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THE HUDSON BAY DRAINAGE SYSTEM: CONFLICTS AND COOPERATION IN TRANSBOUNDARY WATER QUANTITY AND QUALITY

William H.N.Paton*

ABSTRACT: Canada's rivers discharge about 9 percent of the world's renewable water supply. Some 60 percent of this runoff flows into the Arctic Ocean and Hudson Bay. The bulk of the Hudson's Bay water arises in the Rocky Mountains of Alberta and flows through Saskatchewan to Manitoba. The rest of the water comes into Manitoba at the North Dakota border as the Red River of the North. This paper will review the impact of the current agreements that influence both interprovincial and international water quantity and quality transfers. Water is a major limitation to economic development on the arid Canadian prairies. The influence of predicted climate change, increased crop irrigation and major expansion of intensive livestock production and meat processing in Manitoba will be discussed. The current limited regulatory framework for water quality in Manitoba as compared to regulations of upstream users will also be highlighted.
KEY TERMS: prairie Canada; water conflicts; comparative regulatory framework.

INTRODUCTION

Water performs many critical functions for all ecosystem components of the Prairies eco-zone. Historically the Hudson Bay region has oscillated between periods of flood and drought, resulting in ongoing pressures depending upon most recent climate experience, to either drain water everywhere or store it behind dams for irrigation or pollution dilution. Dams and reservoirs have been constructed on all the major river systems, with two completed in Saskatchewan and one in Alberta in the last five years. Several more dams and water diversions have been recommended by governments and the irrigation industry in both western Canada and North Dakota in recent years. Water quantity and quality issues are vital to every aspect of economic and environmental sustainability in the Central Plains.

This paper examines the past, current and future pressures on water quantity and quality in Manitoba and adjacent provincial and state jurisdictions, as influenced by international and inter-provincial policies, predicted global climate warming and economic development. Principle economic development issues are a massive increase in intensive hog production and processing, increased irrigated Irish potato production and processing and associated predicted increases in human population. Experience from over twenty years of monitoring the Brandon stretch of the Assiniboine River will be used to illustrate some major issues that must be addressed by government.

The Hudson Bay Drainage System

Runoff from the eastern slopes of the Rocky Mountains is the major water supply for the large southern rivers of the Prairie provinces. These rivers flow eastward across Alberta, Saskatchewan and Manitoba to empty into Hudson Bay. In addition two rivers cross into Manitoba from North Dakota, the Souris and the Red. The Souris joins the Assiniboine and the Red drains into Lake Winnipeg and the Hudson's Bay system (see Figure 1).

* Professor, Brandon University, Department of Botany/Biology, Brandon, Manitoba, Canada R7A 6A9, E-mail: Patonw@BrandonU.CA

WATER APPORTIONMENT

The ownership of the waters of a river system flowing through several jurisdictions can give rise to many administrative and water use problems. The management of water in Canada has primarily been concerned with the consumptive needs of society, ensuring that there were adequate supplies for irrigation, livestock, industrial and domestic purposes. To resolve conflicts between upstream uses and downstream needs, Alberta, Saskatchewan, Manitoba and Canada signed the Prairie Provinces Water Board Agreement in 1948. In 1969 the parties to the original agreement signed the Master Agreement on Apportionment. This formula states that Alberta and Saskatchewan may each take up to one half of the natural flow of water originating within its boundaries and one half of the flow entering the province. The rest is left to flow into Manitoba. Natural flow is defined as the volume of flow that would occur in a particular river if that river had never been affected by human activity. Water flow and limited water quality monitoring is conducted at fourteen locations along the provincial borders (Figure 1). On issues of water quantity the process has worked to date, although it should be noted that Saskatchewan currently uses only a small portion of its 50 percent entitlement and if it did it could seriously impact users of the Assiniboine River downstream (Environment Canada, 2000).

Climate Change

Drought is the most significant climatic characteristic of the Prairies. Historically droughts have had a return period of 30 to 50 years (for example. the1930' and 1988 droughts were severe). Significant impacts on the economy and natural resources resulted. During the 1930's drought, wheat yields declined 32 percent, 200,000 farms failed and 300,000 people migrated from the southern Prairies.

Figure 1. The Hudson's Bay Drainage System and Inter-provincial Monitoring Locations.

After the 1988 drought, crop insurance and special drought assistance paid out over CAD 1.3 billion to cattle and grain farmers. Manitoba reported net farm income losses of 50 percent, Saskatchewan 78 percent. Export losses were CAD 4 billion and an estimated 10 percent of all farmers and farm workers left the agriculture sector. The lack of available water in 1988 resulted in widespread deterioration in water quality and an increase in the consumptive use of water on the prairies. It is predicted that with climate warming all demands on the limited water resource on the prairies will increase (Herrington et al., 1997). Temperature increases in the Prairie ecozone have exceeded overall global rise, particularly in the past 20 years. Climate forecasts predict a 5-7°C rise in annual surface temperature for the Prairies over the next 50 years. For both the north and south Saskatchewan rivers significant reductions in summer flow and increased duration of low flow were projected. Possible changes in the type of water demand were also considered. For example, a warmer climate may make it feasible to change from dryland farming of cereal grains to higher value irrigated crops. All of these scenarios would result in increased Saskatchewan consumption and decreased supplies to Manitoba. Saskatchewan has sufficient, good quality soils and water to expand the irrigable base to over 405,000 hectares. Erickson and Linsley (1998) predicted the development of value-added industries and the further introduction of irrigated specialty crops. The Upper Assiniboine River Basin Report (Environment Canada, 2000) avoided even reviewing worst and best case possible scenarios, concluding that there was no reliable method to determine the effect of climate on supply or demand. They also anticipated no major increase in demand for water in Saskatchewan.

INTERNATIONAL ISSUES

Canada is a signatory to several treaties and agreements with the United States dealing with waters which flow along or across the common boundary. The Boundary Waters Treaty of 1909 established the International Joint Commission (IJC) and set the basic principles for guiding boundary water relations between the two countries (International Joint Commission, 1980). The Commission in turn has created bilateral boards to assist it in carrying out its investigative, monitoring and surveillance functions. The Treaty clearly addresses by way of legal reparation, both water quality and quantity. The Souris river rises in southern Saskatchewan, flows in a southeasterly direction across the international boundary into North Dakota, then veers north and recrosses the boundary into Manitoba (Figure 2). The Rafferty Reservoir on the Souris river near Estevan, Saskatchewan and the Alameda Reservoir on Moose Mountain Creek near Oxbow were constructed in 1991 after environmental reviews concluded that the reservoirs had the potential to cause negative effects downstream in North Dakota and in Manitoba. The

governments of Canada and the United States entered into an agreement for water supply and flood control in the Souris River Basin in 1989. Prior to that the 1959 Interim Measures, administered by the IJC on behalf of the governments, stipulated that North Dakota was entitled to one half of the natural flow of the river in any given calendar year. Certain of the Interim Measures were further modified in 1992. Under conditions pertaining to a specified water elevation on Lake Darling and flow at the border, the minimum flow passed to North Dakota will be 40 percent of the natural flow at the Sherwood Crossing, border point. Saskatchewan has been in deficit to North Dakota, but so far the state has not insisted on delivery of the shortfall (Souris River Bilateral Water Quality Monitoring Group, 2000). Diversion of water from the Qu'Appelle river which flows into the Assiniboine has been considered as a means of meeting the shortfall, since the Saskatchewan commitment represents a significant demand on their portion of the Souris basin.

Figure 2. Manitoba/ Saskatchewan/ U.S.A. Border Crossings of the Souris River

The 1909 Boundary waters Treaty stipulated that the water flow should have no significant deterioration in quality. Article VI of the Souris River Basin Agreement also deals specifically with water quality and the creation of the Bilateral Water Quality Monitoring Group. This Group has the task of producing annual reports on the Souris and establishing water quality objectives at the two boundary crossings. If exceedances of objectives are reported, they are expected to determine how the objectives can be met, revised or otherwise addressed. The numeric objective set for total phosphorus was 0.10mg/L, double the concentration recommended by the Prairie Water Services Board to avoid eutrophication in surface waters. Phosphorus frequently exceeds this concentration at the two boundary sites. In 1998, at the North Dakota/ Saskatchewan boundary exceedances of the water quality objectives have been recorded for chloride (11 percent), phosphate (100 percent), sodium (33 percent), iron (100 percent), total dissolved solids (22 percent), pH (12 percent), the herbicide MCPA (33percent) and total phenols (50 percent). Chlordane and PCBs also occasionally exceeded the objectives at the border (Souris River Bilateral Water Quality Monitoring Group, 2000) . Manitoba only monitors at Treesbank, immediately above the confluence of the Souris river with the Assiniboine river, and therefore reflects contributions from the entire Souris Watershed in Manitoba. Historically, pollution from sewage lagoons and intensive livestock operations have negatively impacted this portion of the river. Measurements made by North Dakota at Coulter on the border in 1992 indicated exceedances of total phosphorus (100 percent), sodium (56 percent), sulphate (17 percent), iron (67 percent), total dissolved solids (11 percent), pH (44 percent) and dissolved oxygen (11 percent). Earlier summer unionized ammonia exceedances were alleviated by the addition in 1992 of a constructed marsh system at the effluent point of the Minot sewage treatment system. Recommendations on new water quality objectives or how existing objectives can be met are expected soon. Once again dilution with better quality water from the Qu'Appelle might be suggested. It should be noted that the United States has *The Clean Water Act* and federally enforced water quality standards administered by the U.S. Environmental Protection Agency (EPA). Canada owns four-fifths of the globe's fresh water, yet the federal government has no law to protect or manage it. If the United States were to rigorously pursue its due water rights under Treaty, again the quantity and quality in the Assiniboine river would be reduced.

Over the last century, the average temperature near Bismarck, North Dakota, has increased 0.72° C, and precipitation has decreased by up to 20 percent in northern and western parts of the state. Further increases in average temperature are predicted by a variety of models. Warmer temperatures are predicted to lead to earlier spring runoff. In the summer, without large increases in precipitation, higher temperatures and increased evaporation would lower stream flows and reservoir/lake levels (U.S. Environmental Protection Agency, 2001).

Some other water management projects under consideration in North Dakota raise a range of transboundary issues that are of concern to the Province of Manitoba. The Devil's Lake outlet would drain water from the currently land-locked Devil's Lake to prevent flooding, eventually into the Red river, Lake Winnipeg and Hudson Bay. To maintain the lake level in dry years, an inlet was originally planned, as part of the Garrison Diversion, a series of canals and structures that would among other things, take water from Lake Sakakawea, a man-made reservoir on the Missouri river into the Red river drainage basin. The concerns with these projects are largely quality issues and the possible transfer of foreign biota from the Missouri into the Hudson's Bay system. Lake Winnipeg supports a major fishing industry, although the 1997 Red river flood together with anthropogenic inputs from other rivers including the Assiniboine have seriously impacted this industry and lake water quality in recent years (Stewart et al., 2000).

Threats of forced export of freshwater to the United States under *The North American Free Trade Agreement* have led some provinces, including Manitoba, to legislate a ban on such transfers, although legal opinion varies on the protection this provides if trade in water is initiated by Newfoundland.

CANADIAN REGULATORY FRAMEWORK FOR WATER

In Canada the division of responsibilities for water is complex and often shared. Under the *Constitution Act*, provinces own water resources and are responsible for flow regulation, authorization of water use development and legislation on water supply, pollution control, thermal and hydroelectric power development. The federal government is responsible for navigation, fisheries, water on federal lands and aboriginal reserves, boundary and transboundary waters. There is shared responsibility for inter-provincial water issues, agriculture and health. Development of the Canadian Water

Quality Guidelines (CWOGs) began in 1984. In 1987, the Water Quality Guidelines Task Group of the Canadian Council of Ministers of the Environment (CCME) and Environment Canada published the Canadian Water Quality Guidelines (Canadian Council of Resource and Environment Ministers, 1987). It was then up to the provinces whether they would legislate water quality standards based on these guidelines. In the Prairies only Alberta has chosen this route, Manitoba and Saskatchewan adopting objectives with no legal enforcement. Canada began handing off environmental power to its ten provinces in the mid 1990's. It was done partially in response to Quebec's demand for more autonomy. Such things as the enforcement of the federal *Fisheries Act* and the *Canadian Environmental Protection Act (CEPA)* was left more and more in the hands of the provinces. In 1998, the devolution of national powers was cemented when the *Canada-Wide Accord on Environmental Harmonization* was signed by most jurisdictions. Prior to this, significant fiscal cutbacks to both federal and provincial environment/conservation departments resulted in much reduced monitoring of water quantity and quality (Day et al., 1994; Pilon et al., 1996) and decimated funding for research and planning (Pearse and Quinn, 1996). Responsibility for drinking water and wastewater treatment has been shifted to the municipalities and self-monitoring is the common means of compliance with environmental licenses for communities and industries. Recent deaths (7 deaths) due to *E.coli* 0157: H7 in drinking water in Ontario and due to *Cryptosporidium* (4 deaths) in North Battleford, Saskatchewan have raised public concerns for high water-quality standards, more effective measures to keep contaminants from agriculture out of water systems in the first place and water rates that encourage conservation. The Canadian Water and Wastewater Association has estimated CAD 90 billion will be needed for water and wastewater infrastructure over the next 15 years (Walker, 2001).

When we critically examine water quality regulations, water use planning and associated measures through expenditures for monitoring and infrastructure improvement in the Hudson's Bay Drainage system, the rank order of the jurisdictions would be the United States (North Dakota) > Alberta >> Canada > Saskatchewan > Manitoba.

CASE STUDIES WITH THE ASSINIBOINE RIVER

The Assiniboine river begins in eastern Saskatchewan; it flows 1070 km southeast across the Manitoba-Saskatchewan boundary to Virden where it then meanders easterly through Brandon, Portage La Prairie to meet the Red river in Winnipeg (Figure 1). It drains an area of 59,000 square miles. The majority of the drainage basin, 56 percent is in Saskatchewan; about 13 percent is in North Dakota and the remaining 31 percent is in Manitoba. The water quality of the Assiniboine is the combined result of many factors (Environment Canada, 1991). The major factors include non-point pollution from agriculture, pesticide use, irrigation, riparian livestock, municipal effluent, industrial effluent and flow regulation (Assiniboine River Management Advisory Board , 1996). Monitoring of the Brandon stretch of the river over the past 20 years has indicated problems with inadequately treated sewage effluents, industrial inputs, livestock and fertilizer runoff.

The flow regime is typical of prairie rivers with maximum discharges usually being recorded in May which has a mean flow of 106 cubic meters per second. Maximum discharges are associated with snowmelt, the highest peak flow being 262 cubic meters per second recorded on May 1, 1975. Minimum discharges occur in winter with February being the lowest month (mean 16.4 cubic meters per second). The lowest minimum daily discharge ever recorded was only 0.566 cubic meters per second on December 11, 1936. Since 1969, the flow regime has been strongly influenced by a flood control dam at the Shellmouth which reduces discharge in the spring and increases it during the summer. Water releases from the Shellmouth Dam in winter account for up to 85 percent of river flows at Brandon. The water is essential to provide for dilution of increasing local discharges and for water supply. Freeze-up on the river normally occurs in mid-November; break-up time is typically mid-April.

The City of Brandon gets its water supply from the Assiniboine (Figure 3). There have been significant quality problems with raw water from the Assiniboine River, largely attributed to excessive algal growth upstream of the Brandon water intake. Extremely low water levels in the 1988 drought almost resulted in a cutoff of Brandon's water supply. The Brandon Recreation Centre Golf Course is also licensed to extract water for irrigation purposes (> 25,000 litres per day requires a license). In addition, River water is used to irrigate the Canada Games

Park area and a few household gardens on the riverbank. All of these uses are upstream of the wastewater discharges from Manitoba Hydro coal-fired thermal electric generating station, Simplot Chemical Company, the City of Brandon wastewater treatment system and the Maple Leaf Meats Wastewater Treatment Plant.

Figure 3. Brandon Stretch of Assiniboine River and Sampling Sites 1997 – 2001.

Since 1967 until very recently, Manitoba Hydro generating station has operated as a peaking station operating usually only for a short time during the winter. However, with the attractive prices for energy in the United States in the past year, the plant has been operating almost continuously for export purposes. The station has been upgraded recently and a cooling system installed. Maximum water intake is approximately 250,000 cubic metres per month. Manitoba Hydro has two effluent discharges. One is precipitation runoff and drainage from the plant, the other is from the ash lagoon system. Simplot Chemicals Canada Limited is licensed to discharge waste into the river during the period from September to early May. Unionized ammonia, nitrates, phosphate and salts are major constituents.

Traditionally, rivers on the prairies have been used for sewage disposal. Upstream of Brandon several communities in Saskatchewan and Manitoba have sewage lagoons which are permitted on an annual or bi-annual basis to discharge effluent into the river system. The performance of these systems is reported to be highly variable and has been recognized in various reports as a factor in the deteriorated quality of the Assiniboine River. The City of Brandon has also had a long history of problematic wastewater treatment discharges. Design problems with an upgraded treatment system costing close to CAD 20 million have resulted in continuing problems with B.O.D., soluble solids, unionized ammonia, residual chlorine and total and faecal coliforms. Continued use of old sewage lagoons has acerbated the problems. The City is also liable for an industrial waste from Ayerst Organics (B.O.D. 38,000 – 100,000 mg/L). This waste is also extremely high in ammonia and after some stripping of ammonia and oxidation it also is discharged to the Assiniboine River. Brandon also has combined storm and sanitary sewers in older parts of the City that can discharge raw sewage to the river. The most recent addition to the industrial effluents is that from the wastewater treatment plant for Maple Leaf Meats. The pork processing plant currently kills 9,000 hogs per day, 5 or 6 days a week. There is no phosphate removal in the plant and additions to the river are at least one tonne per week. This new plant has also had problems with achieving total and faecal coliform license requirements, discharges 30 degree Celsius water to the river, has electrical conductivities > 3,000 uS/cm and during last summer discharged highly toxic levels of nitrites to the river. A doubling of production is anticipated within two years. Associated with this increase in pork processing the province anticipates the eventual production of 10 million hogs in Manitoba.

Yet another government review panel identified inadequate monitoring of the current state of water quality in the province as a major concern with respect to intensive hog production in the province. Our independent monitoring over the past three years has consistently measured failures to comply with environmental licenses in winter and in summer by the City of Brandon, Simplot Chemical Canada Ltd. and the new Maple Leaf Meats wastewater treatment plant. No action has been taken by Manitoba Conservation or Environment Canada, despite a fish kill in May of 2001. Paton (1998) has also reported serious impacts of current effluent and river water quality on downstream irrigators, livestock and drinking water and health.

CONCLUSION

Canada must institute national standards for water quality across the country. Otherwise the future portends serious impacts on the sustainability of water and its uses on the prairies. Manitoba and Saskatchewan must seriously address the long list of research initiatives proposed over the past 10 years by the scientific and conservation communities to answer key questions of future water quantity and quality. Manitoba must commit to environmental monitoring and license compliance for polluters of water.

NOTE

The three figures for this paper are available from the author.

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