Occasional Paper
No. 8

VACATION HOME OCCUPANCE OF HAZARD LANDS IN CANADA: FLOOD AND EROSION HAZARDS

R. D. Kreutzwiser
J.G. Nelson

November, 1975

Environment Canada
Lands Directorate

Environnement Canada
Direction générale des Terres

L 77-3

Vacation Home Occupance of Hazard Lands in Canada
Flood and Erosion Hazards

by

R.D. Kreutzwiser
and
J.G. Nelson

for

Outdoor Recreation - Open Space Division
Land Use Studies Branch
Lands Directorate
Environment Canada

June 30, 1975

Préface

Depuis le milieu de la dernière décennie (1960), l'augmentation de l'affluence, du temps consacré au loisir et de la densité des effectifs récréatifs publics ont contribué à accélérer le rythme auquel les côtes et rivages canadiens ont été dévorés pour le développement des résidences secondaires privées. Cet avertissement des développements privés sur les côtes et rivages pose trois problèmes majeurs aux différents niveaux de gouvernement. Le premier se rattache au rythme auquel les activités de récréation sur les fronts d'eau ont été soustraites à l'acres au grand public. Le second se fait surtout sentir chez les gouvernements à l'échelle de la municipalité, de la commune ou du comité, et se rattache aux coûts élevés de la desserte en services et en routes de régions à faible densité de développement. Le troisième problème, celui dont ce document nous entretient, consiste en l'augmentation du rythme de développement de ces fronts d'eau lesquels, en vertu de leur localisation physique sont les plus susceptibles d'inondations périodiques et d'érosion littorale.

La Direction générale des terres manifeste un vif intérêt sur des questions reliées au développement des littoraux ceci en tant qu'organisme touché par l'altération appropriée des terres parmi une variété d'utilisations concurrentielles et par l'approvisionnement en possibilités de récréation de plein air pour tous les canadiens. En accord avec ces principes, la Direction a commandé cette étude comme première estimation des tendances de désertion des domiciles situés sur les fronts d'eau affectés par les calamités naturelles, et de l'ampleur des politiques gouvernementales instaurées pour composer avec les inondations et les effets de l'érosion.

Les auteurs ont dépensé la majeure partie de leur temps et de leur efforts à analyser la prévention des inondations et la réaction aux politiques fédérale, provinciales et municipales, ainsi qu'en discussion sur le coût et l'efficacité de ces politiques dans les trois cas d'échantillon: rive nord du lac Erié, la section montréalaise du fleuve St-Laurent et la côte du détroit de Northumberland. Les opinions exprimées par les auteurs en ce qui a trait à l'efficacité des divers organismes mentionnés, et de leurs politiques ne représentent pas nécessairement celles de la Direction générale des terres. Toutefois comme ce document donne une vision étendue bien que préliminaire de ces organismes et politiques, les opinions des auteurs ont été retenues sans arrangement éditorial. La Direction générale des terres croit que, en publiant des études de cette nature, la discussion et la communication sur les questions reliées au développement des littoraux s'en trouvera stimulée, dans les secteurs de la recherche et de la planification.

R.J. McCormack,
Directeur général
Direction générale des Terres

Preface

Since the mid - 1960's, increased affluence, leisure time, and crowding of public recreational facilities have contributed to an acceleration of the rate at which Canadian shorelands are being consumed for private cottage development. This increase in the private development of shorelands poses three major concerns to varying levels of government. The first relates to the rate at which recreational shorelands are being removed from public access. The second is primarily manifest at the municipal, township or county level of government, and centers on the high cost of providing roads and services in low-density development areas. The third concern, and the issue to which this paper is addressed, is the increased rate of development of those shorelands which, by virtue of their physical location, are most susceptible to periodic flooding and/or shoreland erosion.

As an agency concerned with the efficient allocation of land amongst a variety of competitive uses, and the equitable provision of outdoor recreation opportunity for all Canadians, the Lands Directorate has a keen interest in issues relating to shoreland development. In accordance with these concerns, the Directorate commissioned this study as an initial appraisal of trends in vacation home occupance of hazardous shorelands, and the range of government policies developed to deal with flood and erosion hazards.

The authors have devoted the major portion of their time and effort to an analysis of flood prevention and reaction policy at the Federal, Provincial and Municipal Government levels, and to a discussion of the cost and effectiveness of these policies for three case study areas: the north shore of Lake Erie; the Montreal - St. Lawrence River area; and the Northumberland Coast. The opinions expressed by the authors regarding the effectiveness of the various agencies and their respective policies are not necessarily those of the Lands Directorate, however, as this paper provides a fairly comprehensive, if initial view of these agencies and policies, the authors opinions have been retained without editorial change. The Lands Directorate believes that, by publishing studies of this nature, discussion and communication of issues relating to shoreland development will be stimulated in the research and planning sectors.

R.J. McCORMACK
DIRECTOR GENERAL
LANDS DIRECTORATE

Sommaire

Ce document représente une étude préliminaire de la présence de chalets dans des zones exposées aux processus d'inondation et d'érosion au Canada. Il présente un aperçu de la nature du développement vacancier sur les terrains exposés aux inondations et à l'érosion et une vue d'ensemble des politiques fédérales et provinciales adoptées pour venir à bout des problèmes engendrés par ce développement. Des études de cas, impliquant les régions de la rive nord du lac Erié, de la vallée du St-Laurent, et de la côte de Northumberland en Nouvelle-Ecosse, servent à analyser l'échelle de cet empiètement sur ces terrains exposés aux inondations et à l'érosion. Les implications de plusieurs politiques traitant des problèmes d'inondation et d'érosion sont considérées.

Abstract

This paper represents a preliminary study of the vacation home occupance of flood and erosion hazard land in Canada. The paper provides an overview of the nature of cottage development on flood and erosion hazard land and federal and provincial policies for dealing with these hazards. Case studies of the Lake Erie north shore, St. Lawrence River valley, and Northumberland coast of Nova Scotia provide more detailed analyses of cottage development on flood and erosion hazard land. The implications of a variety of policies for dealing with flood and erosion hazards are considered.

Avant-propos

Plusieurs personnes ont bien voulu consacrer du temps pour fournir les informations nécessaires à la rédaction de ce rapport. Il serait impossible de nommer tous les fonctionnaires fédéraux et provinciaux, et autres individus qui ont contribué à cette étude; plusieurs sont cités dans les renvois au bas des pages.

Les auteurs voudraient remercier Derry Graves et le personnel de la section de la cartographie du département de Géographie, de l'Université de Western Ontario, pour leur aide dans la préparation des figures, et David Day, de la Division des loisirs en plein air, Direction générale des terres, Environnement Canada, pour avoir passé en revue les premières ébauches de ce document.

Enfin, les auteurs voudraient témoigner leur appréciation au Dr. J.H. Ross de la Direction des loisirs de plein air, Direction générale des terres, Environnement Canada, pour leur avoir donné la possibilité d'entreprendre cette étude préliminaire (Approvisionnements et services Canada, numéro de contrat 02SU.KL303-4-0193).

Acknowledgements

A great many individuals, both federal and provincial officials, academics, and others, kindly provided information for this study. While it is impossible to list here all those contributing information, reference to some appear in the footnotes.

The authors wish to thank Derry Graves and his staff of the cartographic section, Department of Geography, University of Western Ontario, for assistance in the preparation of the figures, and David Day of the Outdoor Recreation-Open Space Division, Lands Directorate, Environment Canada, for reviewing earlier drafts of this paper.

Finally, the authors wish to express their gratitude to Dr. J.H. Ross of the Outdoor Recreation-Open Space Division, Lands Directorate, Environment Canada, for the opportunity to undertake this preliminary study(Department of Supply and Services contract 02SU.KL303-4-0193).

Table of Contents

List of Figures

Introduction

Many influences on vacation home location have been studied in Canada but little research has been conducted on vacation homes and environmental hazards, which is the focus of attention in this preliminary study.[1] It is based on an intensive literature review during January-April, 1975, and on interviews and correspondence with government officials and other interested parties during the same period. Some information also has been gathered during on-going research by the authors and associates on the human ecology of hazard lands in the vicinity of the Pelee, Rondeau, and Long Point peninsulas on the north Lake Erie shore.[2]

Vacation homes in Canada are subject to a wide variety of environmental hazards, both natural and man-made. Some hazards represent little more than inconvenience for cottagers; others can cause extensive property damage and occasionally injury and death. Landslides, earthquakes, avalanches, wind storms, hail,

1. Research indicates that proximity to and accessibility from urban centres, aesthetics and recreational opportunities available, and seclusion are important factors in vacation home location in Canada. See, for example, P. Klopchic, Analysis of Ontario Cottage Survey 1968, Toronto: Ontario Department of Tourism and Information, 1971, p. 22, and C.J. Kirby, A Study of Cottagers in the Meadow Lake Region, Regina: Saskatchewan Department of Natural Resources, 1970, p. 8.

2. This research has been supported by The Canada Council since the spring of 1974. To date, in addition to the authors, Dr. J.C. Day, Dr. R.H. King, J. Battin, G. Brewster, and R. Needham have contributed to this project.

and heavy snowfall are among the natural hazards affecting vacation home developments. Bears and other animals also are a hazard in some cottage areas. Noise and air pollution are among the man-made hazards which can affect cottagers.

Not surprisingly, the most widespread hazards affecting cottages in Canada are associated with water. Examples include poor water quality, unstable soil conditions, ice piling, fluctuating water levels, flooding, and erosion.

Water quality can have important health implications when domestic use and body contact water recreation are involved. As well, water quality can have an impact on aesthetics.[3] Excessive weed growth has been a particularly severe problem on some inland lakes.[4]

High water tables, wetland soils, and poor drainage associated with many shoreline areas can present problems for vacation home development. High water tables can render septic tank systems ineffective, creating a significant source of nutrient enrichment in some inland lakes.[5] Wetland soils and drainage conditions can complicate building construction, providing a poor base for foundations or footings.

Ice piling can be a significant hazard to vacation homes

3. See, for example, J.G.M. Parkes, Public Perceptions of Water Quality and Their Effect on Water-Based Recreation, Ottawa: Environment Canada, 1973.
4. "Lake Wabamun weeds under attack this summer", Environment News, 2(3), 1972, pp. 3-9.
5. M.F.P. Michalski, M.G. Johnson and D.M. Veal, Muskoka Lakes Water Quality Evaluation, Report 3, Toronto: Ontario Ministry of the Environment, 1973.

in some areas, damaging docks, boathouses, and poorly located cottages. The effects of ice piling have been documented recently for Lake Simcoe in Ontario.[6]

Water levels, and associated processes of flooding and erosion are, however, perhaps the most widespread environmental hazards affecting vacation homes in Canada. Low water levels can seriously impair the recreational enjoyment associated with cottaging, particularly such activities as boating and swimming. Low water may only be a temporary condition associated, for example, with reservoirs.[7] It may also be a problem of several years duration, such as the Great Lakes during the mid 1960's. In extreme cases, low water can be permanent.[8]

Usually, low water levels are little more than an inconvenience to cottagers. On the other hand, in terms of magnitude and extent of damages, flooding and erosion may be the most serious environmental hazards associated with vacation homes. Flooding and erosion are the only hazards considered to any degree in this paper, although it must be emphasized that a variety of other hazards may be significant in any particular cottage area in Canada.

6. Gee Tsang, Ice Piling on Lakeshores with Special Reference to the Occurrences on Lake Simcoe in the Spring of 1973, Burlington: Canada Centre for Inland Waters, 1974.
7. Reiner Jaakson, Water Level Fluctuation and Cottaging on the Trent Canal Reservoir Lakes, Toronto: Canada-Ontario Rideau-Trent-Severn Study Committee, 1973.
8. Edo Nyland, "This Dying Watershed", Alberta, 12(3), 1969, pp. 22-38.

It is often difficult to separate cottaging from urban, agricultural, or other land uses in a discussion of flood and erosion hazards. Many of the adjustments or attempted solutions to these hazards, such as flood control dams, involve a variety of land uses. Therefore, while this paper is directed primarily at the vacation home occupance of flood and erosion hazard land in Canada, some of the data presented and many of the conclusions have broader implications.

The basic objectives of this study are:

1. to provide an overview of vacation home development on flood and erosion hazard land in Canada, and the nature of adjustments adopted by the federal and provincial governments;

2. to consider in some detail cottage development and flood and erosion hazards on the north Erie lakeshore, along the St. Lawrence River, and on the Northumberland coast; and,

3. to consider the policy implications of various flood and erosion hazard adjustments.

Overview

Vacation Homes and Flood and Erosion Hazards in Canada

Information on the number and distribution of vacation homes in Canada varies considerably from province to province. While it has been estimated that there were approximately 400,000 cottages in Canada in 1966, it is impossible to map the distribution of vacation homes in most provinces with any degree of accuracy.[9]

Similarly, information on vacation homes and flood and erosion hazards is not plentiful. Major floods in Canada invariably generate studies by government agencies and other bodies.[10] Occasionally these studies contain specific information on cottages. The International Great Lakes Levels Board study of lake level regulation on the Great Lakes has resulted in a number of relevant projects, including inventories of land use and flood and erosion susceptibility along the Great Lakes and St. Lawrence River.[11] Shore erosion and storm surges on the lower Great Lakes have been investigated by

9. W.M. Baker, The Nature and Extent of Vacation Home Data Sources and Research in Canada, Ottawa: Statistics Canada, no date, p. 5.
10. See, for example, Environment Canada, New Brunswick Flood, April-May 1973, Halifax: Environment Canada, 1974.
11. International Great Lakes Levels Board, Regulation of Great Lakes Water Levels, Report to the International Joint Commission, December 7, 1973.

staff of the Canada Centre for Inland Waters. Shore erosion has also been investigated on Lake Winnipeg.[12] Several overviews provide an excellent perspective of riverine flood problems in Canada.[13] Unfortunately, these overviews do not deal specifically with cottages.

Water-oriented vacation home environments in Canada can be divided into three basic types: the lakeshore, the river valley, and the marine coast. All three environments are subject to both flood and erosion hazards.

Inland lakeshores can be flooded basically because of fluctuating water levels. Long term lake level fluctuations are a result of persistent high or low water supply conditions over a period of several years. Seasonal fluctuations are a response to the annual hydrologic cycle. Short term fluctuations, lasting from a few hours to several days, are caused by storms and changing atmospheric pressure. Short term fluctuations are most significant on the larger inland lakes.

Erosion occurs to some extent on all shorelines, but varies considerably due to shoreline geometry, beach material characteristics, currents, and storms. Erosion can be

12. V.J. Galay, "The Importance of Shoreline Processes in the Management of Shorelines for Inland Basins", The Allocative Conflicts in Water-Resource Management, Winnipeg: Agassiz Centre for Water Studies, 1974, pp. 405-422.
13. See, for example, Environment Canada, Report by Canada to the International Commission on Irrigation and Drainage for the Proposed Publication "Flood Control-A Global Review", Ottawa, 1972, and Ian Burton, "Flood-Damage Reduction in Canada", Geographical Bulletin, 7(3-4), 1965, pp. 161-185.

particularly noticeable during periods of high lake level or storm activity.

A river floods when the volume of water exceeds the capacity of its channel. This often occurs for a combination of reasons rather than because of any single influence. A major cause of flooding on Canadian rivers is spring snowmelt, which may be associated with heavy rains.[14] Flooding can also occur after heavy rainfall from convectional or cyclonic storms. Flooding can increase the rate of stream bank erosion.

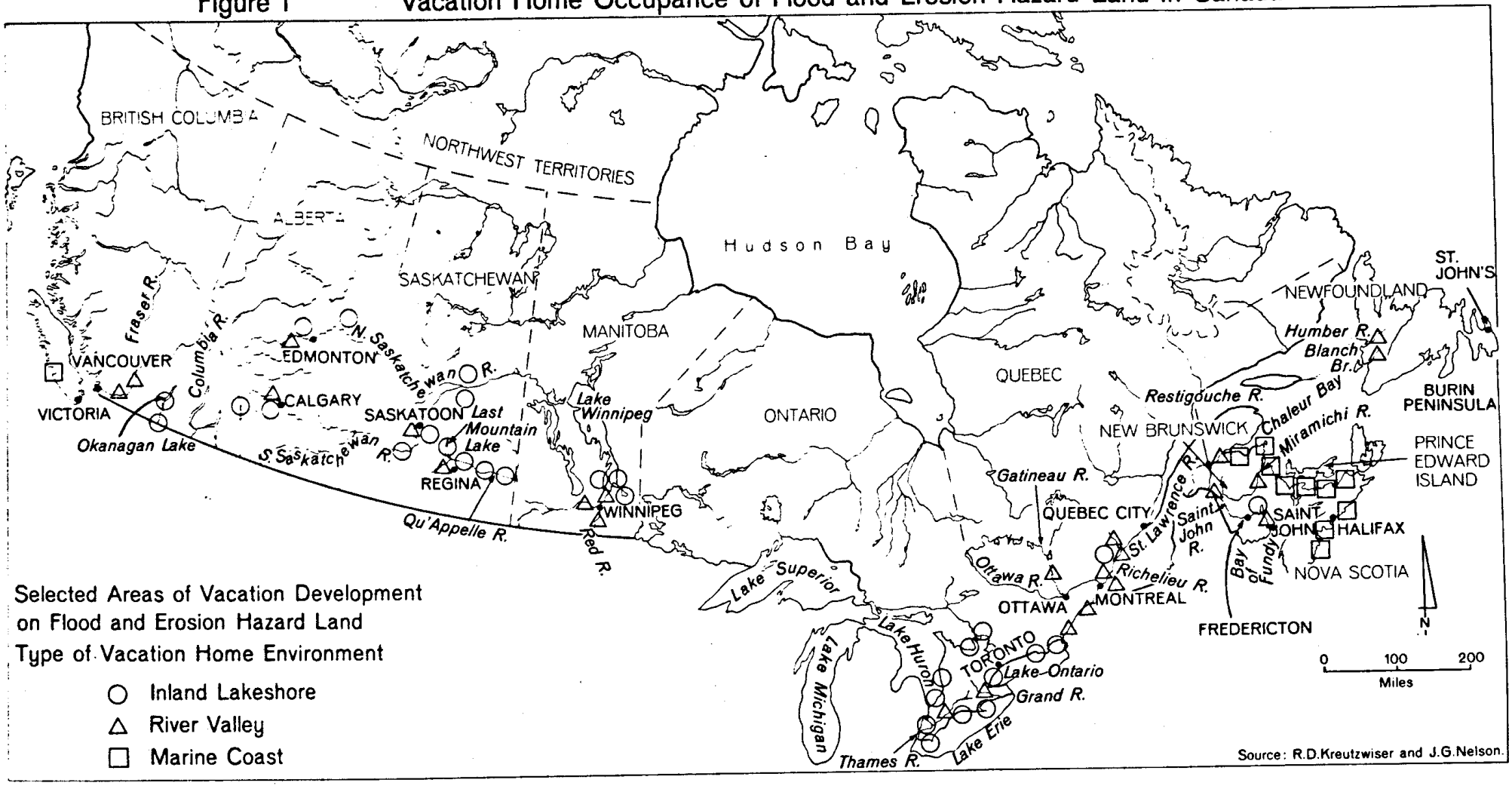
Flooding along the marine coast can result from such phenomena as tidal variations, storm surges, and tsunamis, or seismic sea waves. Coastal erosion often is significantly increased by vigorous wave action and flooding.

Man can exercise considerable influence over flooding and erosion in all three cottage environments. Land fill in flood plains may increase the magnitude of river flooding, as may drainage or other land use changes upstream. Groynes and other structures may increase deposition along lakeshores and marine coasts, aggravating erosion problems elsewhere.[15]

The nature of flood and erosion hazards in relation to vacation home development will now be considered province by province. Some cottage areas with flood and erosion problems are shown on Figure 1. One significant result of the

14. Ibid., p. 166.
15. Charles H. Carter, Natural and Manmade Features Affecting the Ohio Shore of Lake Erie, Columbus: Ohio Department of Natural Resources, 1973.

Figure 1 Vacation Home Occupance of Flood and Erosion Hazard Land in Canada



Selected Areas of Vacation Development on Flood and Erosion Hazard Land

Type of Vacation Home Environment

- ○ Inland Lakeshore
- △ River Valley
- □ Marine Coast

Source: R.D.Kreutzwiser and J.G.Nelson.

author's survey is the finding that few general statistics are, in fact, available on cottage development on hazard lands in Canada. Several notable exceptions can, of course, be found.

Newfoundland

Information is not readily available on the extent and distribution of cottaging in Newfoundland, although it is probably not extensive. Cottages are found along the east coast near St. John's, along several rivers such as the Humber, and on some inland lakes. Flooding apparently is not a significant problem in the province, although the potential for some flood damage exists along Blanch Brook in the Stephenville area in western Newfoundland.[16] As well, coastal flooding is a possibility in some areas. A tsunami destroyed several villages in the Burin Peninsula in the southeastern part of the province in 1929.[17]

Prince Edward Island

One 1971 estimate placed the number of cottages in Prince Edward Island at 1,947.[18] Rivers are short and tidal, and flooding does not occur in any significant amount. The coastline, however, is subject to erosion upwards of 3 feet per year.[19] Information is not readily available on the significance of this erosion to cottage development.

16. Personal Communication from Mr. E.W. Jamieson, Newfoundland Department of Tourism, St. John's, April 2, 1975.
17. Willard Bascom, Waves and Beaches, Garden City, N.Y.: Doubleday, 1964, p. 107.
18. W.M. Baker, op. cit., p. 23.
19. Personal Communication from Mr. J. McClellan, Prince Edward Island Land Use Commission, Charlottetown, March 3, 1975.

Nova Scotia

Vacation home development is more extensive in Nova Scotia, with over 13,000 cottages serviced with hydro in 1966.[20] The total number of cottages in the province would exceed this amount somewhat. Many of Nova Scotia's cottages are located along the coast, with erosion and flooding particularly serious along the Northumberland Strait.[21] Erosion and flooding also affect vacation homes in some east coast areas of the province. Tidal flooding affects cottages on Cobequid Bay and Minas Basin on the Bay of Fundy. Both tidal and river flooding are a problem in the Truro area.

In Canada, coastal flooding and erosion in relation to vacation homes probably is greatest in Nova Scotia.

New Brunswick

In 1966 in New Brunswick an estimated 13,740 cottages were distributed along accessible coastal areas, rivers, and lakes.[22] Cottages along the Northumberland Strait, the Gulf of St. Lawrence, and Chaleur Bay can be affected by flooding from abnormally high tides accompanied by high onshore winds.[23] The major New Brunswick rivers, such as the Saint John, Restigouche, and Miramichi, are subject to flooding which can involve considerable damage to vacation homes. The spring

20. W.M. Baker, op. cit., p. 26.
21. Personal Communication from Mr. J.S. Mactavish, Nova Scotia Department of the Environment, Halifax, March 26, 1975.
22. W.M. Baker, op. cit., p. 27.
23. Personal Communication from Mr. E.H. Bringloe, New Brunswick Department of Municipal Affairs, Fredericton, February 21, 1975.

1973 flood, for example, incurred a total economic cost to cottagers of over $1,000,000.[24] Most of this damage was sustained by cottages in the Saint John River basin, principally in the Grand Lake, Grand Falls, and Saint John areas.

Quebec

No information is available concerning the number and distribution of vacation homes in Quebec. Flooding and erosion along the St. Lawrence and Richelieu Rivers is known to affect cottages. As well, cottages on Lake Maskinonge and along the Assomption River are subject to flooding.[25] Flooding on the Gatineau, Chateauguay, Chaudiere, and a number of smaller rivers in southern Quebec undoubtedly causes damage to some cottages. Quebec government surveys show that the average annual flood loss amounted to approximately $3,000,000 for the years 1967-1971.[26] Of total damages of $3,772,890 in 1971, residential properties sustained an estimated $1,333,065 loss. Flooding in southwestern Quebec was particularly severe in the spring of 1974, with total damages estimated at $75,000,000.[27] It is not known what portion of these amounts was sustained by cottages.

Ontario

In 1971, an estimated 220,000 cottages, or approximately

24. Environment Canada, New Brunswick Flood, p. 88.
25. Personal Communication from Mr. C. Triquet, Quebec Department of Natural Resources, Quebec, April 21, 1975.
26. Bureau de la Statistique du Quebec, Les Inondation au Quebec en 1971, Quebec, 1972, pp. 37-39.
27. Montreal Star, May 25, 1974.

one-half the Canadian total, were located in Ontario.[28] Several sources of information are available on the distribution of cottages throughout the province.[29] Cottaging is widespread throughout the Precambrian shield area in southern Ontario, with heavy concentrations in the Muskoka and Kawartha Lakes areas. Vacation home development is also extensive along the lower Great Lakes shoreline. Flooding and erosion are widespread and significant problems along most of the Erie, Ontario, and Huron lakeshores, particularly during periods of high lake levels. During the 1972-1973 floods on the lower Great Lakes, damage was estimated at $20,000,000.[30] Most of this damage was sustained by cottage properties. A previous high lake level period during 1951-1952 also caused considerable damage to cottages. Cottage properties along the St. Lawrence River, the lower Grand River, and a number of smaller rivers are also susceptible to flooding.

The Canadian lakeshore flooding and erosion problem in relation to vacation home development is believed to be greatest in Ontario.

Manitoba

No information is readily available on the number and

28. Ontario Ministry of Industry and Tourism.
29. The distribution of cottages by county for southern Ontario based in part on seasonal hydro contracts has been estimated. Lynda Beatty, Estimation of the Number of Cottages in Southern Ontario, by County, unpublished report for the Ontario Ministry of Natural Resources, April 4, 1973.
30. Interview with Mr. W.S. Haras, Canada Centre for Inland Waters, Burlington, January 30, 1975.

distribution of vacation homes in Manitoba. A significant erosion problem affecting cottages exists along the southern part of the Lake Winnipeg shore.[31] Flooding has also affected cottages on Lake Winnipeg. The Lake rose to a record level during the summer of 1966, mainly due to high precipitation in 1965 and 1966.[32] Several times during the summer of 1966, strong winds added over 3 feet to already high levels in some areas. Flooding in southern Manitoba in April, 1974, forced the evacuation of more than 2,000 residents.[33] It is not known to what extent cottages were affected by this spring flood.

Saskatchewan

In 1969, an estimated 11,844 vacation homes were located in Saskatchewan.[34] Vacation home development occurs on many lakes and reservoirs throughout the southern part of the province, with concentrations in the Prince Albert area, Last Mountain Lake near Regina, and the Qu'Appelle valley at such lakes as Katepwa, Echo, Round, and Crooked. Most lakes and reservoirs in the Qu'Appellee basin are subject to lake level fluctuations and flooding. Extensive flooding in 1971 and 1974 affected urban centres such as Regina, Moose Jaw, and Lumsden, as well as lakeshore developments on many of the lakes

31. V.J. Galay, op. cit.
32. Department of Energy, Mines and Resources, High Water on Lake Winnipeg, Ottawa: Information Canada, 1971.
33. London Free Press, April 23, 1974.
34. W.M. Baker, op. cit., pp. 32-36.

and reservoirs in the Qu'Appelle basin.[35] In addition, flooding has affected cottages at Emma, Candle, Pelican, and Green Lakes.[36]

Alberta

Vacation home development has occurred around lakes and reservoirs in many areas of the province, particularly near the larger urban centres of Calgary and Edmonton. Fluctuating lake levels and erosion have been problems on some of these lakes and reservoirs. Flooding also occurs on most of the rivers originating in the foothills and mountains in western Alberta. 1974 spring flooding, for example, resulted in damages in excess of $11,000,000.[37] Flooding was particularly severe in the Vermilion, Battle, Pembina, and Paddle river basins. Information on damages sustained by cottages was not readily available.

British Columbia

There were 10,015 seasonal hydro customers in British Columbia in 1972; however, the number of cottages in the province is probably somewhat greater.[38] Vacation homes have been affected by flooding in the Okanagan basin and at Lake Windermere, near the headwaters of the Columbia River.[39]

35. Qu'Appelle Basin Study Board, Report, Regina, 1972, p. 54.
36. Personal Communication from Mr. R.J. Poliquin, Saskatchewan Department of the Environment, Regina, March 27, 1975.
37. Alberta Disaster Services, Operation Wetfoot '74 Report, Edmonton, 1974.
38. W.M. Baker, op. cit., pp. 36-37.
39. Personal Communication from Mr. J.D. Watts, British Columbia Department of Lands, Forests, and Water Resources, Victoria, March 10, 1975.

Flooding in the spring of 1972 caused damage to cottages on Lake Okanagan and Osoyoos Lake. Total economic damage was $56,000 and $211,000 on Okanagan and Osoyoos Lakes, respectively.[40] Total economic damage to residential properties at Osoyoos Lake was $92,927, of which a major portion was sustained by cottages. There is extensive cottage development on the Gulf Islands and adjacent mainland and Vancouver Island coasts near Vancouver and Victoria. These locations are somewhat sheltered from coastal storms. Some cottage development on the western coast of Vancouver Island is more susceptible to flooding. The Port Alberni area sustained heavy damage from a tsunami in 1964.[41]

Flood and Erosion Hazards Policy in Canada

Man can adjust or respond in many ways to environmental hazards. The range of possible adjustments to hazards can be organized in terms of a model developed by Burton, Kates, White, and other researchers.[42] Man can choose to modify the hazard cause, modify the hazard, modify the loss potential, or adjust to losses. The theoretical range of adjustments to

40. M.J. Fumalle, Socio-Economic Damage Evaluation of the Osoyoos Lake Flood, Spring 1972 in Canada, Penticton: Okanagan Study Committee, 1973.
41. J.H. Erb, "Tsunami Warning in British Columbia", EMO National Digest, 12(1), 1972, pp. 1-3.
42. See, for example, Ian Burton, Robert W. Kates, and Gilbert F. White, The Human Ecology of Extreme Geophysical Events, Toronto: University of Toronto, Department of Geography, 1968.

flood and erosion hazards in lakeshore, river valley, and marine coast cottage environments is shown on Figure 2 in terms of this model.

Canadian Government Flood and Erosion Hazards Policy

Under the British North America Act, the regulation of natural resources in Canada is primarily a provincial responsibility. The federal government can regulate water resources through powers relating to navigation, shipping, and sea coast and inland fisheries.[43] However, federal government control over these aspects of water resource management does not preclude provincial governments legislating upon matters of local or provincial significance.

Traditionally, it has been the policy of the federal government to consider flood and erosion problems to be the responsibility of local and provincial authorities. The federal government has generally become involved when disasters were of such a magnitude that local authorities could not cope with the results.[44] Special federal-provincial agreements for the construction of large scale flood control systems were concluded after the Fraser River flood in 1948 and the Red River flood in 1950. Other ad hoc arrangements provided federal assistance for the construction of several dams in Ontario.

43. Michael Whittington, "Environmental Policy", in G. Bruce Doern and V. Seymour Wilson, eds., Issues in Canadian Public Policy, Toronto: Macmillan, 1974, pp. 208-211.
44. House of Commons, Debates, April 7, 1952, Ottawa: Queen's Printer, 1952, p. 1162.

Figure 2
Theoretical Range of Adjustments to Flood and Erosion Hazards
in Lakeshore, River Valley, and Marine Coast Vacation Home Environments

Modify the Hazard Cause	Modify the Hazard	Modify the Loss Potential	Adjust to Losses: Spread the Loss	Adjust to Losses: Plan for the Loss	Adjust to Losses: Bear the Loss
weather modification	seawalls(lakeshore and marine coast)	flood proofing	public relief	flood insurance and relief funds	individual loss bearing
channelize the lake (lakeshore)	groynes(lakeshore and marine coast)	zoning and land use regulation	subsidized insurance	tax write-offs	
diversions(lakeshore and river valley)	dykes	forecasting	government purchase of land and property		
control inflow and outflow(lakeshore)	breakers and bars(lakeshore and marine coast)	warning systems			
dredging and beach material regulation (lakeshore and marine coast)	rip-rap	emergency measures			
watershed treatment (river valley)	levees(river valley)	temporary and permanent evacuation			
	gabions	subsidized relocation			
	land fill and landscaping	building codes and design			
	flood fighting	subdivision regulation			
	beach nourishment(lakeshore and marine coast)				
	dune planting(lakeshore and marine coast)				
	reservoirs(river valley)				
	channel improvement(river valley)				
	floodways(river valley)				
	various loans and payments from senior governments for the above				

Note: Adjustments are applicable to all vacation home environments unless indicated in parentheses.

Source: Adapted with modifications from Ian Burton, Robert W. Kates, and Gilbert F. White, The Human Ecology of Extreme Geophysical Events, Toronto: University of Toronto, Department of Geography, 1968, James K. Mitchell, Community Response to Coastal Erosion, Chicago: University of Chicago, Department of Geography, 1974, and Jacquelyn L. Beyer, "Global Summary of Human Response to Natural Hazards: Floods", in Gilbert F. White, ed., Natural Hazards Local, National, Global, New York: Oxford University Press, 1974, pp. 265-274.

Federal involvement in flood control was formalized to some extent by the Canada Water Conservation Assistance Act of 1953, which provided for federal financial assistance of up to 37-1/2% for construction costs.[45] The federal government required benefit-cost analyses for some of the projects undertaken.[46] The Canada Water Conservation Assistance Act has been used to finance several projects in Ontario and British Columbia. The Act was repealed in 1970, with the passage of the Canada Water Act.

The confused jurisdiction over water resources in Canada makes federal-provincial cooperation essential. The Canada Water Act, administered by the federal Department of the Environment, provides for the establishment of federal-provincial consultative committees for water resources matters, and for cooperative agreements with the provinces for the development and implementation of comprehensive water resource management plans.[47] Comprehensive water resource management plans have been undertaken for the Okanagan, Saint John, and Qu'Appelle river basins. The flood problem has been considered in each of these plans. Recently, the Canada-Quebec Consultative Committee recommended an investigation of the flood problem in the Montreal area, and a Committee on

45. Statutes of Canada, 1-2 Elizabeth II. c. 21. 1953.
46. I. Burton, "Investment Choices in Public Resource Development", in J.G. Nelson and M.J. Chambers, eds., Water, Toronto: Methuen, 1969, p. 301.
47. Environment Canada, The Canada Water Act Annual Report 1973-1974, Ottawa: Information Canada, 1974, p. 2.

Flow Regulation, Montreal Region, was subsequently established.[48]

Other agreements under the Canada Water Act provide for a pilot flood hazard mapping program, a Canada-Ontario Great Lakes Shore Damage Survey, and dyking in southwestern Ontario to protect agricultural land. The pilot flood hazard mapping is being conducted in Fredericton, Moose Jaw, Oshawa, Sault Ste. Marie, and Carmen, Manitoba, and represents a federal government effort to encourage hazard mapping as a prerequisite for sound management of flood problems in urban areas. The mapping is seen as an important means of improving public understanding of the flood hazard.[49] The Water Planning and Management Branch of Environment Canada is the principal agency in these and other programs under the Canada Water Act.

Several Environment Canada branches, as well as other federal departments are concerned with flood and erosion problems. The Water Resources Branch of Environment Canada is responsible for the Water Survey of Canada, and provides flood forecasts, with the cooperation of the Atmospheric Environment Service of Environment Canada.[50] Environment Canada is also involved in research on storm surges and erosion, principally through the Canada Centre for Inland Waters

48. Personal Communication from Mr. J.-Y. Pelletier, Environment Canada, Montreal, April 2, 1975.
49. Interview with Mr. B. MacLock, Environment Canada, Ottawa, March 7, 1975.
50. Environment Canada, Annual Report 1973-1974, Ottawa: Information Canada, 1974.

in Burlington.[51] The Canadian Wildlife Service of Environment Canada has acquired wetland areas throughout the country, including recent acquisitions on Lake Erie and Lake St. Clair.

The federal Department of Public Works is directly involved in the construction of erosion control works benefiting cottages and other land uses in several parts of Canada. The Department protects shorelines where erosion is caused by federal structures or by commercial navigation.[52] Shoreline protection along the St. Lawrence, Richilieu, St. Clair, and Detroit Rivers is a result of this federal policy.

The federal Department of Agriculture and Department of Regional Economic Expansion have been involved in several programs, such as the Maritime Marshland Rehabilitation and Prairie Farm Rehabilitation programs, for the development of flood control and irrigation systems. By the end of the 1968-1969 fiscal year, 232 miles of dykes, 5 major tidal dams, and other structures had been built by the federal government under the Maritime Marshland Rehabilitation Act to protect over 82,000 acres of drained marshland in New Brunswick and Nova Scotia.[53]

The National Emergency Planning Establishment supports

51. Canada Centre for Inland Waters, Great Lakes Shore Erosion Studies, Burlington: Canada Centre for Inland Waters, 1973.
52. Task Force on Available Shore Erosion Information, Shore Erosion Information on the Great Lakes-St. Lawrence System, Part 1, Summary Report, Ottawa, 1973, p. 4.
53. C.I. Jackson and J.W. Maxwell, Landowners and Land Use in the Tantramar Area, New Brunswick, Ottawa: Information Canada, 1971, pp. 1-2.

emergency measures organizations at the provincial and local level.[54] In addition to its supportive and coordinating role, the National Emergency Planning Establishment assists in damage assessment following disasters, and holds a spring flood conference annually in Arnprior, Ontario.

The federal Department of Finance administers the federal disaster compensation scheme. Under this scheme, a province pays the first $1.00 per capita. The federal government contributes 50% on the next $2.00 per capita, 75% on the next $2.00 per capita, and 90% on any compensation costs beyond $5.00 per capita. The scheme therefore favours the provinces with smaller populations, those perhaps least able to cope with major disasters. It is important to note that cottagers are not eligible for compensation under this federal scheme.

The federal Department of National Defense provides Canadian Armed forces personnel and equipment during some disasters. During the 1973 New Brunswick flood, for example, Canadian Forces personnel assisted with emergency measures and evacuation.[55]

The federal Department of Transport provides ice breaking on the St. Lawrence River and operates ice retention works to reduce the flood hazard due to ice jams.[56]

54. Personal Communication from Mr. A.F. Wigglesworth, National Emergency Planning Establishment, Toronto, November 22, 1974.
55. Environment Canada, New Brunswick Flood, p. 71.
56. Personal Communication from Mr. C. Pellegrin, Department of Transport, Ottawa, March 11, 1975.

Figure 3
Adjustments to Flood and Erosion Hazards: Government of Canada

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of the Environment	cost sharing agreements with several provinces for protective works		flood forecasting	hazard mapping in several cities		comprehensive river basin studies, land acquisition, erosion research by CCIW
Department of Agriculture	cost sharing agreements for protective works, primarily for agriculture					
Department of Public Works	erosion protective works					
National Emergency Planning Establishment			support to other levels of government			assesses damage in most provinces
Department of Finance		disaster compensation cottagers not eligible				
Department of National Defense			flood fighting, evacuation			
Department of Transport						ice breaking in St. Lawrence River
International Joint Commission						Canada-U.S. cooperation on water problems

At the international level, the federal government cooperates with the United States federal government on water resource and other problems through the International Joint Commission. The Commission, established by the Boundary Waters Treaty of 1909, has quasi-judicial, investigative, surveillance, and coordinating functions. Recent activities of the International Joint Commission include studies on the effects of regulation on water levels on the Great Lakes and Lake Champlain.

The involvement of various federal agencies in flood and erosion hazards in Canada is summarized on Figure 3. Five general categories of adjustments are listed: construction of flood and erosion protective works, disaster relief and compensation, emergency measures and flood forecasting, hazard mapping and public education, and hazard zoning and development control. Other adjustments, such as research and land acquisition, are listed as well.

Provincial Government Flood and Erosion Hazards Policy

Traditionally, the principal responsibility for flood and erosion hazards has rested with provincial and local authorities. The provinces have developed a variety of adjustments to flood and erosion hazards.

In most provinces, the construction of flood and erosion protective works is undertaken by the natural resources department. As a result, it is frequently the case that the provincial department responsible for wildlife, fish, recreation

and related matters is also responsible for construction of works which may sometimes conflict with these and other responsibilities. A somewhat different approach has been developed in Saskatchewan, where the provincial environment department coordinates and regulates all aspects of water resources, but does not undertake construction.[57] The agriculture department does most of the province's water management construction.

Agriculture departments in most provinces are also very much involved in the construction of flood and erosion control works, primarily to benefit agricultural land uses. Some highways departments are also involved in protective works mainly related to roads.

In most instances, flood and erosion control works are undertaken to benefit urban and agricultural land uses. In some cases, however, cottages also benefit from these works. In Ontario, loans are now available to cottagers for the construction of flood and erosion protective works and the reconstruction of damaged buildings. In Alberta, vacation homes can be protected by cost-sharing water management projects if the projects are initiated by local authorities such as municipalities.[58] No assistance is available to individual cottagers, however. In Manitoba, assistance has occasionally

57. Saskatchewan Water Resources Commission, Annual Report, year ending March 31, 1972, Regina, 1972, p. 50.
58. Personal Communication from Mr. M. Chrapko, Alberta Department of the Environment, Edmonton, April 4, 1975.

been granted to cottagers, as in 1974 when temporary dykes were built along the Lake Winnipeg shore.[59]

Disaster relief and compensation for flood and erosion damages are available in all provinces, but almost without exception, cottagers are not eligible for financial assistance of any kind. Most provinces appear to follow the guidelines of the federal Department of Finance regarding compensation, which specifically exclude cottagers. The Manitoba government has extended limited compensation to cottagers for flood damages. Disaster relief and compensation are administered by a variety of departments and agencies in the various provinces.

The National Emergency Planning Establishment provides coordination and financial assistance to provincial emergency measures organizations. These organizations have been established in all provinces, although the Ontario government has recently announced that it is dissolving its emergency measures branch.[60] In several provinces, the emergency measures organizations have been reorganized and strengthened. Recent legislation in Alberta, for example, provides for a broad and aggressive emergency measures program, including provision for the forcible evacuation of people from disaster areas. Legislation in Manitoba also provides for forcible evacuation.

59. Personal Communication from Mr. N. Mudry, Manitoba Department of Mines, Resources and Environmental Management, Winnipeg, March 25, 1975.
60. London Free Press, April 8, 1975.

Provincial emergency measures organizations issue warnings of impending floods or other disasters, provide a number of emergency services, and serve in a coordinating capacity.

Flood forecasting systems have been developed in some provinces, including New Brunswick, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia. These services are generally supplied by the provincial natural resources or environment departments.

Hazard mapping is not well developed in Canada. The Ontario government has recently started a program of detailed flood hazard mapping in some urban areas based on a 100 year flood criterion. This is approximately the recurrence interval of a storm of the magnitude of Hurricane Hazel, which struck the Toronto area in 1954. British Columbia is also engaged in detailed hazard mapping of major rivers, on the basis of a 200 year flood criterion.[61] Some hazard mapping is also underway in New Brunswick, Saskatchewan, and Manitoba.

Zoning is a municipal matter in all provinces, and most municipalities have been very slow in adopting zoning bylaws to regulate flood plain development. Municipalities receive technical assistance from the provincial governments, generally the municipal affairs departments. Ontario is one of the few provinces where considerable control over zoning and development matters is exercised by the provincial government. In

61. Personal Communication from Mr. J.D. Watts, British Columbia Department of Lands, Forests, and Water Resources, Victoria, March 10, 1975.

Alberta, the environment department can prevent development of flood plain lands.[62] The department can also designate restricted development areas to preserve open space and prevent development in flood plain areas.

Subdivision control is generally a provincial responsibility, although in Manitoba this power rests with municipalities. Subdivision control is usually exercised by the municipal affairs department, with assistance from natural resources, environment, and other departments. In British Columbia, the control over subdivisions proposed in flood plains rests directly with the water resources department, which can require flood proofing and other measures as a condition of approval. Guidelines for the development of cottages on crown lands are available in most provinces. In Saskatchewan, the environment department regulates development around designated reservoirs.

Comprehensive water management affords an opportunity to consider a broad range of adjustments to flood and erosion hazards. Ontario conservation authorities are somewhat unique in Canada as a vehicle for comprehensive water management on a watershed basis. With federal assistance, comprehensive water management programs will soon be implemented in the Saint John, Qu'Appelle, and Okanagan basins.

Summaries of provincial involvement in flood and erosion hazards are provided on Figures 4 to 13.

---

62. Ian Burton, "Flood-Damage Reduction", p. 173.

Figure 4
Adjustments to Flood and Erosion Hazards: Newfoundland

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of Forestry and Agriculture	protective works primarily for agriculture				guidelines for cottages on crown land	
Department of Justice, Emergency Measures Organization		disaster relief	emergency measures			
Department of Transportation and Communications	protective works primarily for road protection					

Figure 5
Adjustments to Flood and Erosion Hazards: Prince Edward Island

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of Provincial Secretary, Emergency Measures Organization			emergency measures			
Department of Community Services					municipal zoning bylaws, subdivision control	

Figure 6
Adjustments to Flood and Erosion Hazards: Nova Scotia

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of Agriculture and Marketing	protective works primarily for agriculture					
Department of Finance, Emergency Measures Organization		disaster relief cottagers not eligible	emergency measures, evacuation			
Department of the Environment				flood hazard mapping		technical assistance to cottagers
Department of Municipal Affairs					municipal zoning bylaws, subdivision regulations	
Department of Highways			emergency road repairs			

Figure 7
Adjustments to Flood and Erosion Hazards: New Brunswick

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of Fisheries and Environment			flood forecasting			
Department of Justice, Emergency Measures Organizations		disaster relief cottagers not eligible	emergency measures, flood warnings, evacuation	public education on all hazards		
Department of Agriculture and Rural Development	protective works primarily for agriculture					
Department of Municipal Affairs					municipal zoning bylaws	
Saint John River Basin Board				hazard mapping in Fredericton area		comprehensive water management plan

Figure 8
Adjustments to Flood and Erosion Hazards: Quebec

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of Natural Resources	flood and erosion protective works	disaster relief cottagers not eligible	flood fighting			
Department of Justice, Civil Protection Branch			emergency measures, flood warnings			
Department of Municipal Affairs						
Department of Highways			flood fighting, road repairs		municipal zoning bylaws	
Bureau of Statistics						annual flood damage assessment
Committee on Flow Regulation, Montreal Region						federal-provincial study of floods in Montreal area

Figure 9
Adjustments to Flood and Erosion Hazards: Ontario

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Ministry of Natural Resources	flood and erosion protective works		flood forecasting, flood fighting	hazard mapping in some urban areas	guidelines for cottages on crown land	land acquisition
Ministry of Agriculture and Food	protective works primarily for agriculture					
Ministry of the Solicitor-General, Emergency Measures Branch			emergency measures, flood warnings, evacuation			
Ministry of Housing					subdivision control municipal bylaws	
Ministry of Treasury, Economics and Intergovernmental Affairs	loans to cottagers for protective works	disaster relief cottagers not eligible				
Ministry of Transportation and Communications	protective works primarily for roads		flood fighting			
Canada-Ontario Great Lakes Shore Damage Survey				delineating lake-shore flood and erosion hazard areas		inventories of flood damage and property values

Figure 10
Adjustments to Flood and Erosion Hazards: Manitoba

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of Mines, Resources and Environmental Management	flood and erosion protective works	limited flood compensation to cottagers	flood forecasting			
Department of Urban Affairs, Emergency Measures Organization			emergency measures, forcible evacuation			
Department of Municipal Affairs					municipal zoning bylaws, municipal subdivision control	

Figure 11
Adjustments to Flood and Erosion Hazards: Saskatchewan

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of the Environment			flood forecasting	hazard mapping in some areas	reservoir development regulations	regulates water use and development
Department of Municipal Affairs		disaster relief cottagers not eligible			municipal zoning bylaws, subdivision control	
Emergency Measures Organization			emergency measures			
Department of Agriculture	flood and erosion protective works					
Department of Tourism and Renewable Resources	finances control works for recreation					
Department of Highways	emergency flood control works		flood fighting			
Provincial Flood Assistance Agency		financial assistance to farmers, small businesses, individuals cottagers not eligible				
Qu'Appelle River Basin Board				hazard mapping in Qu'Appelle basin		comprehensive water management plan

Figure 12
Adjustments to Flood and Erosion Hazards: Alberta

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of the Environment	flood and erosion protective works		flood forecasting, flood fighting		can restrict development on flood plains	technical assistance to cottagers
Department of Agriculture	protective works primarily for agriculture					
Department of Municipal Affairs					municipal zoning bylaws	
Alberta Disaster Services Agency		disaster relief cottagers not eligible	emergency measures, forcible evacuation	public education on all hazards		
Environment Conservation Authority						review of major projects, public hearings
Department of Highways and Transport			flood fighting, emergency road repairs			

Figure 13
Adjustments to Flood and Erosion Hazards: British Columbia

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Department of Lands, Forests and Water Resources	flood and erosion protective works	disaster relief cottagers not eligible	flood forecasting	hazard mapping on major rivers	subdivision control of land subject to flooding	can require flood proofing
Department of Municipal Affairs					municipal zoning bylaws	
Department of Highways	emergency protective works		flood fighting			
Department of the Provincial Secretary, Provincial Emergency Programme			emergency measures			
Okanagan Basin Consultative Board						comprehensive water management plan
Fraser River Board	dyking program					

Case Studies

Having discussed the general nature of flood and erosion hazards affecting vacation homes in Canada and institutional arrangements for dealing with these hazards, it is appropriate to study in some detail how federal, provincial, and municipal government policies and institutional arrangements have worked in particular areas.

In selecting case study areas, ideally discussion should involve the way policies have interacted with land and people. How have policies related to the realities of erosion and deposition, plant succession, marsh habitat, and the need for recreation and conservation land? How have policies related to changing flood protection technology? How have policies related to varying value sets of cottagers, farmers, and other users? In taking all of these natural and human elements and processes into account, the authors are advocating the adoption of an ecological approach of the type already used on the north Erie lakeshore.[63] This ecological approach is seldom taken in research and evaluation of hazard policies.

Three case study areas have been selected: the north Erie lakeshore, the St. Lawrence River valley, and the

63. J.G. Nelson, J.G. Battin, R.A. Beatty, and R.D. Kreutzwiser, "The Fall 1972 Lake Erie Floods and Their Significance to Resources Management", Canadian Geographer, 19(1), 1975, pp. 35-59.

Northumberland coast. Considerable information on the north Erie lakeshore has been obtained previously by the authors, and this case study is dealt with in some detail. The St. Lawrence River valley and Northumberland coast studies are dealt with in much less detail. Discussion of them is based mainly on available reports without the advantage of detailed field investigations such as those conducted by the authors on the north Erie shore.

Vacation Homes and Flood and Erosion Hazards on the North Erie Lakeshore

The first case study area selected is the north Erie lakeshore, and it is appropriate for several reasons. The inland lakeshore cottage environment is the most popular in Canada and the north Erie shore is extensively developed in cottages. Moreover, perhaps the most significant area of damage potential to cottages in Canada is found along the lower Great Lakes shoreline.

A comprehensive ecological approach is necessary here, although relatively little has been done thus far on perceptions, attitudes, and values as they relate to policies and institutional arrangements. In this case study, the physical nature of flooding and erosion, human encroachment onto the lakeshore, and adjustments to flood and erosion hazards on the north Erie lakeshore will be considered. Particular attention

will be directed to events during and after the 1972-1973 floods and high lake levels, and interpretations will be made regarding the nature of adjustments adopted. An effort will be made to relate these interpretations to the findings of previous hazards research.

Physical Nature of Flood and Erosion Hazards

The total length of the north Erie shore, including Pelee Island, is 403 miles. Most of this shoreline consists of soft erodible bluffs from 10 to 120 feet high.[64] (see Figure 14) Exposed bedrock is found in the eastern part of the Erie lakeshore in the Niagara Region. Three large sand peninsulas, Pelee, Rondeau, and Long Point, occur along the north Erie shore. These peninsulas consist of low lying beaches, dunes, and marshes. (see Figure 15)

Erosion is most severe along the shoreline of the Lake Erie Central Basin. Bluff recession rates of 6 inches to 22 feet per year occur here.[65] The peninsulas or sand spit areas are also subject to erosion, as well as deposition. (see Figures 16 and 17) These processes are particularly affected by lake level fluctuations, including storm surges.[66] It is estimated that 132 miles of north Erie shore suffers critical erosion,

64. Task Force on Available Shore Erosion Information, op. cit. Part 2, Shore Erosion on the Great Lakes System, p. 28.
65. Bruce Edward Zimmer, A Study of Bluff Erosion as Investigated at a Geomorphological Field Station Near Port Bruce, Ontario, B.A. thesis, University of Western Ontario, 1965, p. ii.
66. J.P. Coakley, W. Haras and N. Freeman, "The Effect of Storm Surge on Beach Erosion, Point Pelee", Proceedings, 16th Conference on Great Lakes Research, 1973, pp. 377-389.

Figure 14 Port Stanley, showing the erodible clay bluffs which are typical of much of the north Erie shore.

Figure 15 Hillman Marsh, Point Pelee, showing the marsh, tree-lined sand bar, and Lake Erie.

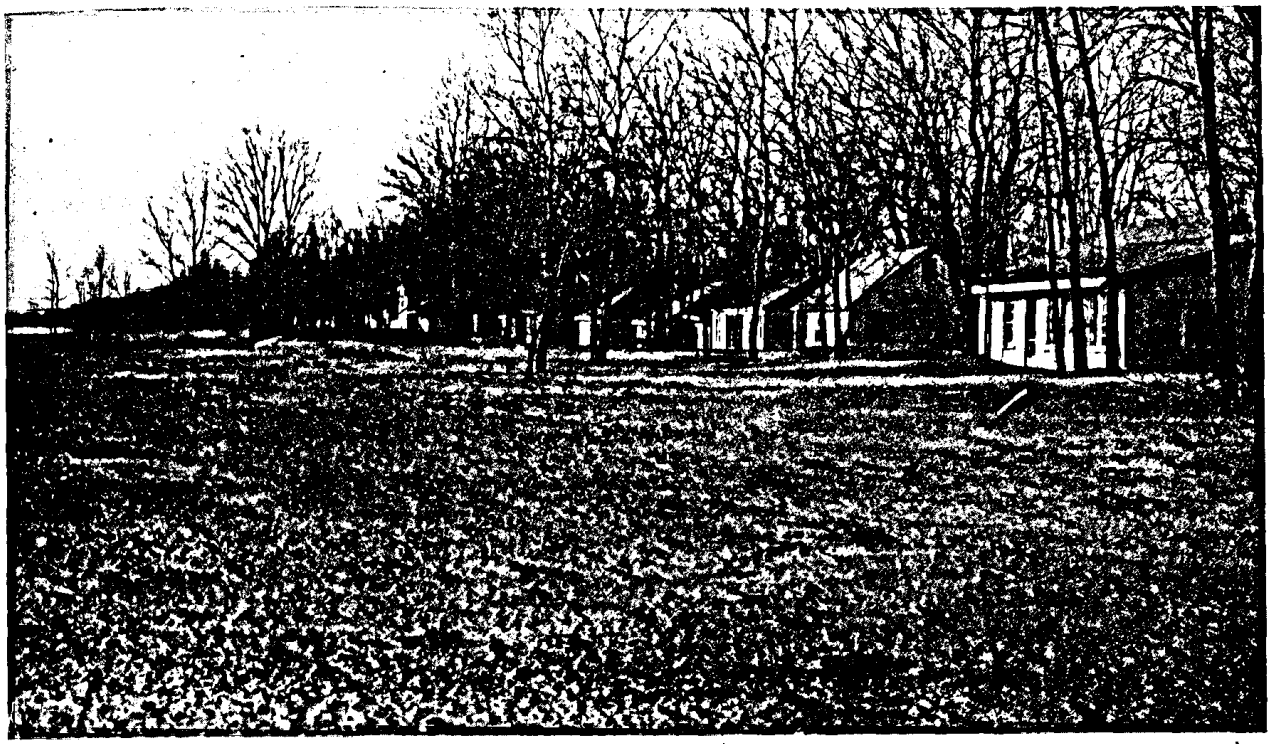


Figure 16 Long Point, showing an area where deposition has created a wide beach providing protection for cottages.

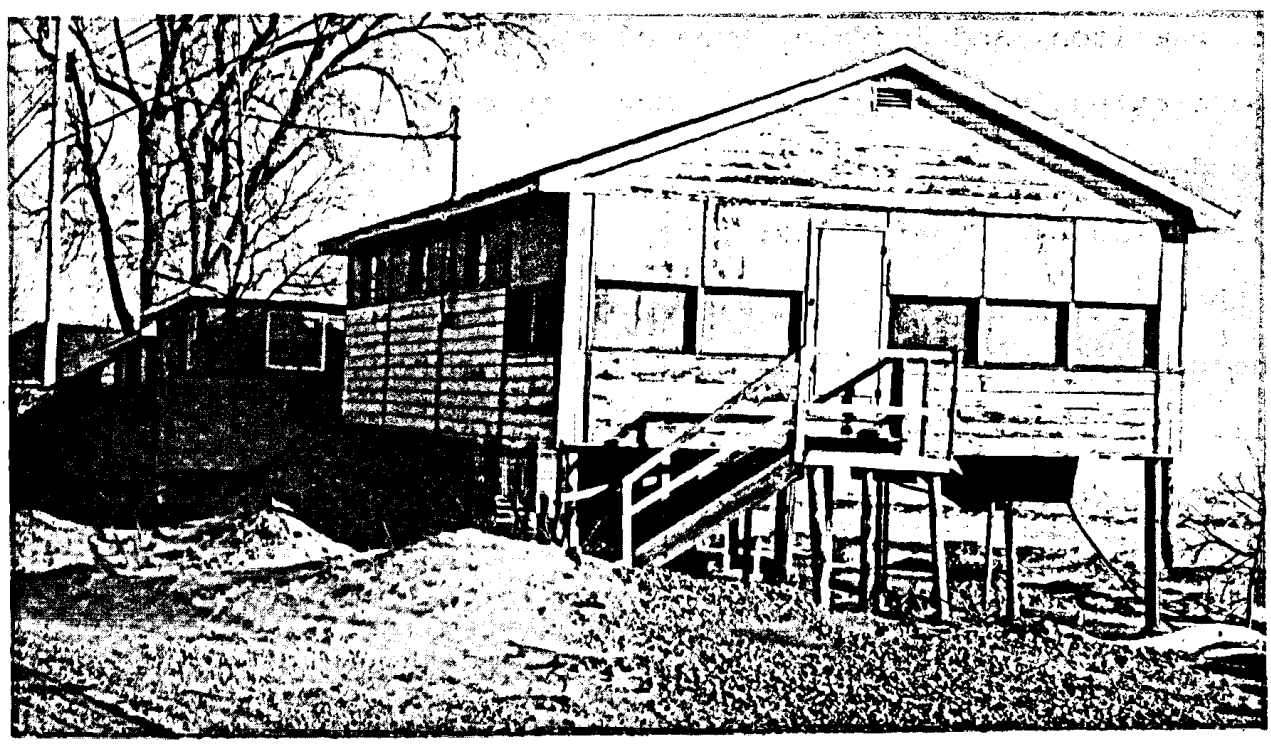


Figure 17 Long Point, showing an area where the beach and dunes have been severely eroded.

with most of the remaining shore susceptible to non-critical erosion.[67]

Flooding is a serious problem mainly in the low-lying sand spit areas at Pelee, Rondeau, and Long Point. Lake Erie, with its long fetch and nearly parallel orientation with prevailing winds, is especially susceptible to short term fluctuations, such as storm surges. The potential for flooding is very great when short term fluctuations are superimposed on longer term fluctuations, as occurred on Lake Erie in 1951-1952 and 1972-1973. The underlying process of lake level fluctuation is fundamental to the processes of flooding and erosion.

Human Encroachment onto the North Erie Lakeshore

In proximity to urban centres such as Detroit, Windsor, London, Hamilton, and Buffalo, much of the north Erie shore has undergone extensive cottage development since the 1890's. Much of this development has occurred in the sand spit areas at Pelee, Rondeau, and Long Point. Cottages are also extensive along the Niagara Region lakeshore.[68] As well, cottage development occurs at nodes such as Port Stanley, Port Bruce, and Port Burwell. An estimated 113 miles, or 26% of the north Erie lakeshore is developed in vacation homes.[69]

67. Task Force on Available Shore Erosion Information, op. cit., Part 2, Shore Erosion on the Great Lakes System, p. 37.
68. J.N. Jackson, Recreational Development and the Lake Erie Shore, Niagara Regional Development Council, no date.
69. Task Force on Available Shore Erosion Information, op. cit., Part 2, Shore Erosion on the Great Lakes System, p. 30.

Other land uses have also encroached onto the Erie Lakeshore. Large marsh acreages were drained at Pelee and Rondeau in the late 1800's and early 1900's, and protected from flooding by dykes.[70] These protected areas are intensively cultivated in vegetables and other crops. Much of the bluff area along the north Erie shore is less intensively developed in agriculture. A number of harbours provide for commercial navigation, recreational boating, and the fishing industry. Major industrialization is underway in the Haldimand-Norfolk Region. Some 58 miles of shoreline in public park use on the north Erie shore are concentrated mainly in the sand spit areas.

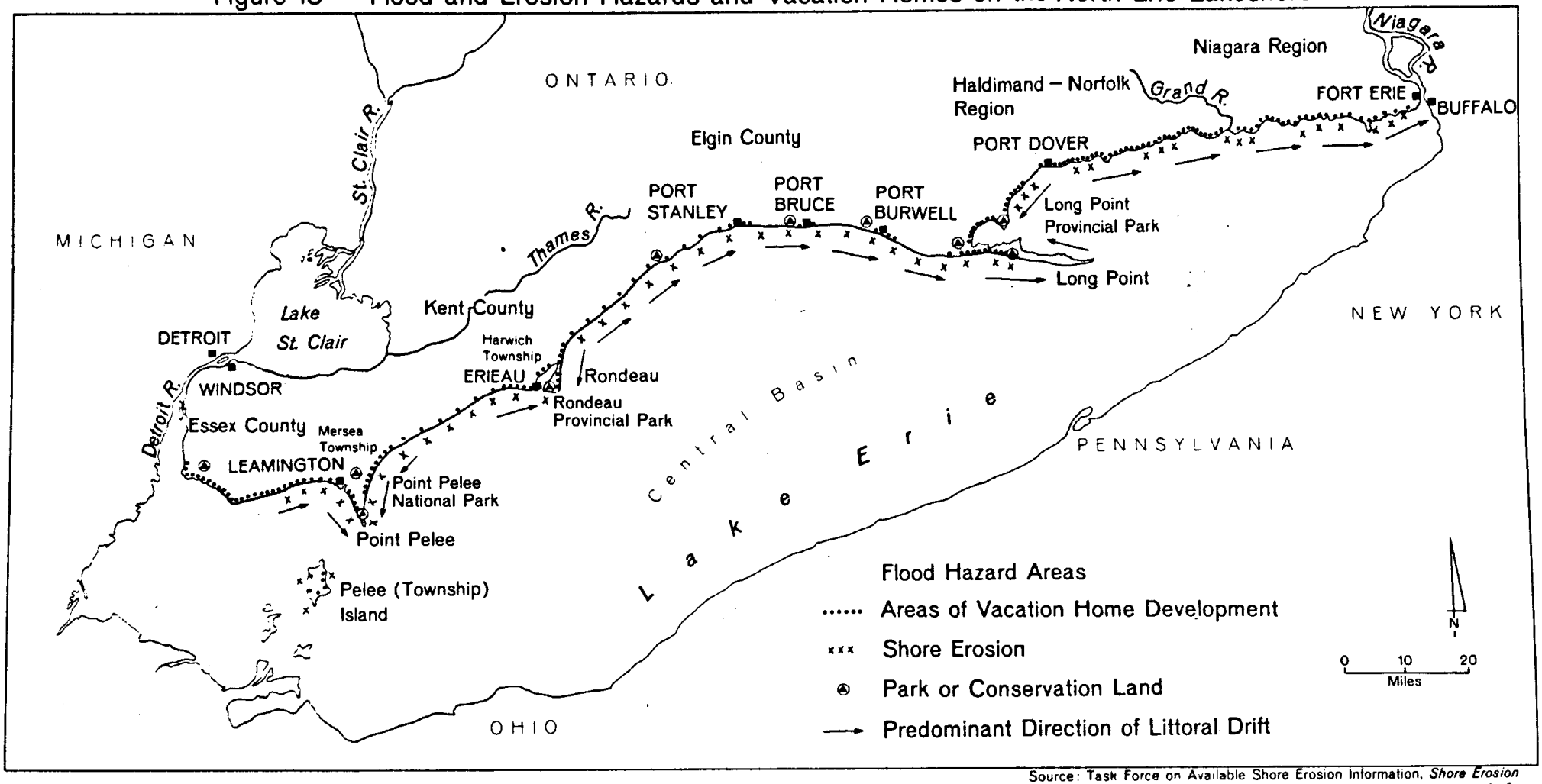
Much human encroachment onto the north Erie lakeshore has been incompatible with shore ecology, notably the processes of flooding and erosion. This has been particularly true of cottage development in the sand spit areas. It has been estimated that annual losses from flood and erosion damages on the north Erie lakeshore vary from $100,000 to over $2,500,000 annually.[71] The distribution of vacation homes and flood and erosion hazards are shown on Figure 18.

Adjustments to Hazards on the North Erie Lakeshore

Man can adjust to flood and erosion hazards individually or collectively, through governments at the federal, provincial, and municipal levels. The theoretical and actual range of

70. J.G. Nelson, J.G. Battin, R.A. Beatty, and R.D. Kreutzwiser op. cit, pp. 40-43.
71. Task Force on Available Shore Erosion Information, op. cit. Part 2, Shore Erosion on the Great Lakes System, p. 44.

Figure 18 Flood and Erosion Hazards and Vacation Homes on the North Erie Lakeshore



Source: Task Force on Available Shore Erosion Information, *Shore Erosion Information on the Great Lakes – St. Lawrence System*, Part 2, Shore Erosion on the Great Lakes System, Ottawa, 1973, Figures 3 + 8.

adjustments to flood and erosion hazards on the north Erie shore are shown on Figure 19.

On an individual basis, cottagers along the north Erie lakeshore have constructed a variety of flood and erosion protective works. Stone rubble, concrete, wood, and steel seawalls, breakwalls, and groynes have been popular means of protection. Gabions, or rock-filled wire baskets, have been less extensively used. Land fill has been used in some areas to elevate buildings above the flood line. In the Long Point area, some cottagers have raised their buildings on pilings. Many individual adjustments have been poorly built, inappropriate, improperly located, and largely ineffective. Cottagers have sustained considerable losses from erosion and flood damages on the north Erie lakeshore.

During the crisis atmosphere associated with periods of high lake levels, flooding and accelerated erosion, cottagers and other lakeshore occupants have appealed to all levels of government for relief and protection from damages. Such appeals led, for example, to a Select Committee of the Ontario Legislature report on lake levels following the 1951-1952 floods on the lower Great Lakes.[72]

Federal government involvement in flood and erosion hazards on the north Erie lakeshore has been primarily financial support for construction of protective works. During times of

72. Select Committee of the Ontario Legislature on Lake Levels of the Great Lakes, Report, Toronto: Queen's Printer, 1953.

Figure 19
Theoretical and Actual Range of Adjustments to Flood and Erosion Hazards on the North Erie Lakeshore

Modify the Hazard Cause	Modify the Hazard	Modify the Loss Potential	Adjust to Losses: Spread the Loss	Adjust to Losses: Plan for the Loss	Adjust to Losses: Bear the Loss
weather modification	seawalls	flood proofing	public relief	flood insurance and relief funds	individual loss bearing
channelize the lake	groynes	zoning and land use regulation	subsidized insurance	tax write-offs	
diversions	dykes	forecasting	government purchase of land and property		
control inflow and outflow	breakers and bars	warning systems			
dredging and beach material removal regulation	rip-rap	emergency measures			
	gabions	temporary and permanent evacuation			
	land fill and landscaping	subsidized relocation			
	flood fighting	building codes and design			
	beach nourishment	subdivision regulation			
	dune planting				
	various loans and payments from senior governments for the above				

Note: Adjustments that have been adopted on the north Erie lakeshore are underlined.

Source: Adapted with modifications from J.G. Nelson, J.G. Battin, R.A. Beatty, and R.D. Kreutzwiser, "The Fall 1972 Lake Erie Floods and Their Significance to Resources Management", Canadian Geographer, 19(1), 1975, Table I.

crisis, ad hoc financial arrangements have sometimes been made with the provincial government in an attempt to provide a quick solution to persistent flood and erosion problems. Ad hoc federal-provincial arrangements during high lake level periods in 1929-1930 and 1951-1952, for example, resulted in the construction of miles of seawall, breakwall, and groynes in the Pelee and Rondeau areas.[73] These arrangements were primarily to protect agricultural land, although many cottages did benefit from the protection. These arrangements, however, have not been entirely effective in the long term, as repeated costly commitments to further protective works have been necessary. (see Figures 20 and 21)

On a much smaller scale, the federal Department of Public Works has provided grants to some municipalities and individuals on the north Erie shore. Cottagers in Port Stanley and Port Burwell, for example, have benefited from this 1966 federal policy of providing assistance where erosion is caused by federal structures or commercial navigation.[74] Under this policy, the Department of Public Works approves federal financial assistance only after the applicant has submitted detailed plans of the protective works proposed and the site has been inspected by a Department official.[75]

73. J.G. Nelson, J.G. Battin, R.A. Beatty, and R.D. Kreutzwiser, op. cit., Table II.
74. London Free Press, November 27, 1973.
75. Department of Public Works, Shore Erosion Contributions Policy and Application Procedure, mimeo, no date.

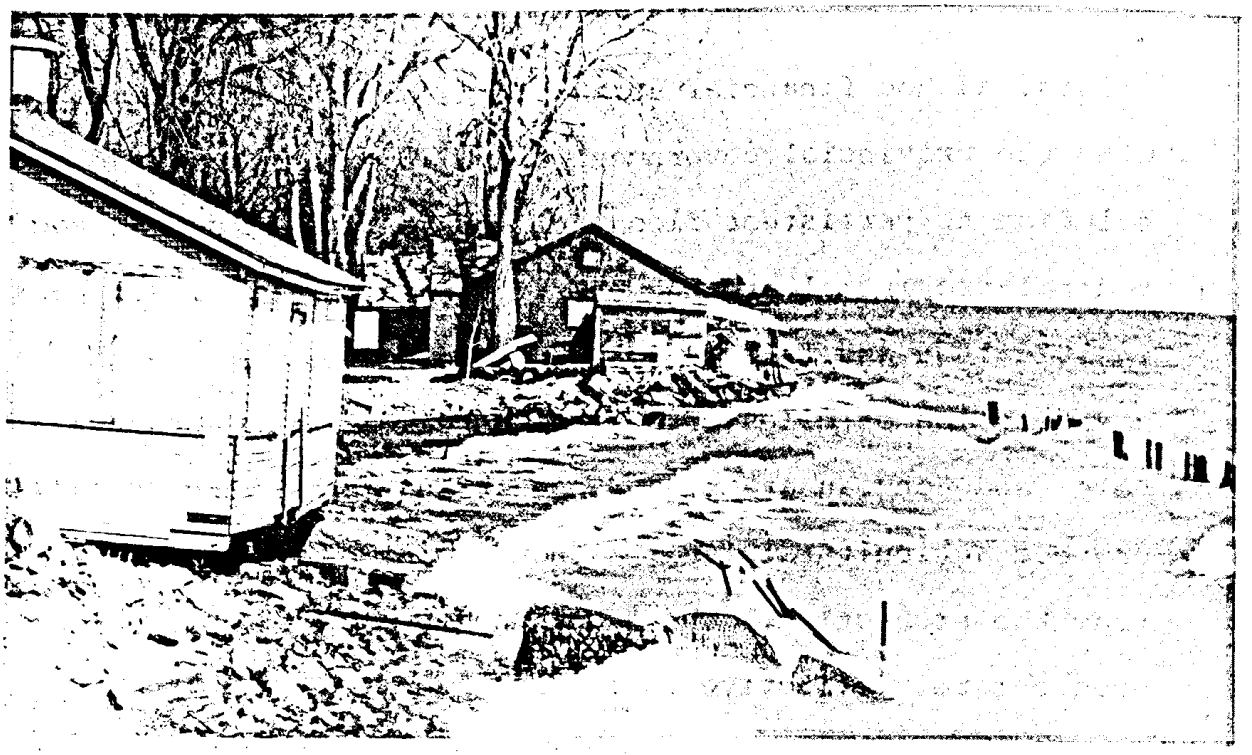


Figure 20 Cottages along the Dyke Road, Harwich Township, showing the remains of a wooden seawall built in 1951.

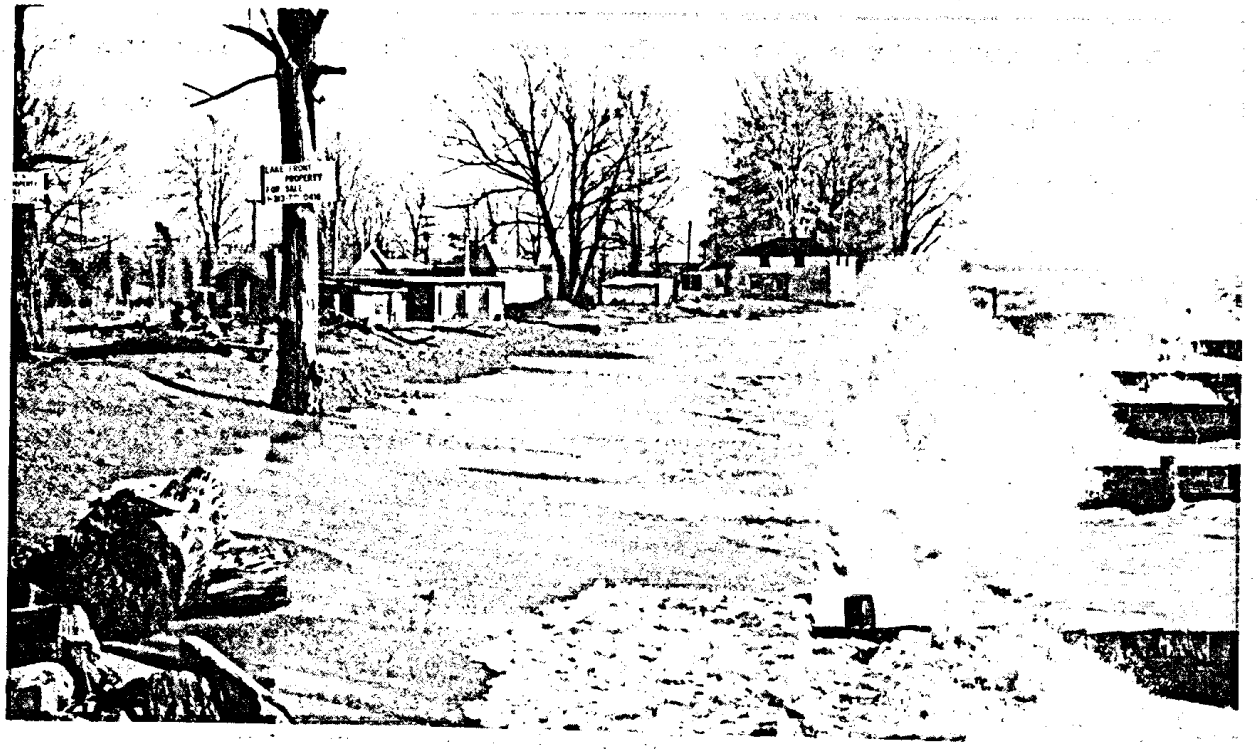


Figure 21 Shore protection along the Dyke Road, Harwich Township. These groynes built in 1969 have not been very effective.

The federal Department of the Environment has been involved in flood and erosion hazards on the north Erie shore in several ways. The Canada Centre for Inland Waters provides a lake level forecasting and high water warning service, and has been involved in research on erosion, nearshore sediment, and storm surges. The Canadian Wildlife Service of the Department of the Environment has acquired several wetland areas on Lake Erie, including Big Creek marsh near Long Point.

The federal Department of Indian and Northern Affairs manages Point Pelee National Park. The Department has, over a number of years, experimented with various structural methods in an attempt to reduce erosion.[76]

Provincial government involvement in flood and erosion hazards has been more extensive and diverse. Longstanding provincial arrangements have aided the development of large scale drainage schemes in the Rondeau and Pelee areas, and the protection of drained agricultural land from flooding and erosion.[77] Over the years, the amount of federal and provincial government assistance for protective works associated with these drainage schemes has increased. Since 1954, the province has contributed 33-1/3% of the costs of all drainage work done under an engineer's report.[78] After the passage of

76. R. Daigneault, Erosion at Point Pelee National Park A Case History, Parks Canada, mimeo, 1973.
77. J.G. Nelson, J.G. Battin, R.A. Beatty, and R.D. Kreutzwiser, op. cit., pp. 40-43.
78. Provincial Aid to Drainage Act, 2 Elizabeth II. c. 74. 1954.

the federal Agricultural Rehabilitation and Development Act (ARDA) in 1961, eligible projects have received a 33-1/3% federal contribution in addition to the provincial assistance. The costs of shore protective works in the Pelee and Rondeau areas are being increasingly spread among the wider Canadian taxpaying public. Provincial drainage aid to municipalities is administered by the Ministry of Agriculture and Food.

The Ministry of Natural Resources has been involved in the preparation of an official plans hazards policy which can be applied on the north Erie lakeshore as well as other parts of the province. The proposed policy considers high and low hazard lands and sensitive areas.[79] The Ministry manages miles of lakeshore in park and other uses, including Rondeau and Long Point Provincial Parks. At Rondeau Provincial Park, the Ministry has recently investigated shore erosion.[80] As well, the Ministry is responsible for crown lands, including the bed of Lake Erie, and issues permits for the construction of protective works on crown land. The Ministry also issues permits for the commercial extraction of sand and gravel from the lake bed. An area of beach in Harwich Township has, for some years, been designated a protected zone under the Beach Protection Act of 1920, and the removal of beach material is

79. Ontario Ministry of Natural Resources, Environmental Protection Areas, Toronto, 1973.
80. Crysler & Lathem Ltd., Rondeau Provincial Park Shoreline Erosion Study-Phase 3, report for the Ontario Ministry of Natural Resources, Willowdale, 1974.

prohibited.

The Ministry of Treasury, Economics and Intergovernmental Affairs administers the Disaster Relief Program, which provides provincial compensation on a dollar for dollar basis with local contributions. Cottagers are not eligible for compensation under this program.

The Ministry of Treasury, Economics and Intergovernmental Affairs and subsequently the Ministry of Housing have been responsible for the Planning Act, which deals with official plans, zoning bylaws, and subdivision control. Subdivision control was effected for the entire province in 1970.[81] Unfortunately, a good deal of the cottage development along the north Erie lakeshore occurred prior to effective provincial regulation.[82]

The Emergency Measures Branch of the Ministry of the Solicitor-General has provided support to local Emergency Measures Organizations. Most municipalities along the north Erie shore are served by local Emergency Measures Organizations. At least one Emergency Measures Organization, the Chatham-Kent EMO, has recently become defunct.[83] Moreover, the provincial government has announced that the Emergency Measures Branch will be dissolved.

81. Ontario Economic Council, Subject to Approval a Review of Municipal Planning in Ontario, Toronto, 1973, facing p. 1.
82. The Haldimand-Norfolk Joint Study Committee, A Lakeshore Study of Haldimand and Norfolk Counties, 1974, p. 12.
83. London Free Press, December 28, 1974.

Municipal government involvement in flood and erosion hazards on the north Erie shore traditionally has been to request senior government assistance during times of crisis. As well, municipal councils typically have authorized emergency road repairs and flood fighting during these crisis periods. Councils have also administered the Drainage Act at the local level, providing for the construction and maintenance of protective works for drained agricultural land and, in several cases, residential areas. Councils have also established local disaster relief committees to raise funds and administer compensation.

For many years, north Erie shore municipalities have had the power to zone flood and erosion hazard land. These municipalities generally have been slow in utilizing this power and have continued to issue building permits for vacation home and other construction in hazardous lakeshore areas. Several north Erie lakeshore municipalities, including Elgin County and Harwich Township, have recently incorporated flood and erosion hazard policies into their proposed official plans.

The involvement of the federal, provincial, and municipal governments in flood and erosion problems on the north Erie lakeshore is summarized on Figure 22.

The 1972-1973 Lake Erie Floods

On November 14, 1972, an intense low pressure system passed south of Lake Erie, generating winds from the northeast at 40 to 55 knots.[84] The high wind velocity over the 200 mile

84. J.P. Coakley, W. Haras and N. Freeman, op. cit., p. 377.

Figure 22
Adjustments to Flood and Erosion Hazards on the North Erie Lakeshore

Note: Adjustments adopted primarily as a result of high lake levels and flooding in 1972-1973 are underlined.

Department or Agency	construction of protective works	disaster relief compensation	emergency measures flood forecasting	hazard mapping public education	hazard zoning development control	other adjustments
Government of Canada						
Department of the Environment	ARDA dyking		forecasting, high water warnings	Shore Damage Survey		land acquisition, erosion research
Departments of Agriculture and Regional Economic Expansion	drainage assistance ARDA dyking					
Department of Public Works	grants for erosion protective works					
Department of Indian and Northern Affairs	erosion protective works					
International Great Lakes Levels Board (International Joint Commission)						studies of lake regulation
Government of Ontario						
Ministry of Agriculture and Food	drainage assistance ARDA dyking					
Ministry of Natural Resources			flood fighting	Shore Damage Survey	official plans hazards policy	crown lands, land acquisition, erosion research, technical assistance
Ministry of Treasury, Economics and Intergovernmental Affairs	grants for protective works, loans to cottagers	disaster relief cottagers not eligible				
Ministry of Housing					official plans, subdivision control	
Emergency Measures Branch			supports EMO's			
Ministry of Transportation and Communications			flood fighting			
Inter-Ministry Flood Damage Working Group			coordinates provincial programs			
Municipalities						
councils	administer Drainage Act				official plans, zoning bylaws	
works departments	repairs to roads, protective works		flood fighting, emergency repairs			
disaster relief committees		administer relief funds				
Emergency Measures Organizations			emergency measures, flood warnings			
Conservation Authorities						expansion into lakeshore areas

length of the Lake piled water at the western end an estimated 4 feet above the already high level.

At Point Pelee, waves reportedly were 10 feet high and were accompanied by erosion, flooding of farmland, and evacuation of residents.[85] Damage to cottages along the east beach of Point Pelee was estimated at $250,000.[86] In the Rondeau area, little farmland was flooded, but some 30 cottages along the Dyke Road near Erieau were damaged or destroyed.

All levels of government responded to the fall 1972 flood and to subsequent flooding in the spring of 1973. The adjustments adopted by the federal, provincial, and municipal governments primarily as a response to high lake levels and flooding in 1972-1973 are underlined on Figure 22.

Federal government involvement included cooperation with the provincial government on dyke construction. An agreement was concluded between the federal Department of Agriculture and Department of Regional Economic Expansion and the provincial Ministry of Agriculture and Food which provided 90%, or approximately $4,000,000, of the costs of shore protection in Harwich, Mersea and Pelee townships.[87] (see Figures 23 and 24) The townships were responsible for 10% of the total costs. Canadian and Ontario taxpayers provided subsidies of over $900 per acre of farmland in the Rondeau area for shoreline

85. Windsor Star, November 1, 1973.
86. J.P. Coakley, W. Haras and N. Freeman, op. cit., p. 377.
87. Personal Communication from Mr. H.W. Rowe, Ontario Ministry of Natural Resources, Chatham, February 19, 1975.

Figure 23 Shore protection, East Beach, Point Pelee. This mile long $800,000 breakwall was built in front of cottages to protect drained agricultural land.

Figure 24 Shore protection, Dyke Road, Harwich Township. After repeated protests from cottagers, this dyke protecting drained agricultural land was built inland of the cottages.

protection.[88] There is no evidence that benefit-cost or environmental impact studies were carried out in conjunction with these projects in Harwich, Mersea, and Pelee townships. Several miles of valuable beach have been destroyed as a result, and it is not known what effect the breakwall and dykes will have on processes of erosion and deposition.

Funds for the construction of shore protective works in Harwich, Mersea, and Pelee townships in 1973 and 1974 were administered through the provincial Drainage Act. Inadequate provision for public input denied cottagers and others influence over the decisions that were made.[89] As a result, 29 cottagers along the Dyke Road in Harwich Township, who were about to lose their cottages so as to permit construction of a dyke on their properties, were forced to take action other than the means provided by the Drainage Act to save their buildings.[90]

Other federal arrangements resulting from the high lake levels and flooding in 1972-73 included the Canada-Ontario Great Lakes Shore Damage Survey and a federal interdepartmental task force on shore erosion.

The federal Department of the Environment cooperated with the provincial Ministry of Natural Resources on the Canada-Ontario Great Lakes Shore Damage Survey initiated in May 1973. This Survey was organized to provide information on shoreline

88. J.G.Nelson, J.G. Battin, R.A. Beatty, and R.D. Kreutzwiser, op. cit., Table III.
89. Ibid., p. 54.
90. Ibid., p. 47.

subject to flooding and erosion, erosion rates, property values, and flood and erosion damages resulting from the 1972-1973 floods on the lower Great Lakes.[91]

The federal interdepartmental Task Force on Shore Erosion was also initiated in the spring of 1973.[92] The three volume report of the Task Force summarizes available information on flooding and erosion on the Great Lakes and St. Lawrence River, including information on shoreline land use and flood and erosion hazard areas.

Provincial government response was immediate. Within three days of the November 14, 1972 flood, senior provincial politicians visited the damaged areas and promised provincial assistance.[93] A number of provincial government agencies responded to the high water situation of 1972-1973.

The Ministry of Natural Resources was involved in flood fighting and emergency programs such as "operation sandbag" and "operation truck", which provided men, machinery, and materials for flood fighting along the north Erie lakeshore.[94] The Ministry also established emergency contingency plans for flood fighting.[95] The Engineering Services Branch of the Ministry provided technical assistance to municipalities and individuals

91. Environment Canada, The Canada Water Act Annual Report, p. 20.
92. Task Force on Available Shore Erosion Information, op. cit., Part 1, Summary Report, p. 2.
93. London Free Press, November 18, 1974.
94. Personal Communication from Mr. H.W. Rowe, Ontario Ministry of Natural Resources, Chatham, February 19, 1975.
95. London Free Press, November 10, 1973.

regarding flood and erosion hazards and suitable protective works.

The Ministry of Treasury, Economics and Intergovernmental Affairs was primarily involved in a financial capacity following the 1972-1973 floods.[96] In addition to administering the Disaster Relief Program, the Ministry's Subsidy Branch administered two new programs established in 1973. Under the Special Emergency Assistance Program, the Ministry provided grants to municipalities covering 80% of the costs for the repair of roads, dykes and other structures benefiting the municipality. Under the Shoreline Property Assistance Act of 1973, the Ministry provided funds to municipalities for loans to cottagers for the repair of buildings damaged by flooding, erosion, or ice, and for the construction of shore protective works. Loans of up to $20,000 are repayable over 20 years. There are no guidelines under the Act to ensure that the most appropriate type of protection is built, or that one cottager's protection does not increase the hazard for his neighbours.

The Ministry of Transportation and Communications was involved in flood fighting following the 1972-1973 floods on the north Erie shore. The Ministry cooperated with the Ministry of Natural Resources with "operation sandbag" and "operation truck".

An Inter-Ministry Flood Damage Working Group was

96. Personal Communication from Mr. M.D. Trewin, Ontario Ministry of Treasury, Economics and Intergovernmental Affairs, Toronto, August 30, 1974.

established in 1973, to coordinate all programs relating to the flood and erosion problems on the lower Great Lakes.[97] The Working Group consisted of representatives of the Ministries of Natural Resources, Agriculture and Food, Solicitor-General, Transportation and Communications, Environment, and Treasury, Economics and Intergovernmental Affairs. One of the functions of the Working Group was to disseminate information to the public and municipalities regarding provincial flood and erosion policies. The Working Group was empowered to allocate funds and draw upon the physical and technical resources of various Ministries. The Working Group divided the Great Lakes shoreline into eight sectors to coordinate field staff and services.

Municipal government response to the 1972-1973 floods included representations to senior governments for assistance. Within one month of the November 14, 1972 flood, several north Erie shore municipalities had sent petitions and delegations to the provincial government requesting assistance.[98] Municipalities also enlisted the support of local members of the provincial Legislature and House of Commons in requesting provincial and federal assistance.

Several municipalities on the north Erie lakeshore undertook emergency road and dyke repairs during and after the 1972-1973 floods. As well, Mersea, Pelee, and Harwich Townships administered federal-provincial dyking assistance under the

97. Personal Communication from Mr. H.W. Rowe, Ontario Ministry of Natural Resources, Chatham, February 19, 1975.
98. Windsor Star, December 15, 1972.

Drainage Act. These municipalities retained engineers to investigate the problem and let contracts for the construction of protective works.

A number of municipalities in Essex and Kent counties formed the Essex-Kent Disaster Relief Committee to solicit local contributions and administer matching provincial relief funds.[99]

The Windsor and Essex County Emergency Measures Organization provided high water warnings and coordinated local emergency measures.[100]

Recently, extensive shoreline areas along Lake Erie have been incorporated into existing Conservation Authorities, or in the case of Essex County shoreline, into a newly created Authority.[101] High lake levels and flood and erosion problems were motivating factors in the expansion of Authorities into lakeshore areas. Under the Conservation Authorities Act, local Authorities can acquire land and make regulations regarding flood plain zoning and land fill.

Interpretations

It is possible to draw several conclusions based on the north Erie lakeshore experience.

99. Personal Communication from Mr. R.A. Van den Brande, Essex County Administrator, Windsor, October 2, 1974.
100. Personal Communication from Mr. R. Norwood, Windsor and Essex County Emergency Measures Organization, Windsor, December 18, 1974.
101. "New Authority for Essex County", Watershed News, Fall 1973, p. 1.

Adjustments to flood and erosion problems by both individual lakeshore occupants and by governments at all levels have generally been introduced in a crisis atmosphere, during periods of high lake level and often immediately following major flooding. Senior government involvement on the north Erie lakeshore has been particularly noticeable during such crisis periods in 1929-1931, 1951-1952, and 1972-1973.

During these crisis periods, there is considerable pressure on all levels of government to provide quick solutions to persistent flood and erosion problems. A narrow range of costly structural or engineering adjustments has been favoured, particularly by senior governments. These technical solutions, however, have not been entirely effective in the long term, in part due to the lack of an adequate understanding of shore processes.

Policies and institutional arrangements have worked to encourage continued occupance of hazardous north Erie lakeshore areas. The reliance on structural protection and the expectation of disaster relief and compensation for some lakeshore occupants has discouraged serious consideration of such alternatives as relocation, and in many cases such alternatives as land use regulation and land acquisition.

Senior government involvement in flood and erosion hazards on the north Erie lakeshore has been largely financial, that is, the provision of funds for the construction of shore protective works. These funds have often been provided without the

advantage of guidelines to ensure consideration of economic and social benefits and costs, environmental impact, and access to the decision-making process of all individuals and groups affected by the adjustments. The lack of guidelines has been true for both large scale projects, such as the 1973-1973 ARDA dyking and shore protection, and for arrangements such as the Shoreline Property Assistance Act, which provides the means for individual lakeshore occupants, including cottagers, to construct small scale protective works.

Research on natural hazards in the United States generally supports conclusions drawn on the north Erie lakeshore experience.

The American experience suggests that while a wide range of adjustments to hazards is possible, emphasis has been on engineering attempts to modify the hazard.[102] The Flood Control Act of 1936 provided a basis for United States federal involvement in flood control. Both the Flood Control Act and legislation authorizing increased federal involvement in coastal erosion were responses to crisis situations.

It is clear from the American experience that structural measures alone are not sufficient to control natural hazard problems. In spite of American expenditures of $500,000,000 annually, there is evidence that flood damages may actually be

102. J.K. Mitchell, "Natural Hazards Research", in Ian R. Manners and Marvin W. Mikesell, eds., Perspectives on Environment, Washington, D.C.: Association of American Geographers, 1974, p. 332.

increasing.[103]

The American experience also indicates that institutional and social factors may discourage occupants from leaving hazardous areas.[104] Rather, public relief and rehabilitation programs often force the reconstruction of structures in the same hazardous locations.

Recent aspects of American flood hazards policy warrant close study to determine what effects they will have on reducing damages in the long term. The Flood Insurance Act of 1968 is one arrangement which may reduce future damages by encouraging municipalities to regulate flood plain land use.

As well, recent years have witnessed a broadening in the range of adjustments adopted to reduce flood damage in the United States. The concept of comprehensive flood plain management, with emphasis on both land and water management, is slowly replacing the traditional concentration on engineering solutions.[105] A number of federal agencies, including the Flood Plain Management Service of the Corps of Engineers, the Geological Survey of the Department of the Interior, and the National Oceanic and Atmospheric Administration of the Department of Commerce, are now involved in hazard mapping and public

103. Hazel Visvader and Ian Burton, "Natural Hazards and Hazard Policy in Canada and the United States", in Gilbert F. White, ed., Natural Hazards Local, National, Global, New York: Oxford University Press, 1974, p. 225.
104. J.K. Mitchell, op. cit., p. 323.
105. George R. Phippen, "A New Course to Ararat", Water Spectrum, 3(2), 1971, pp. 8-15.

education concerning flood plains.[106]

Vacation Homes and Flood and Erosion Hazards along the St. Lawrence River

The St. Lawrence River is significant as a case study of a river valley cottage environment for several reasons. The St. Lawrence has a long history of erosion and flood problems. The River is affected to some extent by control works upstream of Montreal on both the St. Lawrence and Ottawa Rivers. Moreover, the federal government has been intimately involved in erosion hazards on the St. Lawrence, and has constructed many miles of shore protection works benefiting cottages and other land use under its policy of protecting shoreline where erosion is caused by commercial navigation or federal structures.

Although the St. Lawrence River from Cornwall, Ontario, to Quebec City will be considered generally, most discussion will centre on the Montreal area, and the reach from Montreal to Trois-Rivières.

Physical Nature of Flood and Erosion Hazards

Quebec City is 250 miles downstream from Cornwall. The total shoreline length including islands is approximately 1,170 miles.[107] Most of this shoreline consists of unconsolidated

106. Corps of Engineers, Flood Plain--Handle with Care, Washington, D.C., 1974.
107. Task Force on Available Shore Erosion Information, op. cit. Part 3, Shore Erosion on the St. Lawrence System, p. 52.

deposits of glacial, marine, and fluvial origin, and is susceptible to erosion.

From Cornwall to Montreal, the shoreline generally is low and marshes are found around Lake St. Francois upstream of Montreal. Rock outcrops appear in the Montreal area. Approximately 100 miles of shoreline in this reach suffer erosion problems. The low-lying areas around Lake St. Francois and Lake St. Louis are susceptible to flooding.

From Montreal to Trois-Rivières, the shoreline height varies from the lowlying marshes around Lake St. Pierre to 20 foot high banks at Lanoraie. There are a number of islands in this reach, with rates of erosion up to 12 feet per year recorded on some islands.[108] Flooding has been a persistent problem in the Montreal area and the Lake St. Pierre area.

From Trois-Rivieres to Quebec City, the shoreline is low in the upper reach rising to 200 feet near Quebec City. Erosion has been a problem along approximately 90 miles of shoreline in this reach.

Flooding on the St. Lawrence is due primarily to spring runoff and ice jams in the winter.[109] Erosion is mainly due to currents, ice, wind waves, and navigation. Wind waves are an important cause of erosion on the wider sections of the river. Along narrow channels, navigation can be a significant cause

108. Ibid., p. 26.
109. Canada Department of Transport, Basic Data Inventory Shore Property Investigation St. Lawrence River Montreal to Trois-Rivieres, Montreal, 1968, p. 6.

of erosion.

Human Encroachment along the St. Lawrence River

The St. Lawrence River downstream to Quebec City is highly developed. More than one-half the population of Quebec lives within a few miles of the River in urban centres such as Montreal, Sorel, Trois-Rivières, and Quebec City.[110] In most areas outside these urban centres, cottage development has been extensive. In the reach between Montreal and Trois-Rivières, 66 miles of shore are in unserviced residential use.[111] The majority of this unserviced residential use is believed to be cottages.

Navigation and hydro-electric power developments upstream of Montreal on the St. Lawrence and Ottawa Rivers affect flows in downstream reaches, as does extensive channel dredging in many areas along the River.

Vacation home development and flood and erosion hazards along the St. Lawrence River between Montreal and Trois-Rivieres are shown on Figure 25.

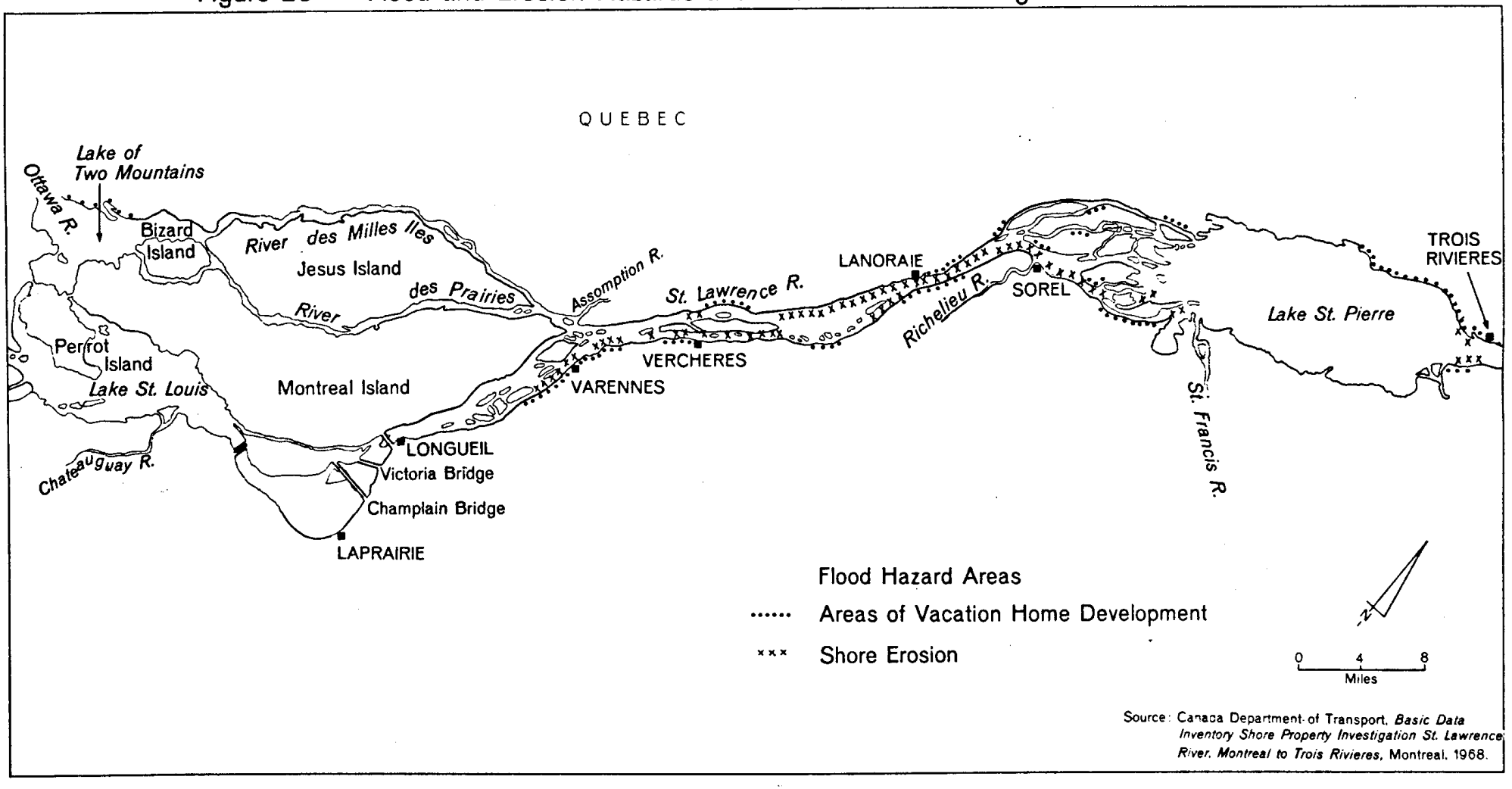
Adjustments to Hazards along the St. Lawrence River

The federal government has been the principal agent in flood and particularly erosion hazards along the St. Lawrence River.

The federal government has been involved since Confederation

110. Task Force on Available Shore Erosion Information, op. cit. Part 3, Shore Erosion on the St. Lawrence System, p. 13.
111. Canada Department of Transport, op. cit., Table 44.

Figure 25 Flood and Erosion Hazards and Vacation Homes along the St. Lawrence River



Source: Canada Department of Transport, *Basic Data Inventory Shore Property Investigation St. Lawrence River, Montreal to Trois Rivieres*, Montreal, 1968.

in the construction of protective works along the St. Lawrence. The federal Department of Public Works has been the principal agency involved.

Since 1947, the Department of Public Works has spent more than $25,000,000 on shore protection works along the St. Lawrence.[112] With increasing development along the River, demand for federal shore protection has also increased in recent years. The Department established a Shore Erosion and Protection Committee in 1960, in an attempt to formulate a rational policy for shore protection.[113] A policy was announced in 1966 which provided that the Department of Public Works construct remedial works and pay 100% of the costs only where erosion could be attributed, by more than 50%, to navigation or federal structures.[114] To further qualify for federal protection, the value of the land protected would have to exceed the costs of protection by 100%. Where navigation or federal structures were contributing but not major causes of erosion, the Department of Public Works could contribute up to 50% of the costs of protection. The Department would continue, under this policy, to maintain protective works.

It is estimated that this federal policy could apply to some degree along 500 miles of the St. Lawrence River between Cornwall and Quebec City, of which 145 miles have already been

112. Task Force on Available Shore Erosion Information, op. cit., Part 3, Shore Erosion on the St. Lawrence System, p. 33.
113. Ibid., p. 34.
114. Ibid., p. 34.

protected.[115]

The federal Department of Transport has also been involved in flood and erosion hazards along the St. Lawrence River. The Department has direct involvement in the prevention of ice jams, an important cause of flooding on the St. Lawrence.[116] Icebreakers keep the ship channel open all winter and an ice retention structure at the Champlain Bridge in Montreal helps form a stable ice cover outside the channel. The Department also limits ship speed during the winter to prevent breaks in the ice cover outside the channel. As well, the Department of Transport has been involved in a number of studies on shore erosion, including studies for the International Great Lakes Levels Board.

The provincial government is also involved in flood and erosion hazards along the St. Lawrence River. Although flood and erosion protective works are considered mainly a municipal responsibility, the provincial Department of Natural Resources undertakes shore protection at the request of municipalities. Under this arrangement, municipalities provide the necessary land for the protective works, contribute financially to construction costs, and are responsible for their maintenance.[117] The amount of municipal financial contribution

115. Ibid., p. 60.
116. Personal Communication from Mr. C. Pellegrin, Canada Department of Transport, Ottawa, March 11, 1975.
117. Quebec Department of Natural Resources, Annual Report 1962-1963, Quebec, 1963, pp. 50-51.

varies from project to project. Under this arrangement, the Department of Natural Resources has constructed flood and erosion protective works along the St. Lawrence River and elsewhere in the province. As a general rule, cottagers are not considered eligible for provincial assistance for the contruction of flood and erosion protective works.[118]

The Department of Natural Resources provides sandbags and flood fighting services during flood disasters such as the Montreal flood in 1974.[119]

The Civil Protection Branch of the Quebec Department of Justice is also involved in emergency flood fighting and evacuation of residents.[120] The Branch was also active during the 1974 Montreal flood.

While the provincial Department of Municipal Affairs provides technical assistance to municipalities, zoning and land use regulation is a municipal responsibility. However, zoning of flood and erosion prone land has been rarely practiced by Quebec municipalities.[121] The Department of Municipal Affairs, in conjunction with the Department of Natural Resources, is currently attempting to define regulations to control development in hazard areas.[122]

118. Personal Communication from Mr. C. Triquet, Quebec Department of Natural Resources, Quebec, April 21, 1975.
119. London Free Press, May 20, 1974.
120. London Free Press, May 22, 1974.
121. Personal Communication from Mr. J.-P. Arsenault, Quebec Department of Municipal Affairs, Quebec, April 15, 1975.
122. Personal Communication from Mr. C. Triquet, Quebec Department of Natural Resources, Quebec, April 21, 1975.

The provincial government provides disaster compensation, for example, following floods in the Gatineau River valley, in the Montreal area, and elsewhere in Quebec in 1974 when damages totalled $75,000,000.[123] The province follows federal guidelines, and cottagers are not eligible for compensation.

As a response to the persistent flood problem in the Montreal area, which has been particularly severe in recent years due to high water levels in the Great Lakes and Ottawa River basins, the Canada-Quebec Consultative Committee recommended in the spring of 1974 the establishment of a Committee on Flow Regulation, Montreal Region.[124] This Committee involves the federal Departments of Environment, Public Works, and Transport, and the Quebec Department of Natural Resources, Environmental Protection Service, and Hydro-Quebec. The Committee is charged with examining all possible means of reducing flood damages and will consider the problem of low water levels as well.[125]

The area of main concern of the Committee is the St. Lawrence River from Lake St. Louis to Vercheres, including Lake of Two Mountains, River des Prairies, and River des Milles Iles. Of secondary interest is the St. Lawrence upstream to Lake Ontario and downstream to Lake St. Pierre, and the Ottawa River upstream to the Carillon Dam.

123. Montreal Star, May 23, 1974.
124. Canada Department of the Environment and Quebec Department of Natural Resources, Joint News Release, October 3, 1974.
125. Personal Communication from Mr. J.-Y. Pelletier, Environment Canada, Montreal, April 2, 1975.

While the Committee will examine various adjustments to flood hazard, including zoning, relocation of residences, and land acquisition, the focus appears to be on possible changes in upstream regulation and storage, dredging of Lake of Two Mountains and Lake St. Louis outlets, and construction of control works.[126]

The final report of the Committee on Flow Regulation, Montreal Region, will be submitted in 1976.

Interpretations

The federal government is heavily committed to erosion protection along the St. Lawrence River through its policy of protecting shorelines where erosion can be attributed by more than 50% to navigation or federal structures. One estimate suggests that an additional 240 miles of shoreline protection could be justified under present federal policy at an additional cost of over $60,000,000.[127] Furthermore, provincial, municipal, and private expenditures could well be over $100,000,000 on currently unprotected shoreline outside of the scope of the federal policy.

Every serious consideration, therefore, should be given to non-structural adjustments such as land use zoning, set backs, and relocation. If necessary, the federal government should gear their expenditures on shore protection to the willingness

126. Personal Communication from Mr. J.-Y. Pelletier, Environment Canada, Montreal, April 2, 1975.
127. Task Force on Available Shore Erosion Information, op. cit., Part 1, Summary Report, pp. 30-31.

of municipalities to zone undeveloped land. Without zoning or land use controls, shore protective works are likely only to confirm or increase cottage and other development along the River at the risk of future damages and requirements for additional protective works.

The federal Task Force on Shore Erosion has suggested that zoning, land acquisition, and relocation may be the best means of reducing shoreline damage. Much of the initiative for these adjustments, however, must come from the provincial and municipal governments. A firm provincial policy on such non-structural adjustments has yet to be developed.

The Task Force on Shore Erosion has made several other recommendations relevant to flood and erosion problems along the St. Lawrence River. A better understanding of shore erosion processes is necessary, including the effects of ice, wind, water levels, and navigation.[128] Detailed hazard mapping should be undertaken, and public information brochures prepared to show shoreline occupants areas of flood and erosion hazards and methods of flood and erosion damage reduction.[129] The Task Force also suggested that because shore processes do not recognize administrative boundaries, that shoreline planning and management would be more effective in the hands of shoreline conservation authorities based on natural shore reaches.

128. Task Force on Available Shore Erosion Information, op. cit., Part 3, Shore Erosion on the St. Lawrence System, p. 40.
129. Task Force on Available Shore Erosion Information, op. cit., Part 1, Summary Report, p. 37.

The federal-provincial Committee on Flow Regulation, Montreal Region, has included non-structural adjustments in its terms of reference aimed at reducing the flood hazard in the Montreal area. These adjustments, however, appear to be of secondary interest to structural adjustments such as regulation, dredging, and diversions. Indeed, in the original terms of reference of the Committee, zoning, land acquisition, and relocation are not even mentioned.[130] The terms of reference have been subsequently modified to include a consideration of these adjustments.

While changes in regulation on the St. Lawrence River, for example, might reduce flood damages in the Montreal area, trade offs might be necessary, such as increased water levels upstream of control works. As well, significant environmental impacts might be associated with changes in regulation, such as reduction of wetland areas. In this regard, the Comittee on Flow Regulation, Montreal Region, proposes to examine impacts on the environment, on the downstream region, and on all uses including navigation and hydro power generation, and presumably uses such as cottaging.

Vacation Homes and Flood and Erosion Hazards on the Northumberland Coast

The Northumberland coast of Nova Scotia, from the New

130. Committee on Flow Regulation, Montreal Region, Regulation Montreal Region Plan of Study, mimeo, June 13,1974.

Brunswick border to Cape George, is significant as a case study of vacation home development in a marine coastal environment. Some areas along this coast are extensively developed in cottages. Moreover, the erosion problem along the Northumberland Strait is apparently more severe than elsewhere in Nova Scotia, and perhaps Atlantic Canada.[131]

Very little research has been undertaken in Canada on the vacation home occupance of hazardous coastal areas.[132] Considerably more research has been conducted on other problems associated with cottage development, such as public access.[133] A significant body of research does exist, however, on coastal hazards in the United States, and reveals several important implications for vacation home development in coastal areas of Canada.

Physical Nature of Flood and Erosion Hazards

The dominant landscape of the Northumberland coast of Nova Scotia is one of gently rolling moraines.[134] Glacial till covers sedimentary bedrock in most areas. The only exception is the Cape George area, where steep rock cliffs rise to 400 feet.

131. Personal Communication from Mr. M. Otis, Nova Scotia Department of Municipal Affairs, Halifax, March 25, 1975.
132. A notable exception is a study by L.A. Gosselin, An Air Photo Interpretation of Geomorphic Features and Cultural Land Use Patterns along Nova Scotia's North Shore, Environment Canada, 1972.
133. See, for example, D.K. Redpath, Policy Implications for Shoreland Recreation: A Pilot Study in New Brunswick and Nova Scotia, M.A. thesis, University of Waterloo, 1971.
134. L.A. Gosselin, op. cit., p. 1.

In most areas along the Northumberland coast of Nova Scotia the bedrock is low and the glacial till overburden is exposed to the erosive forces of waves and ice. The average rate of erosion over the entire coast is about 1 foot per year, with maximum rates up to 3 feet per year in some areas.[135] Higher rates of erosion appear to occur on coasts oriented in an easterly direction. As well, erosion is greatest during storms accompanied by strong easterly winds and above normal tides.[136]

The dominant direction of littoral drift over the entire coast is westerly, although sediment moves only short distances. Most deposition takes the form of beaches, baymouth bars, and spits, often associated with the formation of marshes inland of the deposits.[137]

Erosion, more than flooding, appears to be the major hazard along the Northumberland coast, although flooding can occur during severe storms. Such a storm occurred in October 1974, and several cottages were washed from their foundations.[138]

Human Encroachment onto the Northumberland Coast

Historically, the major activities along the Northumberland coast of Nova Scotia have been agriculture and fishing, with settlement concentrated mainly in small villages.[139] The fine beaches and warm water of the Northumberland Strait attracted

135. Ibid., p. 37.
136. Ibid., p. 38.
137. Ibid., p. 40.
138. Personal Communication from Mr. J.S. Mactavish, Nova Scotia Department of the Environment, Halifax, March 26, 1975.
139. L.A. Gosselin, op. cit., p. 2.

some early cottage development in the Tidnish, Heather Beach, and Melmerby Beach areas. This development was not extensive, and by 1939, there were only about 300 cottages along the entire coast.[140]

Since 1945, however, cottage development has been rapid in many areas along the coast. By 1954, there were about 1,200 cottages in a linear, dispersed pattern along much of the shoreline west of New Glasgow.[141] In 1971, there were an estimated 2,400 cottages along the Northumberland coast of Nova Scotia, again, mostly in the New Glasgow area and west.

The distribution of vacation homes in relation to erosion hazard is shown on Figure 26.

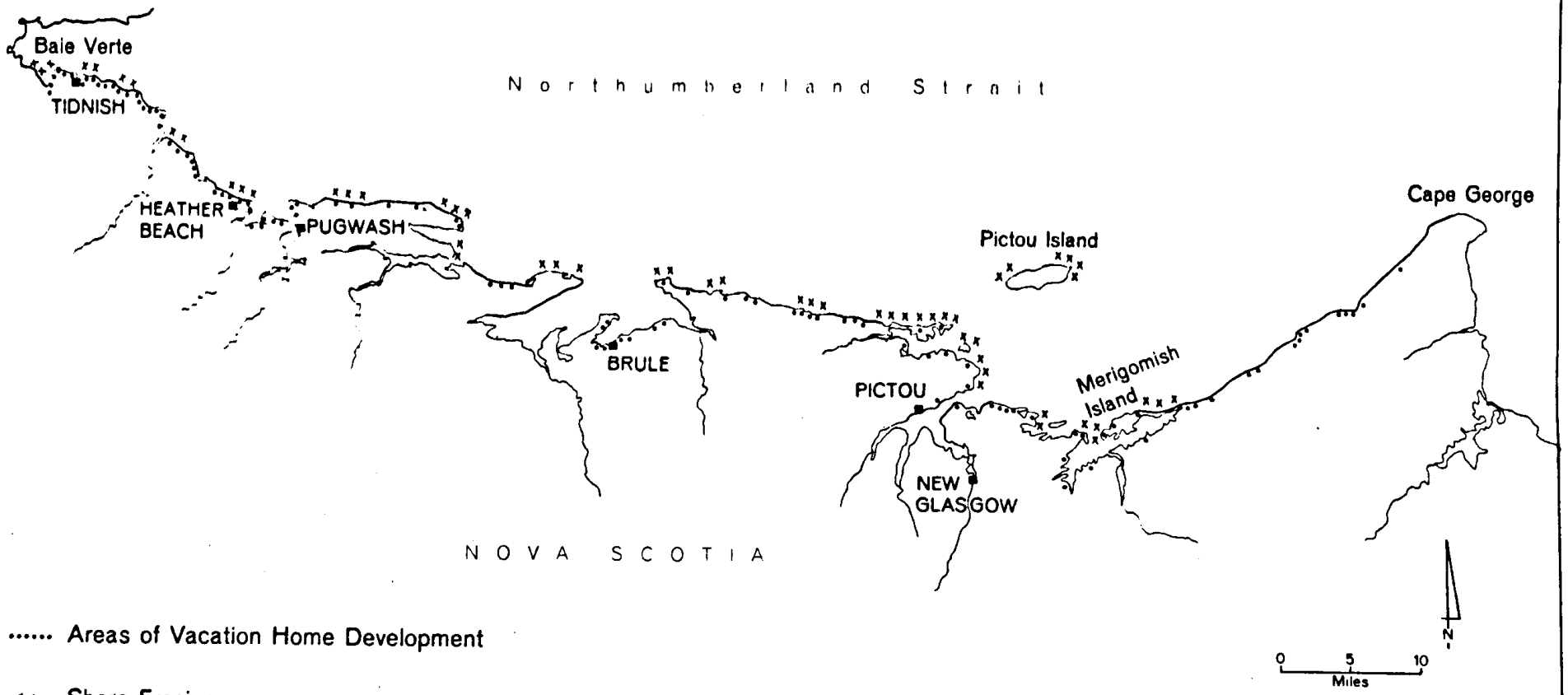
Adjustments to Hazards on the Northumberland Coast

Little information is available on the nature and extent of adjustments to flood and erosion hazards on the Northumberland coast. Apparently, most adjustments have been private. Some cottagers have relocated their buildings further back on their lots.[142] Other cottagers, particularly in the older cottage areas such as Tidnish and Brule, have constructed seawalls and groynes in an attempt to protect their properties. As well, some roads have been relocated as a result of receding shorelines.[143]

The provincial Department of Highways has been involved in

140. Ibid., p. 43.
141. Ibid., p. 43.
142. Ibid., p. 44.
143. Ibid., p. 44.

Figure 26 Erosion Hazard and Vacation Homes on the Northumberland Coast



Source: L A Gosselin, *An Air Photo Interpretation of Geomorphic Features and Cultural Land Use Patterns along Nova Scotia's North Shore*, Environment Canada, 1972.

some shoreline protection and road repairs on the Northumberland coast. The October 1974 storm, for example, eroded away part of the sandbar and road leading to Merigomish Island, necessitating emergency road repairs.[144] A wooden seawall and groynes built to protect this road have not been entirely effective.[145]

Cottagers are not eligible for either financial assistance for the construction of shore protective works, or for disaster relief and compensation administered by the provincial Department of Finance. Technical assistance is available to cottagers from the provincial Department of the Environment in the form of information on tides, soil conditions, and construction methods.[146]

In Nova Scotia, cottage development can be controlled by municipalities through the use of zoning bylaws. The provincial Department of Municipal Affairs can also exercise some control through subdivision regulations.[147]

Interpretations

Interest in marine coastal environments by the federal government, and particularly the Department of the Environment, has increased significantly in recent years.[148] Given the

144. Halifax Chronicle-Herald, October 23, 1974.
145. L.A. Gosselin, op. cit., p. 60.
146. Personal Communication from Mr. J.S. Mactavish, Nova Scotia Department of the Environment, Halifax, March 26, 1975.
147. Town Planning Act, R.S.N.S. 1967, c. 308.
148. See, for example, Canada Department of the Environment, Coastal Zone Activities of the Department of the Environment, Ottawa, 1972.

little information available, however, it is apparent that the federal government has been much less involved in flood and erosion hazards on the Northumberland coast than in either the St. Lawrence River valley or on the north Erie lakeshore. The Department of the Environment did fund the study of geomorphic features and cultural land use patterns on Nova Scotia's north shore that has provided most of the information for this case study.

Available information suggests that cottage development is increasing along much of the Northumberland coast, and at a rapid rate in some areas. Moreover, cottagers appear to place more importance on coastal frontage than on the presence of a high quality beach.[149] As a result, a linear pattern of cottage development has taken place along the Northumberland coast, and this trend is likely to continue. Most coastal areas, regardless of their suitability for development, particularly with respect to flood and erosion hazards, will be under considerable pressure to satisfy the demand for more coastal cottage lots. In the absence of any restrictions, more tidal marshes could be filled to help satisfy this demand. Several studies demonstrate that this has been the case along the Atlantic coast in the United States, where cottage development has expanded onto barrier bars, bluffs, and marshes.[150] This

149. L.A. Gosselin, op. cit., p. 43.
150. See, for example, Ian Burton, Robert Kates, and Rodman Snead, The Human Ecology of Coastal Flood Hazard in Megalopolis, Chicago: University of Chicago, Department of Geography, 1969, p. 175.

suggests the need for serious consideration of land use zoning, building regulations, land fill control, and subdivision regulations.

Recent research on coastal erosion on the United States Atlantic coast may raise several important implications for the nature and extent of adjustments along the Northumberland coast. Coastal occupants are less well informed about the coastal erosion hazard than the coastal flood hazard.[151] This is no doubt due, in part, to the fact that erosion is continuous and less spectacular than flooding associated with severe coastal storms. As well, coastal occupants perceive a narrow range of adjustments to erosion, with some emphasis on structural shore protection.[152]

If, in fact, occupants on Nova Scotia's Northumberland coast have a similar perception of the erosion hazard and possible adjustments, every effort should be made to educate coastal occupants about the nature of the hazard, the level of risk involved, and appropriate means available to cottagers and other coastal occupants of reducing hazard damages. In this regard, several studies have stressed the need for detailed hazard mapping of coastal areas.[153]

151. James K. Mitchell, Community Response to Coastal Erosion, Chicago: University of Chicago, Department of Geography, 1974, p. 101.
152. Ibid., p. 124.
153. See, for example, Donald A. Crane, Coastal Flooding in Barnstable County, Cape Cod, Massachusetts, Boston: Massachusetts Water Resources Commission, 1963.

It is apparent from research on coastal hazards in the United States that man's understanding of natural processes is inadequate. It has been suggested that knowledge of littoral drift and the impact of storm surges are two areas requiring further research.[154] It has also been suggested there is an urgent need for research on the human process of encroachment onto coastal hazard areas.[155] In this regard, Gosselin's study of the Northumberland coast is significant in that it provides preliminary information on the historical development of cottaging and other land uses in relation to erosion hazard.

154. Ian Burton, Robert Kates, and Rodman Snead, op. cit., p. 178.
155. Ian Burton and Robert Kates, "The Floodplain and the Seashore", Geographical Review, 54(3), 1964, p. 385.

Policy Implications

A number of individual and collective, or government, flood and erosion hazard adjustments have been used on the north Erie lakeshore, along the St. Lawrence River, on the Northumberland coast, and throughout Canada. It is possible, based on evidence available for the case study areas and elsewhere, to discuss some of the implications of various adjustments.

For each adjustment, it is possible to pose several questions. Does the adjustment reduce flood and erosion damages? Does the adjustment encourage continued occupance of hazard lands? Do individuals or the general public bear most of the economic costs of the adjustment? Is the adjustment politically acceptable? Are environmental costs associated with the adjustment?

The policy implications of selected flood and erosion hazard adjustments are summarized on Figure 27.

Flood and Erosion Protective Works

Protective works have been the most widespread type of adjustment. In most provinces, cottagers have not been eligible for direct government assistance for protective works. Many cottagers have made large personal expenditures on a variety of protective works, often with little long term success. In Ontario, cottagers now have access to provincial funds under

Figure 27
Policy Implications of Selected Flood and Erosion Hazard Adjustments

Adjustment	are flood and erosion damages reduced?	is continued occupance of hazard land encouraged?	do individuals bear most economic costs?	does the general public bear most economic costs?	is adjustment politically acceptable?	are there environmental costs?
protective works(individual)	variable	yes	yes	no	yes	variable
protective works(government)	variable	yes	no	yes	yes	variable
disaster relief, compensation	no	yes	no	yes	yes	variable
emergency measures, flood forecasting	yes	yes	variable	variable	yes	variable
hazard mapping, public education	yes	no	no	yes	variable	no
hazard zoning, development control	yes	no	variable	variable	variable	no
flood proofing	yes	yes	yes	no	variable	variable
relocation	yes	no	yes	no	no	no
subsidized relocation	yes	no	no	yes	no	no
government land acquisition	yes	no	no	yes	no	no
subsidized flood insurance	no	variable	variable	variable	variable	variable
do nothing	no	yes	yes	no	no	variable

the Shoreline Property Assistance Act of 1973 in the form of loans for the repair and reconstruction of buildings and the construction of shoreline protective works. In the absence of guidelines, however, there is no guarantee that these funds will be expended effectively either from the standpoint of the cottagers or the Ontario taxpayers who are subsidizing the loan system. This type of assistance should be related to hazard risks, possible public purchase of hazard land for recreation or conservation use, environmental considerations, and other factors, before it is provided by government.

On the north Erie lakeshore, along the St. Lawrence River, and in other parts of Canada, such as the Qu'Appelle basin, large scale public expenditures for flood and erosion control have benefited some cottagers, although these expenditures usually have provided greatest benefits for agricultural or urban land uses.

Protective works, whether individual or government, encourage continued occupance of hazard lands. Moreover, protection may create a false sense of security and cause further encroachment onto hazardous areas. Events such as the May 1974 flood on the Grand River in Ontario indicate, however, that control works alone are seldom able to provide complete protection.[156]

The economic, social, and environmental costs of flood

156. Royal Commission Inquiry into the Grand River Flood 1974, Report, Toronto: Ontario Ministry of the Attorney General, 1975.

and erosion protective works can be substantial, particularly in large scale government projects. Senior levels of government are increasingly being called upon to provide higher proportions of assistance for control works, which often benefit relatively few individuals. Generally, detailed benefit-cost analyses or environmental impact statements have not been carried out in conjunction with proposed works, and few guidelines have been attached to the use of substantial senior government assistance.[157]

A variety of environmental costs can be associated with flood and erosion control works. These include reduction of wetland areas with resulting destruction of fish spawning areas and wildlife habitat, destruction of beach and dune areas, alteration of shoreline processes including changes in patterns of erosion and deposition, and aesthetic changes.

Conflicts can often arise from both the construction and operation of flood and erosion control works. The protection of agricultural land from flooding, for example, has in many instances greatly reduced wetland areas. In Nova Scotia, over 44,000 acres of former marsh land have been protected from flooding under the Maritime Marshland Rehabilitation program, leaving an estimated 24,500 acres of salt marsh in the province.[158] As another example, the operation of reservoirs

157. J.G. Nelson, J.G. Battin, R.A. Beatty, and R.D. Kreutzwiser, op. cit., pp. 56-58.
158. Nova Scotia Department of Lands and Forests.

for recreational or hydro power use can lead to large scale downstream flooding.[159]

Experience on the north Erie lakeshore and elsewhere indicates that guidelines are necessary for massive senior government funding of protective works. Provision must be made for procedures to help ensure that economic, social, and environmental costs are minimal and that individual benefits are widely rather than narrowly distributed. As well, provision should be made for all affected individuals and agencies to express their views concerning large scale projects. Benefit-cost analysis, environmental impact statements, and public hearings are possible procedures. In this regard, the Ontario government is in the process of introducing legislation providing for environmental impact statements on provincial projects.[160] Other procedures are possible as well. In Saskatchewan, for example, a wetlands committee must approve all flood control projects constructed under the Conservation and Development Act.[161] There is provision for public hearings when contentious issues are involved.

Disaster Relief and Compensation

Disaster relief and compensation have also been widely

159. James S. Gardner, "Beyond the Impact Statement: A Discussion of the Dynamics of Environmental Impact", Geographical Inter-University Resource Management Seminar, 3, 1972-73, pp. 154-166.
160. London Free Press, March 25, 1975.
161. Personal Communication from Mr. J.E. Dehm, Saskatchewan Department of Agriculture, Regina, April 1, 1975.

used as adjustments to flood and erosion hazards in Canada. With few exceptions, however, cottagers have not been eligible for compensation. Most provinces follow federal guidelines which specifically exclude cottagers.

Disaster relief and compensation tend to encourage continued occupance of hazard lands at public expense. Developers and municipalities who indiscriminantly or deliberately encourage encroachment onto hazard lands often do so on the expectation that disaster relief and compensation will be provided if damage occurs. They ask the general public to pay the external costs of their decisions.

Any proposed increase in relief and compensation funding should be treated with great caution and only approved after due consideration of the nature and distribution of economic, social, and environmental consequences. These remarks extend to any possible changes in the present federal $1.00 per capita compensation formula. So long as there is a tendency to spread the costs of hazard zone encroachment among all Canadians, less effort will be directed toward achieving more appropriate use of hazard lands. Municipalities will only realize the magnitude of the costs if they have to bear a substantial proportion of them.

There is some potential for the use of compensation as a tool for encouraging relocation of structures, flood proofing, and other adjustments which help to reduce damages. Federal and provincial governments, however, have not pursued this

possibility to any extent. As a result, in most instances, disaster relief and compensation tend to encourage the rebuilding of structures in the same hazardous areas.

Emergency Measures and Flood Forecasting

Emergency measures and flood forecasting are relatively recent innovations in Canada, prompted in part by major floods on the Fraser River in 1948 and the Red River in 1950, and by the Hurricane Hazel floods in Ontario in 1954. Emergency measures depend on an adequate system of flood forecasting and warning. Although these adjustments also tend to encourage continued occupance of hazard lands, they can reduce damages at relatively little cost. They do not, however, represent an effective long term solution to the hazard problem.

Hazard Mapping and Public Education

Hazard mapping and public education are among the less favoured adjustments to flood and erosion hazards in Canada. These adjustments serve to increase public awareness of hazards and encourage wiser use of hazard lands. As well, hazard mapping provides a necessary base for effective zoning of hazard lands. Several provinces and the federal government have recently become involved in detailed hazard mapping in some urbanized river valleys. These programs should be continued and expanded to other hazard lands, such as marine coasts and lakeshores. The federal government proposes to define and map selected flood-prone areas in Canada and to refuse disaster relief and compensation for further development in those areas

where the public has been made fully aware of the hazard.[162]

Hazard Zoning and Development Control

The significance of flood and erosion hazards in relation to vacation home development varies considerably throughout Canada. This is due, in part, to the varying physical nature of flood and erosion hazards from place to place. It is also due to the extent of human encroachment onto hazard prone coastal, river valley, and lakeshore areas. Until recently, subdivision approval procedures were not well developed or extensively exercised in most provinces. In the absence of strong provincial leadership, most municipalities, particularly those in rural areas, have been reluctant to take a firm position on zoning of hazard lands.

The implications are clear. Undeveloped areas must be protected from uncontrolled vacation home development. Hazard zoning, subdivision regulation, and development control are measures available for reducing flood and erosion damages by carefully regulating development in hazardous areas. These measures require hazard mapping as a basis for decisions as to what type of development should be permitted where. The hazard mapping will, however, involve difficult decisions about the degree of risk or the probability of hazard occurrence that is acceptable for development. These decisions should involve both professional and lay judgement and should be based,

162. London Free Press, April 22, 1975.

therefore, on considerable public participation.

In areas extensively developed in vacation homes, such as the north Erie lakeshore, zoning can be used as a means of reducing future damages. Non-conforming uses may exist for some time, and some individual costs such as reduced property values may be incurred. These costs must be weighed against the costs of damages to the individual and of relief and compensation from the general public.

In areas such as the St. Lawrence River valley, where senior governments are committed to shore protection, zoning can reduce the magnitude of future commitments.

Several recent reports, notably that of the International Great Lakes Levels Board, have urged that zoning be used much more extensively as an adjustment to flood and erosion hazards.

Other Adjustments

A number of other adjustments, including flood proofing, relocation, government land acquisition, and flood insurance, have been used very little or not at all in Canada.

While flood proofing tends to encourage continued occupance of hazard lands, it can reduce damage. Moreover, the costs of flood proofing are borne by the hazard land occupant and not the general public. Associated with flood proofing are building design, elevation of buildings on pilings, and land filling. These adjustments have been adopted by some cottagers, although government policy, with few exceptions, has not encouraged flood proofing and related adjustments. The

British Columbia Department of Lands, Forests, and Water Resources can require flood proofing as a condition for the granting of approval of subdivisions on flood plains.[163] Land filling has been required by health authorities in Ontario in some instances to ensure proper functioning of septic tank systems. Land filling, however, often reduces valuable wetland areas. Continued cottage development on the Northumberland coast, for example, could result in further destruction of wetlands.

Relocation is a neglected adjustment to flood and erosion hazards in Canada. It has been recommended on occasion for areas along the north Erie lakeshore. The Haldimand-Norfolk Joint Study Committee, for example, recommended subsidized relocation and removal of 2,500 cottages along the Erie shore in the two counties.[164] It was suggested that the costs of relocation and removal might compare favourably with the costs of servicing and erosion protection. Despite its potential for encouraging more appropriate use of hazard lands, relocation does not appear to have been seriously considered as government policy in Canada.[165]

Government land acquisition has been adopted in some areas,

163. Personal Communication from Mr. J.D. Watts, British Columbia Department of Lands, Forests, and Water Resources, Victoria, March 10, 1975.
164. The Haldimand-Norfolk Joint Study Committee, op. cit.
165. The federal government relocated several homes near Sept-Isle on the St. Lawrence River. It was found that relocation was less expensive than shore protection. See Task Force on Available Shore Erosion Information, op. cit., Part 3, Shore Erosion on the St. Lawrence System, p. 37.

including several areas along the north Erie lakeshore, as an adjustment to flood and erosion hazards and a means of expanding public recreational access to shoreline areas.

Flood and erosion insurance is virtually unavailable in Canada. Private insurers have been reluctant to become involved in such an undertaking, and the federal and provincial governments have given insurance little consideration. The American experience suggests that flood insurance may have to be heavily subsidized by the government. The federal government in the United States is using flood insurance as a means of gaining the cooperation of local authorities in zoning flood plain areas to reduce future damages. Municipalities must enact flood plain regulations to become eligible for coverage under the subsidized scheme. Any persons in hazardous areas who not not purchase insurance will be denied disaster relief and other federal assistance following flooding in future.[166] As municipalities have until July 1, 1975 to enter the Flood Insurance Program, it is too early to assess what impact the program will have. It is intended that the insurance program will eventually replace federal flood disaster relief.

166. United States Department of Housing and Urban Development, National Flood Insurance Program, Washington, D.C., January 1974.

Summary

As a first objective of this paper, an attempt was made to provide an overview of the nature of vacation home occupance of flood and erosion hazard land in Canada and the nature of federal and provincial adjustments for dealing with flood and erosion hazards. Very little information exists on vacation homes in relation to flood and erosion hazards. In terms of adjustments adopted, it appears that emphasis has been largely on modifying the hazard by protective works, spreading the loss through public disaster relief and compensation, and individual loss bearing. For cottagers, the options have essentially been individual loss bearing and protective works.

As a second objective, flood and erosion hazards and hazard adjustments were considered in some detail in case studies of the north Erie lakeshore, the St. Lawrence River valley, and the Northumberland coast. A number of conclusions were drawn, including the need for a better understanding of both natural and human elements and processes at work along the shore.

As a final objective, a number of flood and erosion hazard adjustments were considered in terms of their implications for public policy.

Vacation home development has occurred in many parts of Canada in the almost total absence of any consideration of

other major floods in Canada as they occur. The use of a consistent format and a framework for estimating costs and benefits similar to the one developed for the New Brunswick report would provide useful comparisons.

The Geographical Papers and Occasional Papers of the Lands Directorate of the federal Department of the Environment provide a medium for the comprehensive consideration of the relation between vacation home development and environmental hazards, both natural and man-made. In this respect, the present study represents a preliminary attempt to consider the vacation home occupance of flood and erosion hazard land in Canada.

In conclusion, it is stressed that this preliminary study should be followed up with a variety of other research projects. One important need is for detailed studies of the history and effectiveness of hazard adjustments in various areas known to have a high hazard risk, such as the Grand River in Ontario, the south Lake Winnipeg shore, and the Northumberland Strait coast. These studies should included details on the various types of land use which have been allowed to develop, the physical nature of the hazard, and a description and evaluation of the effectiveness of structural and other adjustments used in these areas. This Hazards Review Series would provide useful educational information for local citizens as well as setting the stage for improved general understanding of human adjustments to flood and erosion hazards throughout Canada.

These studies will necessarily consider the more well known flood and erosion hazard areas. But the exact nature of flooding and erosion varies from area to area, so that detailed studies of particular areas would be very instructive from both the academic and the practical standpoints. Furthermore, other natural and man-made hazards deserve careful study, as do the often complex relations between the two. One example that is familar and significant to the authors is changing water quality in Lake Erie.

It must be stressed that hazard studies can be effectively understood if analyzed in a human ecological context. This context or approach involves understanding the basic natural elements and processes at work in the local or regional system under study and also the human processes at work in the system. Some of the significant human processes are technology, government policies, legal and institutional arrangements, industrialization, and cottaging, all of which are changing significantly not only in areas such as the north Erie lakeshore and the Northumberland coast, but throughout much of Canada. Without a detailed understanding of the type that is provided through a human ecological approach, a full understanding of the implications of policy proposals for the future is not possible.

Bibliography

Selected References on Flood and Erosion Hazards

Burton, Ian, and Robert Kates, "The Floodplain and the Seashore", Geographical Review, 54(3), 1964, pp. 366-385.

_____, "The Perception of Natural Hazards in Resource Management", Natural Resources Journal, 3(2), 1964, pp. 412-441.

_____, and Rodman Snead, The Human Ecology of Coastal Flood Hazard in Megalopolis, Chicago: University of Chicago, Department of Geography, 1969.

_____, and Gilbert F. White, The Human Ecology of Extreme Geophysical Events, Toronto: University of Toronto, Department of Geography, 1968.

Goddard, James E., "Flood-plain Management must be Ecologically Sound", Civil Engineering, 41, 1971, pp. 81-85.

Great Lakes Basin Commission, Proceedings of the Recession Rate Workshop, Ann Arbor: Great Lakes Basin Commission, 1975.

Hoyt, W.G., and W.B. Langbein, Floods, Princeton: Princeton University Press, 1955.

Levin, T.H., "The National Flood Insurance Program, A New Element in Water Resource Management", Water Resources Bulletin, 6, 1970, pp. 120-125.

Mitchell, James K., Community Response to Coastal Erosion, Chicago: University of Chicago, Department of Geography, 1974.

_____, "Natural Hazards Research", in Ian R. Manners and Marvin W. Mikesell, eds., Perspectives on Environment, Washington, D.C.: Association of American Geographers, 1974, pp. 311-341.

Murphy, Francis C., Regulating Flood-Plain Development, Chicago: University of Chicago, Department of Geography, 1958.

Phippen, George R., "A New Course to Ararat", Water Spectrum, 3(2), 1971, pp. 8-15.

United States Army Coastal Engineering Research Center, Shore Protection Manual, Washington, D.C.: U.S. Government Printing Office, 1973.

United States Army Corps of Engineers, Flood Plain--Handle with Care, Washington, D.C., 1974.

_____, Report on the National Shoreline Study, Washington, D.C., 1971.

_____, Shore Management Guidelines, Washington, D.C., 1971.

_____, Shore Protection Guidelines, Washington, D.C., 1971.

United States Department of Housing and Urban Development, National Flood Insurance Program, Washington, D.C., January 1974.

White, Gilbert F., Choice of Adjustment to Floods, Chicago: University of Chicago, Department of Geography, 1964.

_____, Human Adjustment to Floods, Chicago: University of Chicago, Department of Geography, 1945.

_____, ed., Natural Hazards Local, National, Global, New York: Oxford University Press, 1974.

_____, Strategies of American Water Management, Ann Arbor: University of Michigan Press, 1969.

_____, "The Choice of Use in Resource Management", Natural Resources Journal, 1(1), 1961, pp. 23-40.

_____, et al, Changes in Urban Occupance of Flood Plains in the United States, Chicago: University of Chicago, Department of Geography, 1958.

Wolman, M.G., "Evaluating Alternative Techniques of Floodplain Mapping", Water Resources Research, 7, 1971, pp. 1383-1391.

References on Flood and Erosion Hazards in Canada

Alberta Disaster Services, Operation Wetfoot '74 Report, Edmonton, October 1974.

Bureau de la Statistique du Quebec, Les Inondations au Quebec en 1971, Quebec, 1972.

Burton, Ian, "Flood-Damage Reduction in Canada", Geographical Bulletin, 7(3-4), 1965, pp. 161-185.

_____, "Investment Choices in Public Resource Development", in J.G. Nelson and M.J. Chambers, eds., Water, Toronto: Methuen, 1969, pp. 295-316.

Canada-British Columbia Consultative Board, Summary Report of the Consultative Board, 1974.

Canada Centre for Inland Waters, Great Lakes Shore Erosion Studies, Burlington: Canada Centre for Inland Waters, 1973.

Canada Department of Energy, Mines and Resources, High Water on Lake Winnipeg, Ottawa: Information Canada, 1971.

Canada Department of Northern Affairs and National Resources, Flood of June 1953 in the South Saskatchewan River Basin, Ottawa, no date.

Canada Department of the Environment, Flood of May-June 1972 in British Columbia, Vancouver, 1973.

Canada Department of Transport, Basic Data Inventory Shore Property Investigation St. Lawrence River Montreal to Trois-Rivieres, Montreal, 1968.

Coakley, J.P., and H.K. Cho, "Shore Erosion in Western Lake Erie", Proceedings, 15th Conference on Great Lakes Research, 1972, pp. 344-360.

Coakley, J.P., W. Haras and N. Freeman, "The Effect of Storm Surge on Beach Erosion, Point Pelee", Proceedings, 16th Conference on Great Lakes Research, 1973, pp. 377-389.

Collier, E.P., and G.A. Nix, Flood Frequency Analysis for the New Brunswick-Gaspe Region, Ottawa: Canada Department of Energy, Mines and Resources, 1967.

Coulson, A., Estimating Runoff in Southern Ontario, Ottawa: Canada Department of Energy, Mines and Resources, 1967.

_____, Flood Frequencies of Nova Scotia Streams, Ottawa: Canada Department of Energy, Mines and Resources, 1967.

Crysler & Lathem Limited, Rondeau Provincial Park Shoreline Erosion Study-Phase 3, for Ontario Ministry of Natural Resources, Willowdale, 1974.

Daigneault, R., Erosion at Point Pelee National Park A Case History, Parks Canada, mimeo, 1973.

Environment Canada, Annual Report 1973-1974, Ottawa: Information Canada, 1974.

_____, New Brunswick Flood, April-May 1973, Halifax: Environment Canada, 1974.

_____, Report by Canada to the International Commission on Irrigation and Drainage for the Proposed Publication "Flood Control-A Global Review", Ottawa, 1972.

_____, The Canada Water Act Annual Report 1973-1974, Ottawa: Information Canada, 1974.

_____, What You Always Wanted to Know About Great Lakes Levels, Ottawa, no date.

Erb, J.H., "Tsunami Warning in British Columbia", EMO National Digest, 12(1), 1972, pp. 1-3.

Evans, Douglas B, Local Perception of Shoreline Erosion Between Port Stanley and Port Bruce, Ontario, B.A. thesis, University of Western Ontario, 1969.

Fraser River Control Program, Information Guide, Victoria, 1968.

Fumalle, M.J., Estimated Damage Around Okanagan Lake During the 1972 Flood, Penticton: Okanagan Study Committee, 1973.

_____, Socio-Economic Damage Evaluation of the Osoyoos Lake Flood, Spring 1972 in Canada, Penticton: Okanagan Study Committee, 1973.

Galay, V.J., "The Importance of Shoreline Processes in the Management of Shorelines for Inland Basins", The Allocative Conflicts in Water-Resource Management, Winnipeg: Agassiz Centre for Water Studies, 1974, pp. 405-422.

Gelinas, P.J., and R.M. Quigley, "The Influence of Geology on Erosion Rates along the North Shore of Lake Erie", Proceedings, 16th Conference on Great Lakes Research, 1973, pp. 421-430.

Gosselin, L.A., An Air Photo Interpretation of Geomorphic Features and Cultural Land Use Patterns along Nova Scotia's North Shore, Environment Canada, 1972.

Governments of Canada and Ontario Joint Task Force on Water Conservation Projects in Southern Ontario, Guidelines for Analysis Streamflows, Flood Damages, Secondary Flood Control Benefits, August 1968.

Haldimand-Norfolk Joint Study Committee, A Lakeshore Study of Haldimand and Norfolk Counties, 1974.

International Champlain-Richelieu Engineering Board, Regulation of Lake Champlain, Final Report to the International Joint Commission, September 1974.

International Great Lakes Levels Board, Regulation of Great Lakes Water Levels, Report to the International Joint Commission, December 7, 1973.

Jackson, C.I., and J.W. Maxwell, Landowners and Land Use in the Tantramar Area, New Brunswick, Ottawa: Information Canada, 1971.

Kindle, E.M., Erosion and Sedimentation at Point Pelee, Ontario Department of Mines Annual Report, Toronto: King's Printer, 1933.

Kite, G.W., Flood Frequency and Risk, Ottawa: Environment Canada, 1974.

_____, Hydrological Forecasting in the Water Resources Branch, Ottawa: Environment Canada, 1974.

Lake Erie Task Force, Lake Erie Shoreline Inventory and Land Use, Ottawa: Canada Department of Public Works, 1969.

Manitoba Department of Mines, Resources, and Environmental Management, Flood Control, Winnipeg, 1974.

Nelson, J.G., J.G. Battin, R.A. Beatty, and R.D. Kreutzwiser, "The Fall 1972 Lake Erie Floods and Their Significance to Resources Management", Canadian Geographer, 19(1), 1975, pp. 35-59.

Ontario Ministry of Natural Resources, Environmental Protection Areas, Toronto, 1973.

Packer, R.W., "Non Linearity in Coastal Geomorphic Processes", in E. Yatsu, et al, eds., Research Methods in Geomorphology, Don Mills: Science Research Associates, 1971, pp. 117-126.

Qu'Appelle Basin Study Board, Report, Regina, 1972.

Richards, T.L., and D.W. Phillips, Synthesized Winds and Wave Heights for the Great Lakes, Toronto: Canada Department of Transport, 1970.

Royal Commission Inquiry into the Grand River Flood 1974, Report, Toronto: Ontario Ministry of the Attorney General, 1975.

Saskatchewan Water Resources Commission, Annual Report, year ending March 31, 1972, Regina, 1972.

Select Committee of the Ontario Legislature on Lake Levels of the Great Lakes, Report, Toronto: Queen's Printer, 1953.

Sewell, W.R. Derrick, Water Management and Floods in the Fraser River Basin, Chicago: University of Chicago, Department of Geography, 1965.

Task Force on Available Shore Erosion Information, Shore Erosion Information on the Great Lakes-St. Lawrence System, Ottawa, 1973.

The Saint John River Basin Board, Floods in the Saint John River Basin, Fredericton, 1972.

University of Western Ontario, The Erie Shoreline Study, London, September 1971.

Visvader, Hazel, and Ian Burton, "Natural Hazards and Hazard Policy in Canada and the United States", in Gilbert F. White, ed., Natural Hazards Local, National, Global, New York: Oxford University Press, 1974, pp. 219-231.

Werner, L.A., Flood of June 1964 in the Oldman and Milk River Basins, Alberta, Ottawa: Information Canada, 1973.

Wood, H.A., Erosion of the Shore of Lake Erie, Point-Aux-Pins to Long Point, M.A. thesis, McMaster University, 1951.

Zimmer, Bruce Edward, A Study of Bluff Erosion as Investigated at a Geomorphological Field Station Near Port Bruce, Ontario, B.A. thesis, University of Western Ontario, 1965.

Selected References on Cottages and Shoreline Planning and Management in Canada

Albert, Joan E., and Peter Harrison, Jurisdictional Problems of New Brunswick Coastal Zone, Ottawa: University of Ottawa, 1974.

Baker, W.M., The Nature and Extent of Vacation Home Data Sources and Research in Canada, Ottawa: Statistics Canada, no date.

Barker, Mary L., Water Resources and Related Land Uses Strait of Georgia-Puget Sound Basin, Ottawa: Information Canada, 1974.

Campbell, C.K., An Analysis of Shoreland Use and Capability for Cottaging in the Georgia Lowland of B.C. in Relation to the Canada Land Inventory, 1967.

Canada Department of Regional Economic Expansion, Land Capability Classification for Outdoor Recreation, Ottawa, 1969.

Canada Department of the Environment, Coastal Zone Activities of the Department of the Environment, Ottawa, 1972.

Canada-Ontario Rideau-Trent-Severn Study Committee, The Rideau Trent Severn, 1971.

Environment Canada, Coastal Zone, Volume 1, Selected Background Papers, Ottawa, 1972.

_____, Shoreland: Its Use, Ownership, Access and Management, Ottawa, 1972.

Hill, P., The Northeast Shore of Lake Erie: Physical Features and Recreation, M.A. thesis, McMaster University, 1964.

Jaakson, R., Lakeshore Recreation Planning for Cottage Development, M.Sc. thesis, University of Toronto, 1968.

_____, "Planning for the Capacity of Lakes to Accommodate Water Oriented Recreation", Plan Canada, 10(3), 1970, pp. 29-40.

Jackson, J.N., Recreational Development and the Lake Erie Shore, Niagara Regional Development Council, no date.

Manitoba Department of Urban Development and Municipal Affairs, Shoreland Recreation An Environmental Approach, Winnipeg, 1971.

Ontario Department of Municipal Affairs, Lakeshore Capacity--Inland Lakes of Ontario, Toronto, 1971.

Ontario Ministry of Natural Resources, Lakealert, Phase 2, Methodology, Toronto, 1972.

Redpath, D.K., Policy Implications for Shoreland Recreation: A Pilot Study in New Brunswick and Nova Scotia, M.A. thesis, University of Waterloo, 1971.