CANADA

1 WATER PARTNERS IN CANADA

Who has the responsibility of managing water in Canada? The Canadian Constitution gives the provinces the responsibility of managing the majority of all the natural resources, including water. The municipalities share the responsibility of supplying water and waster water treatment. As for the Federal Government, its assumes the global responsibility of navigation and fisheries as well as cross-boundary water or waters located on First Nations lands and in the northern territories.

The policies adopted by the federal and provincial governments are aimed at a sustainable management of water resources.

The federal and provincial governments have created a partnership for water management that is called the Canadian Council of Ministers of the Environment that is composed of federal, provincial and territorial ministers responsible for the environment.

2 BACKGROUND ON IRRIGATION AND DRAINAGE IN CANADA

2.1 IRRIGATION

Canada is extraordinarily rich in water resources. Almost 25 percent of all surface fresh water in the world is in Canada. We have more water per capita than any other large country.

The world's 260 million irrigated hectares of land (which is one sixth of the world's cropped land) now produces greater than one third of the world's food supply (Wolter & Kandiah, 1997). Of Canada's 33.5 million hectares of arable land, only 842,000 ha. are irrigated (Table 1). Yet,

irrigation is important to Canada. In the province with the most irrigated land, Alberta, 40 percent of the agricultural output comes from 4 percent of the province's arable land: that which is irrigated. Many of Canada's major crops are also irrigated crops, such as cereals, oilseeds, alfalfa, non-cereal forage, sugar beets and potatoes. In those provinces that depend on irrigation only as a supplement to rainfed cropping, it has been shown to be economically rewarding. As the price of land continues to rise, producers are looking to increase crop yields per unit area of land. Irrigation is often the tool used to meet this objective.

Table 1. Lands irrigated in Canada

Province	Area irrigated, ha	Percent of total
Maritimes	4,800	0.6
Quebec	33,000	4.6
Ontario	65,000	8.0
Manitoba	21,900	3.0
Saskatchewan	92,200	11.0
Alberta	510,600	61.0
British Columbia	114,000	13.5
Total	841,700	19 % increase since 1991

Water in agriculture is withdrawn mainly for irrigation (85%) and livestock watering (15%). The Eastern Irrigation District of Alberta estimates an overall irrigation water use efficiency of 75 percent. This is likely typical for irrigated agriculture in western Canada.

Cropping patterns and irrigation needs differ among the various regions of Canada. Some areas such as southern Alberta have a relatively large portion of land under irrigation. Other regions such as Quebec have a very small portion of the arable land under irrigation. Irrigation is needed mainly in the drier parts of Canada, such as the southern regions of Alberta, British Columbia, and Saskatchewan (accounting for 84.5% of all irrigation in Canada). In British Columbia most irrigation is for fruit and vegetable production with micro-irrigation systems or with permanent-set standing sprinklers for hay production. The southern regions of Alberta and Saskatchewan receive less than 350 mm of precipitation per year. In general, without irrigation, a summer fallow rotation must be practiced. Most irrigation in these regions is by use of center-pivots, side wheel-role systems or flood irrigation for grains, oilseeds, forage crops and sugar beets. Manitoba is not as dry as the other two prairie provinces. Yet, in recent years, center-pivot irrigation of potatoes has become important to this province. The major agricultural areas of Ontario and Quebec receive on average 900 mm of precipitation per year. Even in these regions, for higher valued crops such as potatoes, and for vegetables grown on organic soils, supplemental irrigation is economically rewarding. On the organic soils, hand move laterals or large guns attached to a reel are used and for potato production, center-pivots are used. Of special mention for these two provinces, is the use of controlled drainage and/or subsurface irrigation. It has become common for farmlands that have artificial subsurface drainage systems, to use these buried pipelines to deliver water to the root zone. In the Maritimes, hand move systems are used primarily for supplemental irrigation and for frost control on berries.

2.2 DRAINAGE

There are approximately 8 million ha of drained land in Canada. Most of that land area is under surface drainage. More than 2.5 million ha are subsurface drained, mostly in Ontario and Quebec. These two provinces have very intensive cereal, grain, forage and vegetable crop production where the soils with have very low hydraulic conductivities. In addition, the cropland is very flat and the region (eastern Canada) experiences high amounts of precipitation that occurs mostly during the spring snowmelt period and the fall. Since the soils are very heavy, mainly clays and clay loams, with some fine sands and silts, and with the conditions described above, artificial subsurface drainage is necessary.

Surface drainage consists mainly of open field ditches, main drains, land levelling or smoothing, bedded lands, ridge and furrow cropping. There is some dyking for flood control in Quebec, Ontario, Manitoba, and British Columbia.

Subsurface drainage consists of mostly corrugated plastic pipe systems installed to an average depth of about 1.2 m below the soil surface. Generally, 75 or 100mm diameter pipes are used for lateral drains, and the collectors are 100 mm in diameter and increase as the area drained increases. Most collector outlets are 250-300 mm diameter. In cases where there is good hydraulic gradient to the rivers, then gravity outlets are used. Pumped outlets are used in regions where the land level is below that of the receiving water bodies.

Licensed drainage contractors undertake subsurface drainage installations. They would normally use trenchless drainlaying plows with laser grade control systems. Some trenchers are used for drain installation. Farmers generally undertake surface drainage works themselves, using leased or owned equipment.

The subsurface drainage industry in Canada has grown significantly and the expertise is recognized internationally. There are well established factories manufacturing pipes, pipe products and envelope materials. There are also a few companies that manufacture drainlaying equipment. Envelopes or geotextiles are required for wrapping around the perforated pipes that are laid on the fine sandy and silty soils. This prevents the entry of soil particles in the pipes.

As mentioned in the previous section, there is growing interest in the use of subsurface drainage systems for subsurface irrigation. This is especially the case on the very flat lands in eastern Canada, on soils with higher hydraulic conductivities. A water source is required to supply water to the sub-irrigation system. One significant advantage of combined subsurface drainage and irrigation is that nitrate pollution can be reduced. The higher water table during the growing season enhances denitrification, thereby reducing nitrate leaching. In addition to the environmental benefits, there are also benefits due to increased crop yields and reduced nitrogen fertilizer inputs. This represents cost savings to the farmers and increased income.

While most drainage is undertaken in the humid regions of the country, it should be noted that there is potential for subsurface drainage in the arid and semi-arid parts of western Canada, where irrigation is extensively practised. There is some subsurface drainage in western Canada, however more could be installed to combat salinity and waterlogging of the irrigated lands.

3. WATER CHALLENGES AND ISSUES

3.1 OVER THE NEXT 25 YEARS

Irrigation sustainability

The long-term environmental effects of irrigation must be understood if its potential negative impacts on soil and water are to be prevented and if irrigation is to continue its contribution to a diversified agriculture.

Land classification for irrigation is the first step in identifying areas that are sustainable for irrigated agriculture. Water quality for irrigation affects the sustainability of irrigated soils. Soil salinity/waterlogging affects between 4 and 25 % of Alberta's irrigation districts (Hecker 1997). Of this area, 70 to 80% of the salinity within the irrigation districts of Alberta is attributed to canal seepage.

Although Canadian irrigated agriculture uses only 8 percent of the total national water withdrawal, 77 percent of this amount is consumed through evaporation and lost to other uses (Environment Canada 1987). Further expansion of irrigation should be considered only in the light of present and future requirements.

Water sources

The way we use water is important because some users borrow or take water from the natural cycle for longer periods that others, and some users may have a greater impact on downstream water than others (Vandierendonck and Mitchell 1997). For example, a farmer who irrigates may affect a region's groundwater supply since most of the irrigation applied is lost in evapotranspiration and may not be contributing to surface and ground water recharge. But whether the water is withdrawn from the surface or ground water sources, it is important to all sectors that rely on water, namely, industrial, municipal, agricultural and rural domestic. Table 2 summarizes water withdrawal and consumption from 1981 to 1991.

Table 2. Water withdrawal*, by use, and consumption, in millions of cubic metres.

	1981	1986	1991
Agriculture	3,125	3,559	3,991
Mining	648	593	363
Manufacturing	9,937	7,984	7,282
Thermal power	19,281	25,364	28,357
Municipal	4,263	4,717	5,102
Total Withdrawal	37,254	42,217	45,095
Water Consumption	3,892	4,279	5,357

**Source: Environment Canada, Water and Habitat Branch, as posted on the Statistics Canada web site.*

The demand for water is highly variable and is seasonally related, with the residential and agricultural sectors accounting for most of the variation (Vandierendonck and Mitchell 1997). In 1991, for an estimated Canadian population of 28 million and a total water consumption of 5,357 million cubic metres, each Canadian consumed 191.3 cubic metres of water per year or about 0.52 cubic metres per person per day. Of the total water withdrawn in 1991, agriculture accounted for 8.8 percent and this proportion has remained fairly constant since 1981.

Agricultural water use data in Canada are not collected or maintained in a systematic basis (Vandierendonck and Mitchell 1997). They mention that, in Ontario, although total amounts of water withdrawn by the agricultural sector have been estimated, actual documentation of the source of the water or its spatial context in a watershed has not been done adequately.

Regional water withdrawals in Canada are largely dependent on its use and climatic conditions. Table 3 shows total water withdrawals for the different regions of Canada. The prairie region has the highest water use per person in Canada and the second highest total water withdrawal. The necessity of irrigation water to produce food for domestic consumption and for export explains the higher needs of the prairies provinces.

Table 3. Summary of water withdrawals across Canada (Source: Symposium sur la gestion de l'eau au Québec, Document de référence, automne 1997, gouvernement du Québec)

Region	Total withdrawal* (millions of m^3)	Percent use of Canada	Water use per person (litre/day)
Atlantic Provinces	1,049	6%	1,209
Quebec	3,493	21%	1,352
Ontario	5,390	32%	1,410
Prairie Provinces	4,196	25%	4,226
British Columbia	2,610	16%	2,415
Canada	16,739	100%	1,596

**Excludes thermal power water use*

3.2 ENVIRONMENTAL AND ECOLOGICAL CONCERNS

The environmental challenges related to water uses in agriculture cover a wide range. As stated in the Environment Strategy for Agriculture and Agri-Food, the water resources challenge is to minimize the negative effect of agriculture and agri-food sector on the water quality and increase water use efficiency.

Water quality issues

Improper agricultural practices can result in nutrient and pesticide concentrations, in surface and ground water that exceed recommended levels. High concentrations of phosphorus and nitrogen can lead to eutrophication and deoxygenation of surface water. Increased pesticide use may cause ground water contamination for the percolation of chemicals through the soil profile.

Irrigation may lead to water quality problems. Improper irrigation practices may degrade the soil structure and quality (soil salinity problems), thus compounding many of the water quality issues associated with agriculture.

3.3 CANADIAN WATER LAWS AND POLICY

A Canadian federal water policy was formulated in the mid-eighties. The objectives were to provide a framework within which all water-related decisions of the federal government would be made by every department and agency as well. Its two main goals are to protect and enhance water quality and to promote wise and sound management of water resources.

As mentioned above, ownership of natural resources rests with the provinces. Consequently, the provinces are charged with managing these resources.

Western Canada

The Federal Irrigation Act is the original water law in Western Canada (Percy 1997) and it has undergone many changes over the past few years or, in some provinces, will undergo some transition.

Ontario

Two main environmental statutes, the Ontario Water Resources and the Environmental Protection Acts, both have restrictions pertaining to water and the environment, respectively.

Specific legislation in Ontario regulates pesticides under the Pesticide Act, which contains a general prohibition affecting nonpoint source pollution.

Quebec

Quebec is currently preparing a new water management policy that is taking an holistic view towards water resources management in the province. The elements of the policy are now being discussed in public hearings. There is a section in the policy that looks at how Quebec can market its services and expertise internationally, given its significant expertise in hydropower generation.

Quebec has set some general objectives for water management (full text can be found at the web site *www.mfe.gouv.qc.ca*) that include the following:

- Guaranteeing protection of public health,
- Seeking the sustainability of the water resources,
- Developing the water resource at the social and economic levels
- Reconciling the uses with a view to satisfying legitimate needs.

3.4 INTERNATIONAL JOINT COMMISSION

Many rivers and lakes are found along the border of Canada and the United States. The International Joint Commission originated back in 1906 when a treaty on lake water was signed. This treaty requires that both countries must collaborate in the management of these waters and protect these waters for the benefit of future generations.

In the 1960's, eutrophication, caused mainly by phosphorus loading, threatened to destroy the Great Lakes aquatic ecosystem. The Governments requested the IJC to investigate the problem and to formulate recommendations. As a result, Lake Erie, one of the most affected by this situation, has improved considerably.

3.5 CLIMATE CHANGE AFFECT ON WATER AND FOOD PRODUCTION IN CANADA

In the development of sustainable water resources policies in Canada, water managers and planners can no longer assume the climate will remain constant. Different scenarios based on studies have suggested that the long-term availability and quality of water in Canada and the frequency, duration and severity of such hydrological events as droughts, storms and floods are likely to change. Research is currently being conducted to determine the consequences of climate change impacts on Canadian water resources.

Climate change includes increasing soil temperatures, increasing growing season length, increasing hot spells, decreasing cold spells, decreasing snow cover area, retreating glaciers and permafrost, extreme droughts and wet spells, increase risk of soil erosion by wind and water, increasing demands for water, increasing conflicts over water, decrease river flows and reservoir levels, northward expansion of the range of weeds, insects and diseases and decrease in water quality.

The development of water resources policies and water management strategies in Canada should consider the impact of climate change. Because hydrological processes are so intimately related to atmospheric processes, any change in climate will have a profound effect on water supply of and demand for water.

Research needs include the following topics :

- Frost and drought tolerant crops
- Heat stress

- Water management
- Irrigation
- Fall seeded crops
- Climatic effects on livestock
- Application of short and long term climatic information
- Relationship among climate and agricultural production and practices
- Modeling of climate and production management relations
- Nutrient management
- Management scheduling
- Soil conservation research and practices

Agriculture in the Canadian prairies is already quite adaptable and innovative. Adaptation strategies if developed soon are likely to be beneficial to today's climate and likely tom offer more protection for future climates (Wheaton 1994).

3.6 INTEGRATED WATERSHED MANAGEMENT OR INTEGRATED WATER MANAGEMENT

Practising sustainable water management

Ten themes are being considered in this approach and include: sustainability, stewardship, ecosystem approach, enhancing effectiveness and efficiency, information and understanding, partnerships and stakeholders, impact assessment, adaptive management, anticipation and prevention, and alternative dispute resolution (Shrubsole and Mitchell 1997).

Several provinces including Quebec and Ontario are undertaking integrated watershed management projects. The objective is to conserve and protect the watershed and its land and water resources. Efforts are being made to reduce soil and ditchbank erosion, and to protect water quality. The landowners, agricultural producers and water users on the basin are regarded as the primary stakeholders. They are encouraged to form associations and to undertake conservation measures as a group. Best management practices which are being promoted include conservation tillage, vegetated buffer strips along ditchbanks, grassed waterways, contour cropping, strip cropping, drainage, manure storage, improved and more efficient manure and fertilizer applications, and improved pesticide management.

Agricultural producers are being encouraged to develop and implement farm conservation plans. Some provinces now require fertilizer management plans.

3.7 WATER USE CONFLICTS

Although Canada may appear to have a favourable water supply-demand balance, in reality the situation is disguised by wide variations. More than 60 percent of river flow goes north where only 10 percent of the Canadian population lives (Environment Canada 1987). Factors such as snow accumulation, spring snowmelt, water pollution, drought and climate change are contributing to water use conflicts.

Some uses to consider include, hydropower generation, wetland preservation, flood control, water reservoirs, irrigation requirements, recreational water and water supply for urban areas.

3.8 FISH PRODUCTION

Fresh water fisheries and aquaculture make important use of fresh water in Canada. In 1995, fresh water fisheries caught more than 38,000 tonnes for a value of $76.6 million. In the aquacultural industry, 4,800 tonnes of fish were produced for a value of $19 million.

3.9 MANAGEMENT OF WATER BY SUPPLY OR DEMAND

An increasing number of users are fighting over the existing water reserves to satisfy the basic needs of people, to maintain economic development, to support the natural environment and to be able to keep water for recreational purposes. It is necessary to reconcile these diverging needs and to promote a utilization that recognizes the social, economic and environmental advantages linked to the water resource. Governments, the private sector, NGOs and citizens, all have a major role to play in this regard.

4 CONCLUDING REMARKS

- The Canadian Constitution gives the provinces the responsibility of managing the majority of all the natural resources, including water. The municipalities share the responsibility of supplying water and waster water treatment. As for the Federal Government, its assumes the global responsibility of navigation and fisheries as well as cross-boundary water or waters located on First Nations lands and in the northern territories.
- Canada is extraordinarily rich in water resources. Almost 25 percent of all surface fresh water in the world is in Canada.
- Although Canada may appear to have a favourable water supply-demand balance, in reality the situation is disguised by wide variations. More than 60 percent of river flow goes north where only 10 percent of the Canadian population lives.
- Of Canada’s 33.5 million hectares of arable land, only 842,000 ha. are irrigated. Yet, irrigation is important to Canada, especially in the province of Alberta.