environmental program that recognizes and rewards the positive contributions that farmers make to clean air and water and biodiversity through their land management practices. The initiative is coordinated and monitored by the agricultural sector and recognizes existing management practices. The pilot is supported financially by federal, provincial and municipal governments and payments are made annually.

Ecological Goods and Services eligible for payment under the ALUS initiative include wetland services, riparian buffer services, natural area services and ecologically sensitive land services. There are three levels of payments available to producers, depending on the quality of services provided. Payments are based mostly on lost opportunity cost and are not high enough to encourage a shift to non-agricultural land uses. The feedback from this project implementation has been positive and similar projects are being considered and proposed elsewhere in Canada.

Environmental Quality Incentives Program (EQIP)

In the United States, the Conservation Security Program is implemented along with the Conservation Reserve Program and the Environmental Quality Incentives Program (EQIP) (NRCS, 2007). Under this program, watersheds with specific programs are identified. For each watershed, payments are granted for farming practices that address environmental objectives.

The program is voluntary and is based on contracts with each participating farm. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. EQIP offers a minimum term of one year and a maximum term of ten years. Agricultural producers participating in the EQIP program must also comply with legislation (Food Security Act) pertaining to erosion-sensitive land and wetlands.

The US program is unique in that practices are not specified at the outset. Outcomes are the focus, leaving producers to choose the methods to achieve them. As a result, reference levels vary depending on the watershed, and for the most, involve the implementation of beneficial management practices or BMPs. The program involves a significant labour component from the involved government agencies and is based on significant amounts of data and knowledge.

6.1.4 Ecosystem services offset trading

Ecosystem service offset trading is an environmental conservation mechanism to offset development impacts so that ecosystem services are maintained or enhanced. In other words, a market is created elsewhere in the landscape for the provision of the ecosystem service which is to be impacted on by development (Coggan et al., 2004). There are currently a number of ecosystem offset trading schemes around the world used to protect and conserve our natural environments. Biodiversity offset trading is one such system where development impacts are offset by providing resources to enhance or preserve biodiversity in other locations. Biobanking and Conservation Banking are two well-known examples of such offset trading systems prevalent in Australia and the U. S. respectively.

Conservation and mitigation banking

Conservation banking is carried out through conservation banks, or parcels of land containing natural resource values that are conserved and managed in perpetuity, through a conservation easement held by an entity responsible for enforcing the terms of the easement, for specified listed species and used to offset impacts occurring elsewhere to the same resource values on non-bank lands (U. S. Department of the Interior, 2003). A conservation bank generally protects threatened and endangered species habitats for which credits can be established using specified guidelines. Conservation banks must be approved by the wildlife agencies, such as the Department of Fish and Game and the U. S. Fish and Wildlife Service.

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The EcoTender approach to payments for ecosystem services

EcoTender is an approach developed by the Department of Sustainability and Environment and Department of Primary Industries in Australia aimed at improving native vegetation management or securing revegetation on private lands that leads to improved environmental outcomes at both the local and catchment scale.

Under this system, landholders competitively tender for contracts to improve the quality or extent of their native vegetation. The benefit offered by these contracts is assessed according to a range of environmental outcomes being sought, including improved biodiversity, reduced saline land and improved in-stream water quality. Captured carbon is also factored into re-vegetation contracts.

Successful bids are those that offer the best environmental value for money, with successful landholders receiving periodic payments for management activities conducted under five-year agreements signed with the Department of Sustainability and Environment. Re-vegetation contracts require that landholders protect the re-vegetation for a further five years beyond the payment period.

EcoTender ensures that priority native vegetation activities on private land are targeted in a cost-effective manner and provides landholders with an opportunity to generate a regular and reliable income stream from native vegetation activities on their land.

6.1.5 Nutrient trading

Nutrient trading allows sources with high mitigation costs to obtain credits from sources that can reduce their contribution of pollutants to waterways at a lower cost. According to Greenhalgh and Sauer (2003), trading focuses on reducing the cause of environmental concern rather than promoting a specific practice or set of practices. For instance, under a nutrient trading program, farmers would be paid according to the size of the reductions they achieve in nitrogen or phosphorus loss, not on the number of acres placed on conservation tillage or the buffer strips they plant. This approach provides greater flexibility for local policymakers and farmers to identify and implement the most appropriate solutions in their region.

Water trading (Murray-Darling Basin, Australia)

In 1995, the Murray Darling Basin Ministerial Council in Australia commissioned an audit of water use in the Murray-Darling Basin, which confirmed the increasing levels of diversions and the consequent decline in river health. A cap was introduced to limit further water diversions based on the 1993–94 levels of development.

The cap serves the dual purpose of preventing further erosion of water access reliability for existing water users and protecting river systems from further reductions in flow. With the implementation of the cap, any water to be used for new developments has to be sourced from existing uses. Waster markets provide an opportunity for new investment in high value added agriculture despite resource constraints, moving the water to a higher value, and more sustainable use. Water markets provide the opportunity for new investment in high value added agriculture despite resource constraints, and trade provides the opportunity to make the most of water availability and helps individual irrigators manage risk. Key requirements for water trade are an agreed transfer mechanism, a set of trading rules (to account for the varying “denominations” in differing “currencies” of water entitlements, environmental and salinity clearances), managing outlying irrigation areas and having a robust accounting mechanism. Responsibility for the use of water after it has been diverted from the river lies with the relevant jurisdiction and risk management options vary between them.

Phosphorus trading in the South Nation River Watershed, Ontario

The South Nation River watershed is located southeast of Ottawa and is approximately 3900 km². It has a population of about 125,000 and comprises predominantly mixed farms with dairy, corn and soya beans as prevailing regional cash crops.

The South Nation watershed exceeds the provincial water quality guidelines for phosphorus, which currently are 0.03 mg/l. Annual mean phosphorus concentrations for the main South Nation River are 0.07 mg/l. in the upper reach, 0.126 mg/l. in the middle and 0.0129 in the lower reach of the river. Watershed studies show that 90 per cent of the phosphorus load comes from non-point sources (O'Grady and Wilson, 2003).

Beginning in 1998, the Ministry of Environment (MOE) in Ontario imposed new standards on phosphorus discharges to watercourses. Since the only alternative for new developments was improved and expensive waste water treatment facilities, an option was developed and called total phosphorus management (TPM). This process allows dischargers to contribute phosphorus from their treatment plants, in contravention of provincial policy, so long as they offset this increased phosphorus load by controlling phosphorus from non-point sources. The Ministry of Environment treats the watershed as a unit and therefore a treatment plant discharging phosphorus in one part of the watershed can pay for measures to reduce phosphorus in another part of the watershed.

The amount of phosphorus credits that need to be bought depend on two factors- the amount of phosphorus that the dischargers contribute, and the ratio of phosphorus required by the MOE to be removed. Due to lack of exact scientific data about the phosphorus loads on watercourses, the MOE requires that for every kg of phosphorus discharged into the watershed, 4 kg of phosphorus must be removed from non-point sources. Therefore, the MOE requires a 4:1 ratio of phosphorus offsets for trading.

O'Grady and Wilson (2003) show that the cost of complete removal of phosphorus using traditional wastewater treatment methods is around $2,000 per kg of phosphorus removed. Using the 4:1 ratio, the cost to remove phosphorus using TPM is about $1,200 per kg. While dischargers have the option of using either TPM or enhanced wastewater treatment, all dischargers have chosen TPM since its inception.

6.1.6 Resource user fees

According to a World Bank study on managing lake basins for sustainable use (2005), charging for resource use serves two purposes. First, charges can be used to modify people's behaviour, encourage or discourage the use of certain resources. Secondly, charges can also be used to finance the operations arising from providing and managing the resources.

The report (World Bank, 2005) goes on to explain that resource-use levies are simple in practice but difficult to apply. The difficulties stem from three basic problems: (1) the cost of collection (dispersed users, poor infrastructure); (2) popular beliefs in free natural goods; and (3) uncertainty about benefits from fees.

6.1.7 Conservation easements

A conservation easement is a restriction on a piece of property to protect its associated resources (Nature Conservancy, 2007). The easement is either voluntarily donated or sold by the landowner and constitutes a legally binding agreement that limits certain types of uses or prevents development on the land in perpetuity while the land remains in private hands. The rights that are most often sold or donated are the rights to subdivide and the right to develop.

An easement selectively targets only those rights necessary to protect specific conservation values, such as water quality or migration routes, and is individually tailored to meet a landowner's needs. Since the land remains in private ownership, with the remainder of the rights intact, an easement property continues to provide economic benefits for the area in the form of jobs, economic activity and property taxes.

A conservation easement is legally binding, whether the property is sold or passed on through generations, since use is permanently restricted. Land subject to a conservation easement may be worth less than on the open market than comparable unrestricted and developable parcels. As a result, conservation easements may sometimes qualify landowners for tax benefits.

6.2 Direct expenditure instruments

Direct expenditure instruments, as explained at the beginning of chapter 6, are the measures taken by governments to influence producer and consumer behaviour through channelling expenditures directly at the behaviour they want to encourage. This category of instruments includes government programs and project operation, green procurement, research and development and moral suasion. Research and development expenditures directed at economic, social and environmental goals have been proven effective diffusive mechanisms for advancing long-term change

6.2.1 Education

Changing social practices to achieve the goals of IWRM involves changes in deeply held attitudes of individuals, institutions, professionals and social organizations within civil society. The key to encouraging an IWRM oriented civil society lies in the creation of shared visions, through joint diagnosis, joint creation of options, joint implementation and joint monitoring. This itself requires broad stakeholder participation in water planning and operating decisions, and is another strong tool for encouraging such new civil society (Global Water Partnership, 2003).

Social change may be achieved through instruments that emerge from participatory experiences and offer people the chance to claim rights and assume consequent responsibilities. Participation is best supported by people with well-informed attitudes who can respond to the need for changing patterns of water management. Hence education, training and awareness-raising emerge as important tools for social change.

Programs to incorporate locally relevant watershed management topics into school and university curricula are important. Bringing water issues into education programs provides a means for young people to understand not only the wider concepts of integrated water management, but also the effects of their own behaviour on water, its quality and ecosystems.

6.2.2 Capacity building

Although an integral part of education, capacity-building is an important component of effective watershed management and for this reason, discussed briefly as a separate section. Institutional capacity for integrated water resources management is a key component of the efficiency of an IWRM program. The way people are organized in the watershed is the institutional structure, and their ability to design, manage, implement and monitor a watershed management program is their capacity for IWRM. An important aspect to take into consideration in the IWRM context is the conventional power structure that appears in such an integrated and interdisciplinary approach that spans political, social, scientific and economic paradigms. The capacity to understand each others' paradigm and coordinate efforts towards an integrated approach is possible through active capacity-building and participation.

Workshops and conferences, dialogue, training and other forms of information-sharing and dissemination are the most comment forms of capacity building. Interdisciplinary and inter-jurisdictional committees are useful capacity-building tools in the context of IWRM.

6.2.3 Research and development

An important part of the task of managing nutrients in the Lake Winnipeg watershed is the research and data collection forming the basis of the management plans. Where do the nutrients come from and how much is going into the lake? What is the efficacy of the systems of management being applied to control nutrients into the lake? Where will the money for the management plans and actions come from? These are all questions that are being answered by ongoing research and development that is supported and conducted by governments, non-governmental agencies, community groups and individuals. These data help set management goals and determine priorities for action.

6.2. Conflict resolution

The procedures around building consensus and resolving conflicts are often an essential part of integrated water resources management. Water related disputes may arise over factual problems of information and information representation, or around interests and values associated with the water resources.

Conflicts exists between rural-urban communities, between natural resource developers and users and those working to conserve them, between producers and consumers of land-based goods and services and between traditional communities that are more dependent on the landscape and those that are completely removed from it. The resolution of such conflicts, in order to move towards a common vision, is a necessary part of the effective implementation of integrated water resources management.

6.3 Regulatory instruments

Regulatory instruments include legislation, liability, enforcement activity and competition and deregulation policy instruments. These instruments aim to induce socially responsible behaviour by establishing legal liability for certain activities such as natural resource damage, environmental damage, property damage, damage to human health, non-compliance with environmental laws and regulations, and non-payment of due taxes, fees or charges (Panayotou, 1998).

6.4 Institutional instruments

Institutional instruments affect the workings of the government itself in an effort to promote change. This category includes internal education efforts and internal policies and procedures. Efforts such as developing of a Lake Winnipeg Stewardship Board and establishing the conservation districts in Manitoba for watershed management would be examples of institutional instruments.

6.5 Mix of policy instruments

Swanson and Pinter (2004) claim that due to the complex and diverse nature of interactions among people and between people and their environment, policy responses to key sustainable development issues will be varied. They further elaborate that governments at all levels have at their disposal a mix of policy initiatives, including regulatory, program or project expenditures, institutional and economic initiatives. While an understanding of appropriate policy instruments for the management of nutrients to Lake Winnipeg is necessary, it is important to understand that multi-jurisdictional and multi-source issues such as demonstrated in the eutrophication of Lake Winnipeg may require the use of a mix of appropriate policy instruments.

An OECD report (2007) lists case studies in the United Kingdom, The Netherlands, Denmark and the United States to demonstrate the use of policy instrument mixes for the purpose of addressing non-point sources of water pollution. The authors indicate that nutrient management is dependent on controlling how the nutrients are applied, where they are applied and their cumulative quantities. They indicate:

> *Whereas increased reliance on economic instruments could result in lower economic costs for reaching given environmental targets related to total quantities involved—or to larger environmental improvements for a given cost—it could be difficult to design economic incentives that would apply to some of the other relevant environmental aspects of the issues studied here [in the context of addressing non-point sources of water pollution]. This constitutes an important rationale for applying a mix of instruments in these areas.*

Case studies have shown the use of an appropriate mix of policy instruments for nutrient management, such as the cap-and-trade mix of regulatory and trading mechanisms applied at the Chesapeake Bay. An appropriate mix of regulatory/legislative instruments to complement incentives and market-based instruments work well in tandem to create the necessary behaviour change and positive reinforcement for appropriate environmental action.

7. Next Steps

It is now undisputed that nutrient loads on Lake Winnipeg from primarily municipal and agricultural sources have exceeded ecological thresholds and Lake Winnipeg is now deservedly the subject of concerted scientific and institutional attention. However, to-date, no broad lake management plan has emerged. Source and non-point sources of nutrients, specifically nitrogen and phosphorus are largely identified and provide some direction to where our concerted efforts to reduce nutrient loads on the lake might be directed.

Synopsis of year one research activities

1. A synthesis of available scientific data on nutrient loading on Lake Winnipeg, highlighting point and non-point sources of nutrients in the watershed.
2. A study of international best practice in integrated water resources management (IWRM) in the context of nutrient management for lessons for the Lake Winnipeg watershed on the application of IWRM principles and watershed governance practice.
3. A study of instruments for nutrient management, including regulatory, economic and social instruments in the international context of water resources management. Once again, this research will provide the basis for developing specific solutions for the Lake Winnipeg nutrient overloading problem.

Next steps

Year two work on Lake Winnipeg nutrient management solutions is based on the direction derived from year one's work on international best practice and the exploration of international instruments used for nutrient management. The need for adequate institutional capacity and appropriate inter-institutional structures for watershed management are highlighted as key components of international IWRM best practice (ICPDR in the Danube River case, WAG in the New York case study and the Red River Basin Commission in the Red River Basin). Therefore our next steps are aimed at matching appropriate instruments for nutrient management with the institutional capacity existing in the Lake Winnipeg watershed.

Towards this goal, our second year's work has the following objectives:

1. An inventory of sub-basins of the Lake Winnipeg watershed, with relative nutrient loading contributions.
2. A synopsis of the institutional capacity existing in the Lake Winnipeg Basin, including financial, technical and physical capacity to enable appropriate matching of nutrient management instruments with existing capacity.
3. An inventory of instruments applicable to Lake Winnipeg nutrient management from international best practice.
4. An inventory of the key institutions responsible for various aspects of IWRM by sub-basin.
5. A preliminary set of recommendations on an appropriate matching of instruments to existing institutions, including observations where institutional strengthening is a clear priority.

Year two's work is anticipated to provide strategic advice to Environment Canada regarding the federal role in supporting IWRM and in the Lake Winnipeg basin, and specifically on the complimentary role for market-based instruments such as PES programs for building and sustaining IWRM capacity.

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