CANADA: *FLOOD MANAGEMENT IN THE RED RIVER BASIN, MANITOBA*

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Abstract. Information is provided about the approach and experience on flood management and mitigation in this important river basin. Solving the flood damage reduction problems while concurrently protecting and enhancing the floodplain environment has required full use of structural and non-structural methods available. A detailed description is therefore provided of the methods applied, both structural (floodway, diversion, reservoir and dyke systems) and non-structural (flood fighting, forecasting and warning, post-flood recovery, land use regulation and mapping, and proofing). Of interest is in particular the list of issues considered under each one of these methods. This is complemented with information on flood and water management policy instruments. The wealth of information and lessons provided in the case study could be used to transfer experience to other basins for purposes of flood management improvement.

1. Location

Situated in the geographic centre of North America, the Red River originates in Minnesota (USA) and flows north. Its basin, which is remarkably flat, covers 116,500 km^2, of which nearly 103,600 km^2 are in the USA. The basin is about 100 km across at its widest. The Red River floodplain has natural levees at points both on the main stem and on some tributaries. These levees (some 1.5 m high) have resulted from accumulated sediment deposit during past floods. Because of the flat terrain, when the river overflows these levees the water can spread out over enormous distances without stopping or pooling, exacerbating flood conditions. During major floods, the entire valley becomes the floodplain. In 1997, it spread to a width of about 40 km in Manitoba. Water tends to remain on the surface for extended periods of time.

In Manitoba, almost 90 percent of the residents of the basin live in urban centres. Metropolitan Winnipeg holds 670,000 people, and another 50,000 live along the Red River north and south of the city. The Red River valley is a highly productive agricultural area serving local, regional and international food needs. There has been an extensive and expanding drainage system instituted in the Basin to help agricultural production by increasing arable land.

2. Nature of floods

Periodically weather conditions exist which promote widespread flooding through the valley. The most troublesome ones (especially when most or all happen in the same year) are as follows: (i) heavy precipitation in the fall; (ii) hard and deep frost prior to snowfall; (iii) substantial snowfall; (iv) late and sudden spring thaw; and (v) wet snow/rain during spring breakup of ice.

The basin floods regularly. History shows that a flood in 1826 was the largest one on record. A sudden thaw in April of 1826, followed by ice jams on the river and simultaneous heavy rainfall, had water on the Red River rise 1.5 m downtown in just twenty-four hours. Losses were enormous. The river carried whole houses away. The water apparently took over one month to recede completely.

The 1950 flood was classified as a great Canadian natural disaster. A very cold winter and heavy snow pack in the USA, combined with heavy rain during runoff, were the primary causes. All towns

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within the flooded area in the upper valley had to evacuate. Over 10,000 homes were flooded in Winnipeg and 100,000 people evacuated.

The large 1979 flood was primarily the result of a rapid thaw and wet spring. Half of the upper valley evacuated. Homes just south of the flood control system were very hard hit, but Winnipeg was largely spared.

Finally, the 1997 flood was the highest recorded last century and a true test of the flood control system throughout the valley. Extreme snow pack and cold north and south of the border, unfavorable time of runoff, and an April blizzard combined to cause the inundation. An estimated 1840 km2 of land was flooded as the Red River rose 12 m above winter levels. Structural measures such as the dyke systems and the Red River Floodway (see below) prevented enormous losses, as did emergency dykes. Estimates of those prevented damages run as high as $6 billion.

3. Flood and water management measures

The 1950 flood clearly revealed the vulnerability of settlements along the flood plain in southeastern Manitoba, and the high costs associated with flood damages. This prompted all levels of government to search for ways to mitigate the flood hazard. The first large scale water control structure in Southern Manitoba, intended as a temporary ameliorative measure; was a boulevard dyke system constructed after the 1950 flood in the greater Winnipeg area. Subsequently, a narrowly averted flood threat in 1956 served as impetus for the Provincial Government to take the first steps in development of a more far-reaching long-term flood damage reduction plan for Manitoba. A benefit–cost analysis was prepared for a range of flood protection schemes, considering different traditional structural approaches to protect vulnerable areas. The comprehensive flood control system finally adopted included an extensive plan to divert water around the city of Winnipeg. It was constructed from 1962-72, with federal and provincial governments sharing the costs.

This major structural system to reduce flood damage (Red River floodway, portage diversion, Shellmouth reservoir, Winnipeg dyke system and ring dykes around select communities) was considered essential, since it was evident that only such measures could provide a significant reduction in flood damages. The land was already in use; the benefits of more appropriate land use would be evident only over a period of time.

Without doubt, the floodway has proved its value to the City of Winnipeg; this was illustrated in the 1997 flood. However, a false sense of security and the resultant complacency of people protected by the major structural flood damage reduction measures has encouraged the “project-induced development” in the floodplain, so that with each successive flood the *potential* damage if structural measures fail is escalating. This highlighted the need for a long-term approach to flood protection, as well as the implementation of non-structural measures to complement structural ones that can both maximize the efficiency of existing structural measures and reduce damages in vulnerable areas. Thus, the main non-structural measures applied to reduce flood damage to Winnipeg are flood fighting, forecasting and warning, post-flood recovery, land use regulation and mapping, and flood proofing.

Nonstructural measures of all types – those related to emergency preparation, flood recovery, land use regulation, flood proofing, etc., all offer additional protection when carefully applied, and are vitally important at the individual and community level. They must therefore be given more priority than they have to date both by government and the public.

4. Flood and water management policy instruments

The evolution of federal-provincial policy on flood damage reduction was based on the three major pieces of federal legislation related to the topic. These were responsible for influencing the nature of federal-provincial agreements and activities for flood damage reduction in Manitoba.

Canada Water Conservation Assistance Act (1953). As the first actual water resources Act, it was intended to provide (to the provinces) federal financial assistance for the construction of "works" designed to conserve or control water.

Canada Water Act (1970). Superseding the previous Act, it outlined the nature of federal involvement in water resource management and water quality programs. It allowed for federal-provincial agreements to conduct research, formulate comprehensive water management plans, and develop water management projects. It also allowed consideration of non-structural water management alternatives.

Flood Damage Reduction Program (1975)[2]**.** The primary objective of the Flood Damage Reduction Program was to reduce escalating flood damage costs; it came about because much of the increasing damage in the 1970's was a direct result of *new* uncontrolled development in floodplains. The *first* goal was to discourage development in high-risk floodplains. To identify these high-risk areas, the program included a flood mapping agreement, and a public education component; this would allow the " designated flood areas" to be formally determined, mapped, and shared with the public to discourage further inappropriate development. For each designated area, provincial and federal governments agreed to the following provisions: (i) they would not build, approve or finance inappropriate development; (ii) they would not provide flood disaster assistance for such development built after the designation as flood-prone; and (iii) provincial authorities would *encourage* local authorities to zone on the basis of flood risk.

The enforcement of these three provisions of the above legislation has only been partially successful.

5. Institutions responsible for flood management

The key institutions with regard to their flood mandate are as follows:

Manitoba Conservation - Water Resources Branch is primarily responsible for flood planning and management. For floods in the Red River Basin the Department's Central Region carries out the delivery of flood related services. Through nine Acts the Branch administers flood management activities such as forecasting, operation of flood control works, monitoring of flows/levels, and dissemination of information as necessary.

Manitoba Conservation – Regional Operations is responsible for field activities, enforcement of legislation, emergency response to floods, and delivery of services at the community level.

Manitoba Conservation - Regional Engineering Staff maintain and operate flood protection systems in rural communities, the Red River Floodway, and the Portage Diversion.

Department of Conservation - Operations Division provides security to dyked communities, and search and rescue during large floods.

Manitoba Emergency Measures Organization (EMO), part of Manitoba Government Services, works with and coordinates federal government's involvement/contribution (including financial)

[2] Umbrella agreement still in effect

during natural disasters such as floods. As the civil defense agency, they help in coordination of emergency response per The Emergency Preparedness Act.

EMO also coordinates damage claim assessment and communicates with federal government about their share of recovery costs according to the federal *Disaster Financial Assistance Arrangements (DFAA)* and the *Canada–Manitoba Agreement on Red River Flood Disaster Assistance (1997).*

6. Main lessons learned

The long history of flood control work in the Red River basin provides a wealth of information and lessons that can be used to further improve the flood management in the basin and/or transfer experience to other basins in Canada and abroad. The following may be highlighted:

- Solving the flood damage reduction problems of the Red River basin, while concurrently protecting and enhancing the floodplain environment, requires full use of all the structural and non-structural methods available. No one approach can solve all the problems by itself. Whether the challenge is protection of an individual, a community, or the basin as a whole, all approaches to damage reduction should be considered and integrated into the solutions.

- It is evident that without the current flood control system protecting the city of Winnipeg, losses from floods since the late 1960's would be much greater in magnitude. This is quite generally accepted, although there are regions south of the city which maintain that the control system has increased their flooding.

- Of the non-structural flood damage reduction measures, land use regulation warrants particular attention. It is evident that poor enforcement by authorities and inconsistent application of land use regulation by municipal governments has greatly reduced the effectiveness of this strategy in the Red River basin.

- The flood-proofing programs sponsored by the federal and provincial governments in past years have made a positive contribution to flood damage reduction. Both communities and individuals who flood-proofed to the 1979 design flood level suffered less damages overall in 1997. However, flood-proofing has its limitations, particularly evident when water levels exceed the standard 100-year level or unpredicted overland flows occur.

- It is clear in the Red River basin that much of the information necessary to implement various strategies is at a municipal level. There are nine municipalities in the Designated Flood Area, each with different approaches to flood risk management. A detailed analysis of the impacts of flood damage reduction strategies requires significant resources and municipal cooperation.

- The institutionalization of flood mitigation is a concern in the Canadian portion of the Red River Basin. Flood fighting, management of flood control systems, and responsibility for post flood recovery all rest largely in the hands of government, freeing the individual from a perception of responsibility until a crisis. This reduces the effectiveness of flood damage reduction initiatives.

- Because of the recent flood (1997), authorities are putting considerable effort into flood management activities. Cooperation and exchange of information between departments and different levels of government must lead to a rigorous analysis of which strategies warrant the input of financial and human resources in future. This is a long-term goal in the Red River basin.