Flood Mitigation Efforts in the Red River Basin

Slobodan P. Simonovic
University of Manitoba
University of Western Ontario

Presentation outline

- Introduction
- Red River basin experience
  - legislation
  - structural measures
  - nonstructural measures
  - 1997 flood
- IJC Red River Basin Task Force
- City of Winnipeg Flood Control Adequacy Study
- Conclusions

Introduction

- Mitigation is the cornerstone of emergency management
- It's the ongoing effort to lessen the impact disasters have on people and property
- Mitigation involves keeping homes away from floodplains, creating and enforcing effective building codes to protect property from disasters -- and more

Introduction

- Definition:
  Mitigation is defined as 'sustained action that reduces or eliminates long-term risk to people and property from natural hazards and their effects' (FEMA, 1995)

Introduction

In practice, mitigation can take many forms:

- Promoting sound land use planning based on known hazards
- Buying flood insurance to protect your belongings
- Relocating or elevating structures out of the floodplains
- Developing, adopting, and enforcing effective building codes and standards
- Developing and implementing a plan in your business or community to reduce your susceptibility to hazards

Human response cycle

(FEMA, 1996)

Mitigation

- Definition - mitigation is any activity that reduces the effects of the hazard
- Physical and financial
- Impediment in Canada:
  - lack of incentive when disasters occurred long time ago
  - public support is much stronger after a disaster
- Financial incentives and public education

Mitigation

- Responsibility for mitigation:
  - the federal government (research)
  - joint federal-provincial (reduction of flood damage)
  - the provinces (flood mitigation and setting construction standards)
  - municipal authorities (flood mitigation and enforcing construction standards)
  - public institutions (research)
  - the insurance industry (promoting mitigation)
  - individual homeowners (private mitigation efforts)

Preparing for emergency

- Definition - development and practice of emergency plans to respond to floods and monitoring to allow timely warnings
- Responsibility of various agencies
- Testing emergency plans as a measure to strengthen emergency preparedness

Disaster response and relief

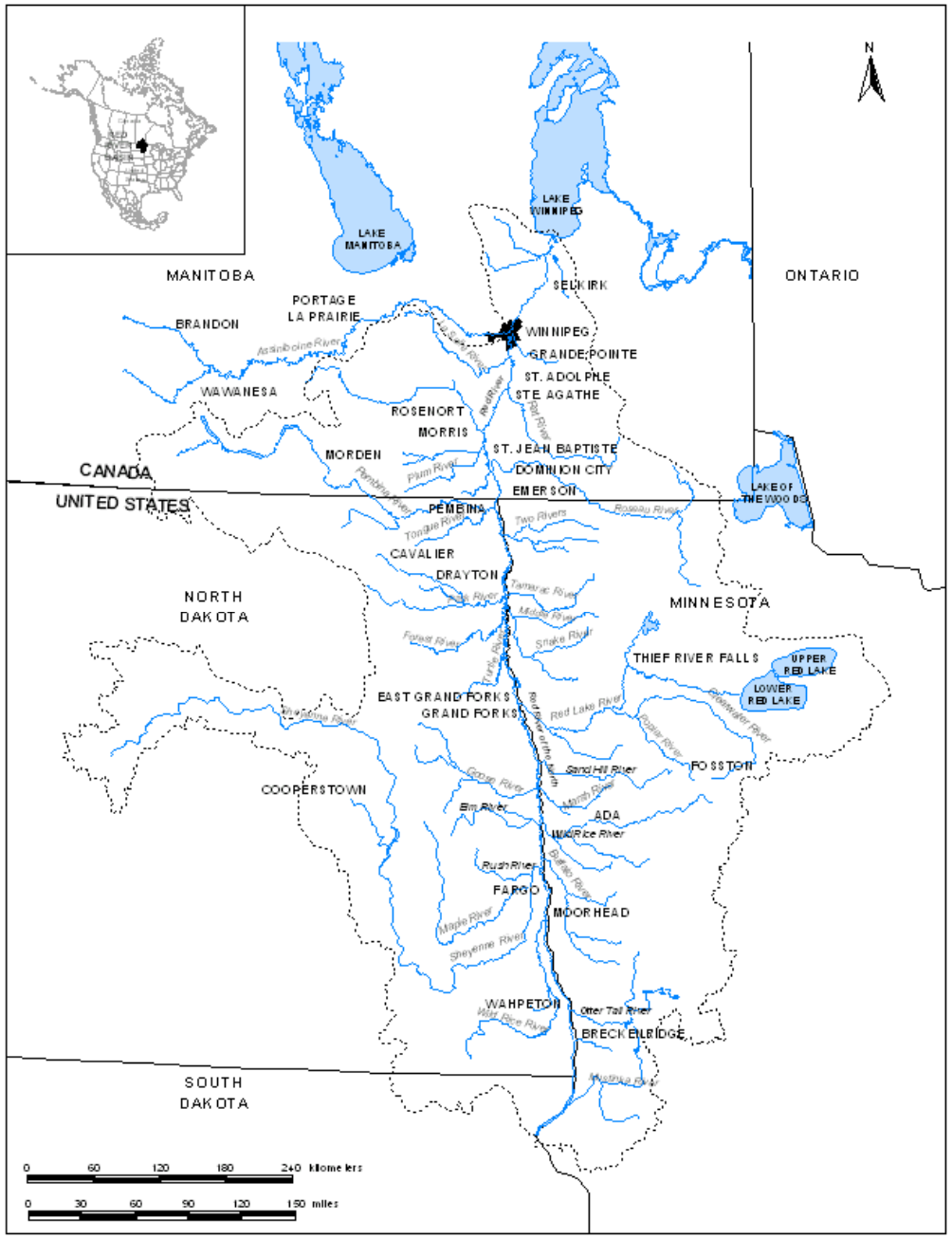
- Start as soon as a disaster is detected
- Involves - mobilization and position of emergency equipment; provision of food, water, shelter, and medical equipment
- Response and responsibility is a function of the size of the disaster
- Co-ordination (MEMO)

Recovery

- Recovery from the physical and financial effects of the disaster - final stage
- Rebuilding can take months, if not years
- Means are required: financial assistance; etc.
- Shared responsibility (governments and insurance companies)

Red River basin experience

- 116,500 km^2
- 89% in USA
- 11% in CDN
- very flat



Flood damage approximations

Flood Year	Amount Paid in Assistance	Source of Monies	Paid For		Comment
			Damages	Other Assistance	
1950	$12.5 M	Federal	X		
	$21.0 M	Province	X		Includes home, farms & small business
	$19.0 M	Private Donations			To supplement for uncovered damages
1966	$10.0 M	Province & Federal (per cost sharing agreement)		Flood fighting & response	Initial predictions very high, so flood fighting costs inflated
	$1.4 M	Province & Federal (per agreement)	X		

Floodway System Completed					
1979	$7.8 M	Province & Federal (per agreement)	X		Includes individual and municipal damage
	$7.1 M	Province & Federal (per agreement)		Flood Proofing	
1996	$12.0 M	Province & Federal (per agreement)	X		Damages largely in upper valley. Includes individual and municipal damage
1997	$150.0 M	Province & Federal (per Disaster Financial Assistance agreement)	X		Includes c.5100 individual and c. 60 municipal claims*
	$120.0 M $200.0 M	Province & Federal		Flood Proofing Restoration of the floodway and ring dikes for 20 communities	includes c.2450 private applications*
	$2.0 M	Province		Temporary housing	more expenditures anticipated-70 families still need housing*

*information as of March 1, 1998

Red River experience

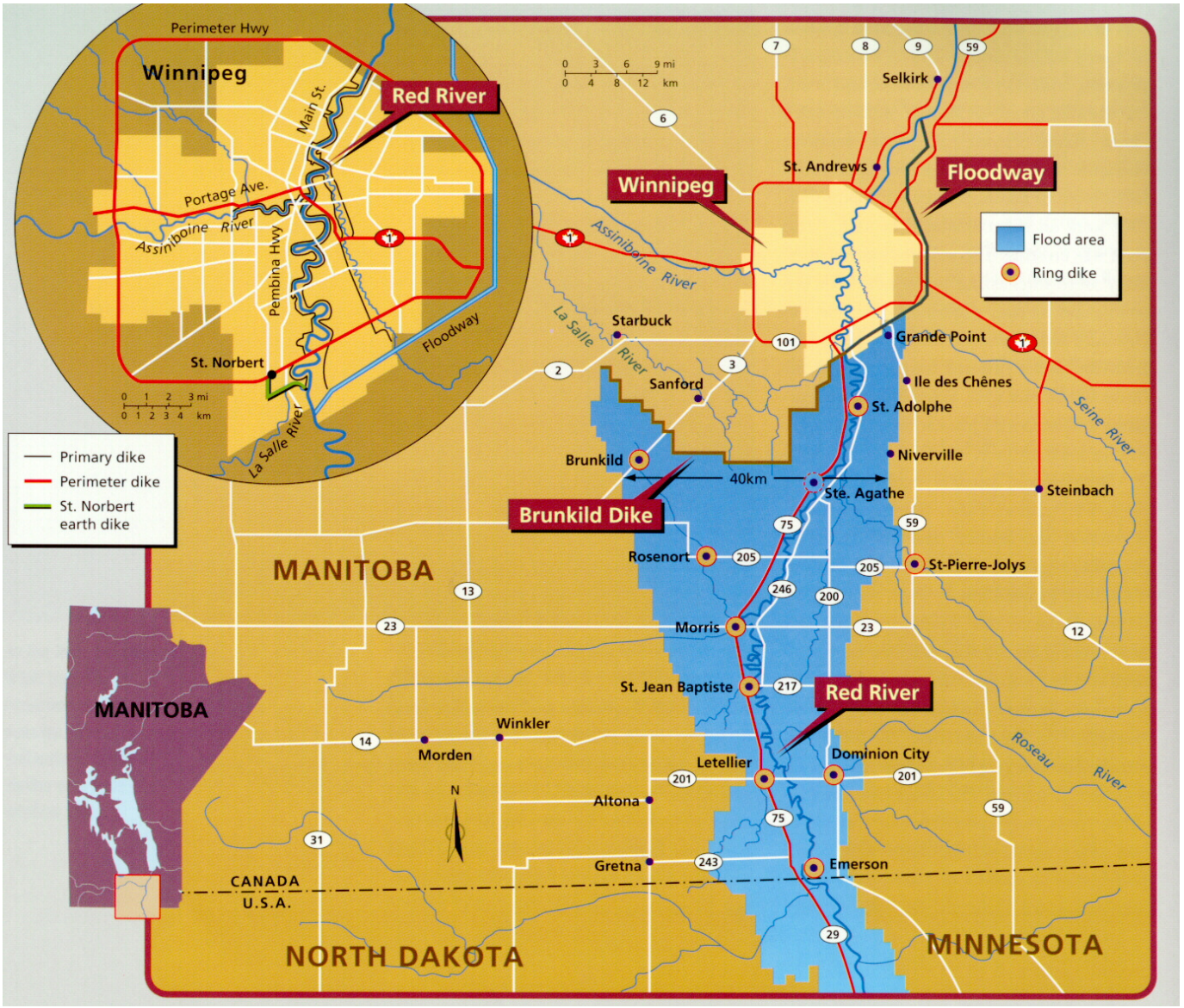
- Legislation
  - Canada Water Conservation Assistance Act (1953)

    (up to 37.5% of the cost of the works)
  - Canada Water Act (1970)

    (focused not only on works but also on nonstructural alternatives)
  - Flood damage reduction program (1975)

    (discourage development in high-risk floodplains; no finances for inappropriate development - no flood disaster assistance - zoning based on flood risk)

Structural measures



The Red River floodway

The Red River floodway

Measure	• excavated channel about 48 km long; capacity 1,698 cms
Implementation	• on advisement of 1958 Royal Commission , based on benefit-cost analysis • completed in 1968, at cost of $62.7 million
Responsibility	• operation and maintenance done by Manitoba Natural Resources- Water Resources Branch
Goal	• to divert flood waters in excess of 30,000 cfs around the city of Winnipeg from south to north
Efficiency	• highly successful at protecting Winnipeg, within technological limitations
Issues	• inappropriate development in highly vulnerable areas due to exaggerated sense of security within the protected area • institutionalization of flood damage reduction (perception that flood damage reduction is a government function and not a public issue) • if flood waters exceed channel capacity, damages could be extremely high • capacity insufficient to handle flood equal to that of greatest flood on record (i.e.1826) • operation is poorly understood by the public, prompting criticism • allegations that operation caused excessive flooding south of structure • currently the Floodway is being refurbished , a three year project costing over $3 million • provincial government claims Floodway has saved over $4.5 billion in potential damages to Winnipeg

Portage diversion

Portage diversion

Measure	• consists of a diked earth channel, a diversion dam and spillway dam • channel is two miles west of city of Portage la Prairie; capacity 700 cms • diverts water from Assiniboine River to Lake Manitoba 18 miles to the north
Implementation	• recommended by Royal Commission (1958) • completed in 1970 • cost $20.5 million
Responsibility	• Water Resources Branch
Goals	• To keep water levels in Winnipeg at acceptable level---below 17 ft. or 18 ft. at James Avenue • Protect agricultural land and communities downstream from Portage la Prairie

Efficiency	• highly efficient, subject to
	  • problems with ice jams which can significantly reduce diversion channels capacity
	  • technological limitations

Issues	• Diversion is most essential when the Red River and the Assiniboine both crest at or close to the same time; Winnipeg floodway would otherwise be heavily taxed • Reduces flood damages along lower Assiniboine River, much of which is agricultural land • May have contributed to false sense of security along lower Assiniboine River

Shellmouth reservoir

Shellmouth reservoir

Measure	• consists of earthfill dam, overflow spillway, and reservoir • Located on Assiniboine River near Russell, Manitoba • Reduces peak flow at Winnipeg by 196 cms
Implementation	• Recommended by Royal Commission (1958) • Completed in 1972 • Cost $10.8 million
Responsibility	• Water Resources Branch
Goals	• provide water storage and control reservoir outflows to minimize downstream flooding in spring or during summer rainfall flood conditions • ensure adequate water supply in summer

Primary dikes

Primary dikes

Measure	• 109 km of earth dikes and 31 pumping stations
Implementation	• recommendation of Royal Commission (1958) • initially implemented by the Greater Winnipeg Diking Board 1950-52 with involvement of three levels of government, later enhanced • initial cost (1950-51) $6 million, cost of enhancements in subsequent years undetermined
Responsibility	• Water Resources Branch (per the Diking Authority Act)
Goals	• protection of Winnipeg property from flood waters • pumping stations operate to lift water and sewage waste over boulevard dikes and prevent sewage back-up
Efficiency	• adequate only to a limited water level • easily breached under bad weather conditions or in very long duration floods • must be properly maintained
Issues	• permanent dikes are insufficient for highest water levels on record • some Winnipeg riverbank properties could not be protected by dikes due to proximity to river • some residents have removed the dikes on their property for aesthetic reasons, placing entire community at risk

Ring dikes

Ring dikes

Measure	• ring dikes around eight communities (earth); 100 year flood protection
Implementation	• recommended by Royal Commission(1958) • cost – benefit analysis conducted prior to construction on 8 communities • first ring dikes completed in 1972, cost $2.7 million • from 1982-1991 new ring dikes and old dike enhancements cost $4 million; this figure is $6.9 million if *total* expenditures on the diking systems are included (such as pumping stations, communications equipment…) • new ring dikes anticipated following the 1997 flood
Responsibility	• Water Resources Branch – regional engineering staff (for maintenance and operation)
Efficiency	• adequate, subject to water level heights, weather conditions and maintenance/monitoring of dike
Issues	• dikes must be maintained, monitored and often enhanced during flood conditions • dike openings such as roads and railways must be closed with earth during floods • adequate pumping facilities must be in place • municipal cooperation required for construction and maintenance of dikes

Nonstructural measures

Flood fighting

Measure	• Flood fighting includes those activities done prior to or during a flood with the intent of reducing damages from the flood
Responsibility	• Water Resources Branch of the Department of Natural Resources • EMO (Manitoba Emergency Measures Organization) • three levels of government • individual property owners
Issues	• need for *ongoing* emergency preparedness and planning, to ensure adequate needs assessment and timely access to human and other resources • proactive and long-term planning required versus reactive • optimal use of forecasts to determine flood fighting strategies, and provide sufficient warning to at-risk areas • improve flood response in some rural municipalities • improve public awareness of provincial government's flood fighting activities, including more specific information on the operation of the Floodway gates • establish nature of government liability, if any, for damages resulting from inaccurate predictions of water levels • improve individual property owners' and communities' emergency response

Flood forecasting and warning

Measure	• River streamflow forecasting involves complex analysis of the many variables which influence river levels, to ultimately best anticipate levels using probability calculations.
Responsibility	• Water Resources Branch – River Forecast Centre
Issues	• enhanced use of modeling techniques needed • improved communication of risk to the public • improved prediction of overland flows

Post flood recovery

Post flood recovery

Measure	• Activities, programs and policies which assist victims post-flood and restore property, including financial compensation and rehabilitation/ restoration
Responsibility	• EMO Claims Department • Three levels of government • Charity Organizations
Issues	• Federal and Provincial governments provide post disaster assistance based on the Canadian Federal Disaster Assistance Arrangement. The cost sharing formula which outlines the federal contribution is as follows: 0% of total rehabilitation costs if the disaster costs are less than $1 per capita of provincial population, 50% for the next $2 of eligible provincial expenditures on assistance, 75% for the next $2, and 90% of the remainder. • Primary responsibility for recovery rests with the provincial level of government. • The willingness of government to pick up a significant amount of costs associated with recovery in recent decades has caused citizens to now see some types of compensation/assistance as government's *responsibility*. • Private and charitable funds are essential to full restoration of victims' households and businesses to pre-flood state. • There is no source of compensation for some types of damages e.g. flood-related hardship, lost wages. • Some citizens want full compensation from government, without a deductible, for damages they feel they incurred because of operation of the flood control system. • Increasing land development and property values contribute to rising flood assistance payments

Land use regulation

Measure	• Land use regulation refers to rules of practice and policy governing how land is used within a designated floodplain, as supported by government. Floodplain mapping activity complements land use regulation by delineating the area at risk during floods of specific magnitude; in Manitoba the 100 year flood level is used in regulation.
Responsibility	• Provincial government, with Federal input and legislation • Municipal government
Issues	• The use of land use regulation as a means of flood damage reduction has been slow to be effectively adopted in Manitoba • Inconsistencies abound in use of Designated Flood Area maps because it is at the discretion of the municipalities • Weak land use regulation has allowed for increasing residential development along the river south of the Floodway which is extremely vulnerable to flooding. • Poor enforcement of regulations has been an ongoing weakness; legislated ministerial powers have not been used in instances of non-compliance. • New legislation is now before the provincial government which is intended to improve the success of land use regulation by more clearly discouraging the building of structures which are not compliant, and improving the inspection process.

Flood proofing

Flood proofing

Measure	• Flood proofing activities are meant to protect individual structures from flood damage; they include diking, terracing, raising buildings, relocation etc.
Responsibility	• Manitoba Water Resources Branch administers the program with the assistance of the Emergency Management Organization. The latter maintains the database of victims and their circumstances. Water Resources Branch provides both technical and financial assistance to communities, businesses and individuals who need help to flood proof.
Issues	• Since summer 1997 the current flood proofing program has been instituted, using the 1997 flood as the design flood. • Due to the large personal losses of some victims of the 1997 flood it is difficult for some victims to access sufficient funding to flood proof • The flood proofing program will be in operation for five years, with applications required within two years; however, the consequences (if any) of failing to flood proof are unknown if future damages are sustained.

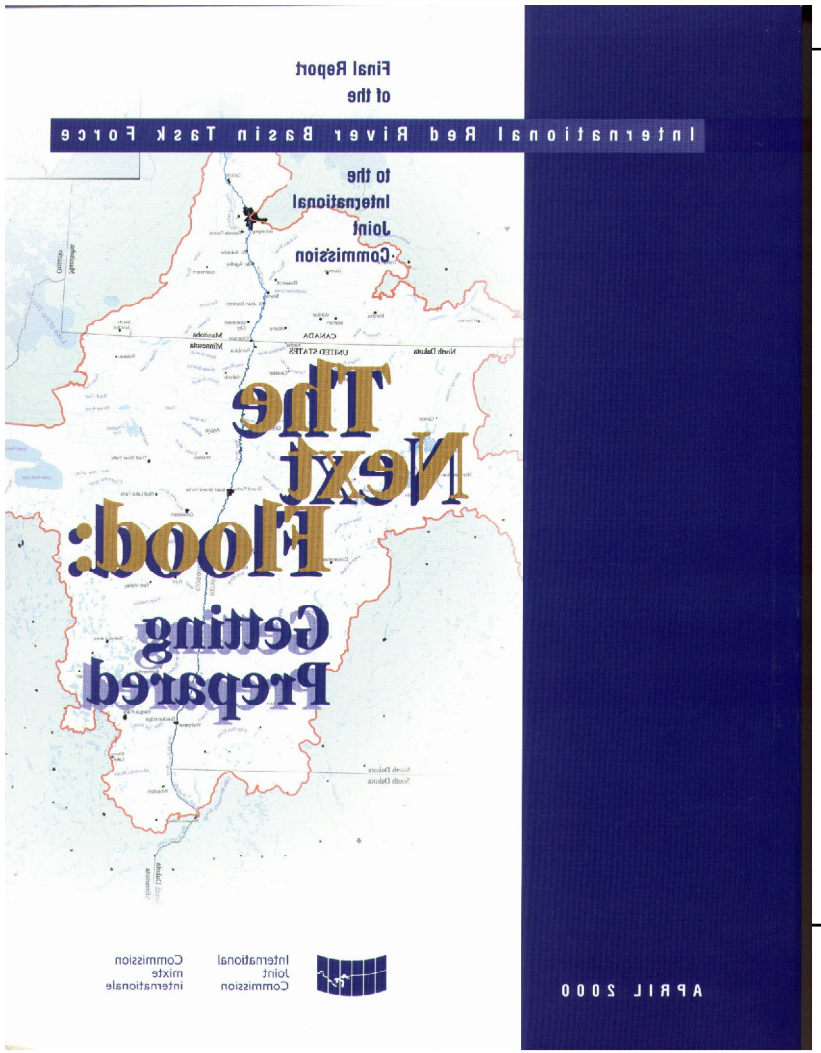
1997 flood

- 4,587 m^3/sec - flood of the century - 2,000 km^2 Red Sea
- 28,000 people evacuated; 8,700 soldiers
- Many temporary dikes; 6 million sandbags; Brunkild dike (40 km in 72 hours)
- Lost Grand Point and St. Agathe
- Many new programs in place
- International Joint Commission - Red River Basin Task Force (http://www.ijc.org)

The Next Flood: Getting Prepared

Final Report of the International Red River Basin Task Force

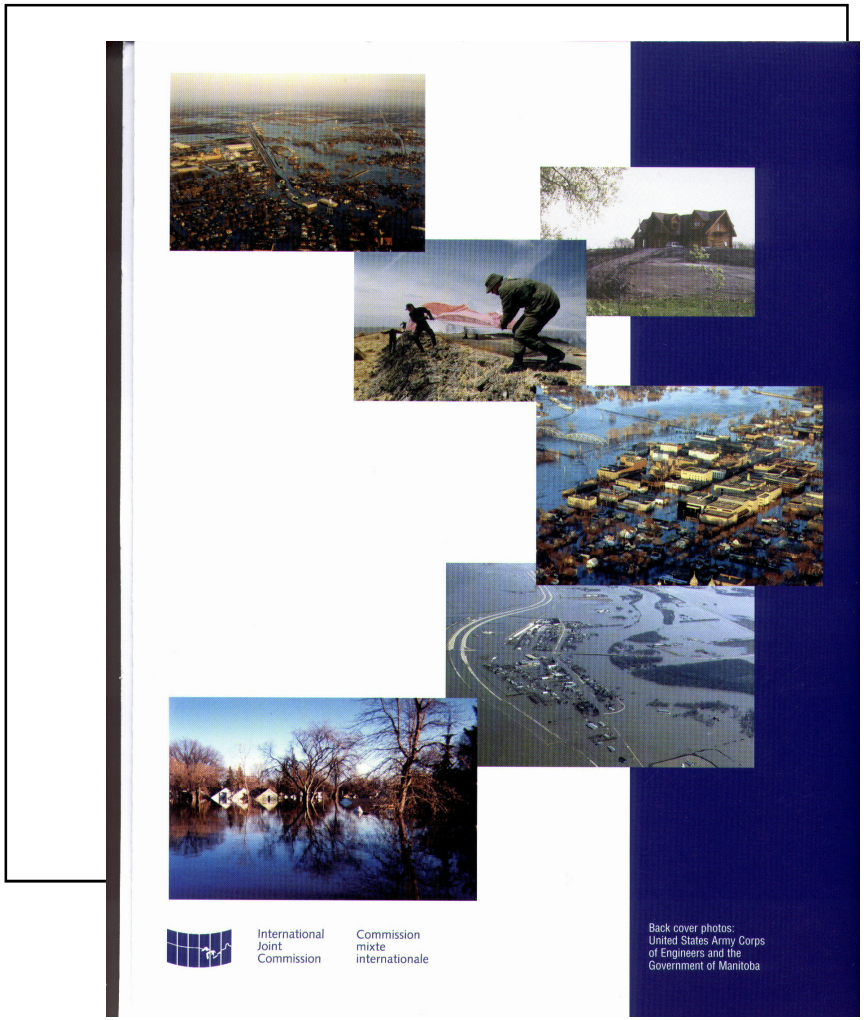
Report Highlights



- Flow management
- Communities at risk (esp. Winnipeg)
- Resiliency
- Lower Pembina
- Lake Traverse
- Water quality
- Data/DSS
- Computer modeling
- Institutions

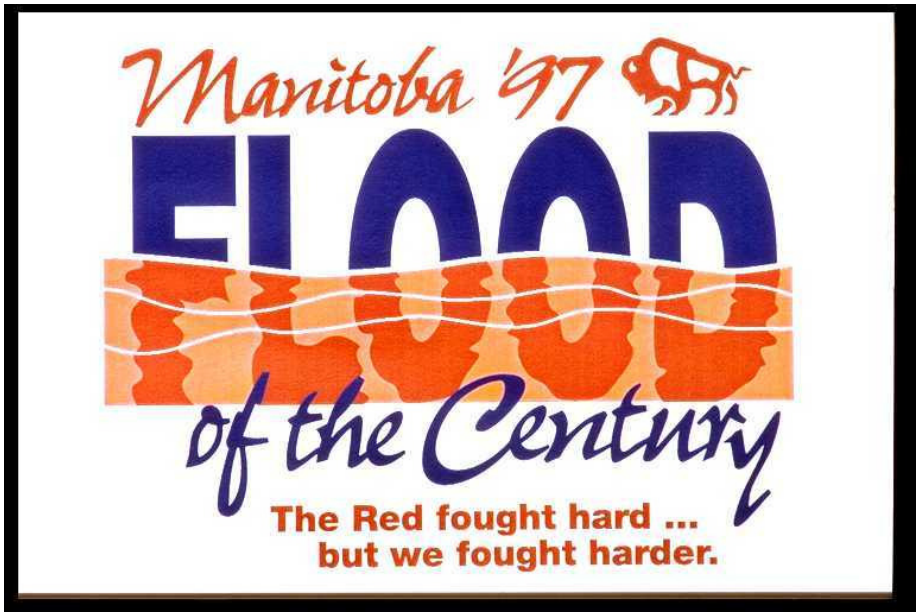
Report

- Report to the IJC from the International Red River Basin Task Force
- Report makes 9 conclusion and 51 recommendations



Red River Flooding

- Expect floods even greater than 1997
- 1826 an historic event that repeat itself



Flow Management

- Storage options unrealistic
  - Insufficient potential new economically & environmentally acceptable reservoir storage
  - Micro-storage impractical & costly
  - Increased wetland storage not significant for large floods on the main stem

Communities at Risk

- Good progress to provide structural protection
  - Grand Forks and East Grand Forks
  - Numerous initiatives on both sides of the border to reduce the flood risk in other valley communities
- Need more inspection of community projects in US

Winnipeg

- Winnipeg largest city at risk
- Design flood for Winnipeg should be highest economically feasible, 1826 flood at a minimum
- Two options to achieve high level of protection
  - expansion of the Floodway or
  - construction of a water detention structure south of Ste. Agathe

Flood Preparedness and Resiliency

- Need to make communities more resilient in the event of a major flood.
- 13 recommendations including
  - definition of the floodplain
  - building codes
  - public awareness
  - enforcement of regulations
  - removal of structures

Flood Preparedness and Resiliency

- Recommendations also include ones for
  - a mitigation program in Canada
  - greater efforts to increase participation in flood insurance in the US.

Lower Pembina

- Pembina flooding affected by dikes and roads on both sides of the border
- Local groups willing to resolve issue
- Task Force provided technical support.
- Propose changes in roads/dikes are modeled prior to construction
- Continue database, models, and DSS prototype
- Reactivate Technical Working Group to provide funding mechanism

Lake Traverse

- Possibility of hydraulic connection during floods and biota transfer
- Initiate studies to eliminate hydraulic connection at Lake Traverse
- Governments should implement plan for eliminating hydraulic connection
  - cost to be shared with Canada

Water Quality: Lake Winnipeg

- A threat from toxic chemicals release during the flood
- Assessed the impact of toxic release and found no risk to human health
- Also looked at nutrient loading, but could not determine a long-term impact
- Need to monitor
- Remove storage of toxic substances in floodplain

Data and Decision Support System

- Need to improve & maintain database
- Continue to improve & maintain hydrometric/meteorological data networks
- Make Canadian data freely available
- DEM for the basin should be completed
- Decisions on continuing the RRBDIN

Computer Modeling

- UNET and MIKE 11 should be maintained and improved
- Outputs from Task Force models should be widely available
- Implement US National Weather Service Advanced Hydrologic Predication System in the Red River
- Implement/couple atmospheric-hydrologic model

Institutions

- Need for basin-wide institution to advocate and report on flood-related issues
- Should be able to deal with federal/ state/provincial governments
- If IJC pursues watershed board concept, consider establishing initial board in the Red River basin

Key Accomplishments

- Flood of 1826 proportions becoming accepted as basis for preparedness
- "Set the stage" for future cooperative problem-solving in the basin.
- Hydraulic Models for entire Red River
  - Mike 11, UNET
- Detailed mapping of basin initiated
- Tools, data, and process to resolve Lower Pembina Transboundary Flooding Issue

Key Accomplishments

- Winnipeg Risk Analysis/protection options
  - Even-handed assessment of alternative flood defense proposals

Conclusions

- Mitigation is good public policy.
- It saves lives; It saves money; It can protect environmental assets.
- References:
  - Morris-Oswald, Sinclair, Simonovic, WRRR 38 (http://www.ce.umanitoba.ca/~simon)
  - FEMA, USA (http://www.fema.gov/mit/)
  - The Natural Hazard Center, Colorado (http://www.colorado.edu/hazards/)

Golden Gates