

Addressing Sea-Level Rise and Storm Events as a Priority Coastal Issue in Nova Scotia

The May 2008 edition of the *Marine Affairs Policy Forum* highlighted some of the substantive and procedural elements affecting the success of Nova Scotia's long-awaited coastal management effort and the proposed Sustainable Coastal Development Strategy (SCDS). Six priority coastal issues were identified by the province to be addressed, namely sea-level rise and storm events, coastal access, working waterfronts, water quality, sensitive ecosystems and habitats, and coastal development.

This edition of the *Marine Affairs Policy Forum* focuses on the priority issue of sea-level rise and storms events and serves as the launching of a coastal priority issues "six-pack". The goal of this series is to provide an overview of some of the key factors and policy implications for effective management of coastal issues in Nova Scotia. Although each edition of the "six pack" will focus on a specifically identified priority issue, linkages between the priority issues will be highlighted to demonstrate the interconnectedness among them.

Introduction

Each year, coastal areas of the Atlantic Provinces are affected by powerful winter storms and tropical cyclones. These storms often generate dangerous storm-surges that cause severe coastal erosion and flooding. In 2003, Hurricane Juan made landfall in Nova Scotia, resulting in eight deaths and causing over \$200 million in damages in Nova Scotia and Prince Edward Island (Figure 1). Climate change and accelerated sea-level rise are expected to increase the frequency and intensity of coastal hazards in Nova Scotia. At the same time, continued development of the province's coastal areas is placing more people, property and infrastructure at risk from these coastal hazards.

Where is Nova Scotia most vulnerable to sea-level rise and storm events?

An assessment by Natural Resources Canada concluded that much of the Maritime Provinces, particularly the Atlantic coast of Nova Scotia, is highly sensitive to the impacts of sea-level rise (Figure 2). This has the potential to have widespread and severe impacts on Nova Scotia's coastal areas. After all, Nova Scotia is practically an island with over 6,000 km of coastline along the Bay of Fundy, Atlantic Ocean and the Gulf of St. Lawrence and as such, is well exposed and inherently vulnerable to coastal hazards. However, as illustrated in Figure 2, this vulnerability is not uniform throughout the province due to variations in the biophysical characteristics and human settlement patterns along the coast.



Figure 1. Hurricane Juan track and damage based on visual observations. Source: Nova Scotia Department of Natural Resources

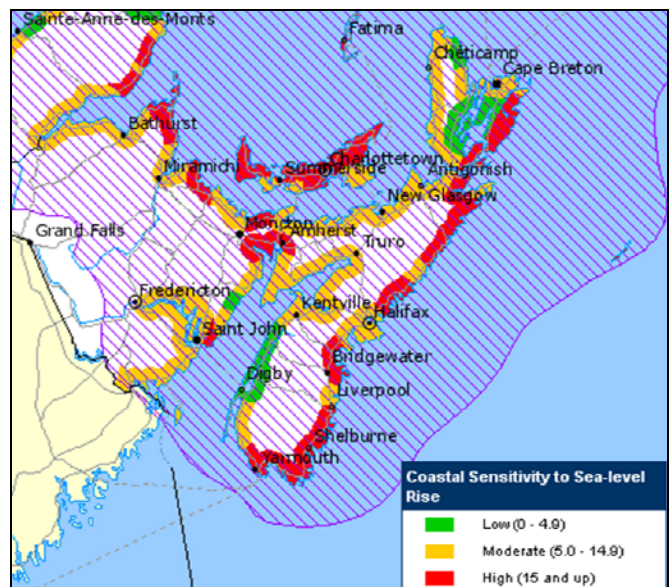


Figure 2. Sensitivity of Nova Scotia's coast to impacts from sea-level rise. Source: Natural Resources Canada

For example, the Halifax peninsula is comprised of rock types that are resistant to erosion, but the area has the highest coastal population density and the greatest concentration of homes, buildings and infrastructure in the province. In contrast, coastal areas along the Bay of Fundy and Northumberland Strait are dominated by rock types more prone to erosion, but the coastal population density and level of development is lower in these areas than in the Halifax Regional Municipality.

It is clear that the issue of sea-level rise and storm events will affect most coastal areas of the province in the future, but what is less certain is the extent to which the impacts of this issue

will extend inland from the shoreline. Today, the impacts of coastal hazards are generally confined to coastal lands adjacent to the shoreline and as one moves further inland, the number of people and amount of property vulnerable to coastal hazards decrease substantially. However, scientific predictions of the rate of sea-level rise over the next century are highly uncertain and range from 40 centimetres to 1.2 metres in the vicinity of Halifax. Even the Intergovernmental Panel on Climate Change (IPCC) hesitate to set an upper limit to these estimates and some researchers fear a five to seven meter rise in sea-level if widespread melting of the West Antarctic Ice Sheet and Greenland Ice Cap occur.

In March 2009, The Chronicle Herald newspaper published an image of what Downtown Halifax might look like if sea-level were to rise to these levels (Figure 3). Although such a rise in sea-level is not currently predicted to occur over the next century, we can be certain that the impacts of coastal storms in the province will continue to extend further inland in the future.

Who should be concerned and why?

A wide diversity of interest groups have already expressed concern over the potential environmental, social and economic impacts that can result from rising sea-level and increased storm events. With growing evidence of the global implication of this phenomenon, the numbers calling for action to address climate change adaption and mitigation are increasing, yet some members of these groups still fail to acknowledge the need to act. In Nova Scotia, key interest groups include coastal property owners, industries dependent on coastal infrastructure and resources, coastal communities and of course, all levels of government.



Figure 3. Artist's impression of the Halifax waterfront after a 6 meter rise in sea-level. Source: The Chronicle Herald

Coastal property owners: Most coastal lands in Nova Scotia are privately owned. Nova Scotia has managed to avoid extensive coastal development outside urban areas until recently and it is not surprising that much of the privately owned coastal land in the province is now being developed for residential purposes. It is these coastal property owners who should be most concerned about sea-level rise and storm events because they are the most vulnerable interest group. However, research in other coastal jurisdictions suggests that many coastal property owners are aware of the threat from coastal hazards, but few are overly concerned about it. This is because coastal property owners tend to focus on the low probability nature of coastal hazards rather than on the potential for catastrophic consequences. Some

coastal property owners are more concerned about government agencies imposing coastal protection regulations on their property that restrict the type and extent of activities they can carry out on their land than on the threats arising from sea-level rise and severe storms.

Real estate, housing and construction industries: Coastal land is highly valued and thus important to the real estate, housing and construction industries. These industries have much interest in how the issue of sea-level rise and storm events is addressed by the provincial government's Sustainable Coastal Development Strategy, particularly if it includes new industry regulations and standards for development in vulnerable coastal areas. It is possible that such regulations could prevent certain types of development in vulnerable coastal areas, thus affecting these industries.

Provincial and municipal governments: Given the *laissez faire* attitude towards coastal hazards exhibited by many coastal property owners, the provincial and municipal governments have a large share of the responsibility for protecting people and property from the impacts of sea-level rise and storm events. At the same time, the government has an interest in supporting coastal development and growth of the real estate, housing and construction industries. The government has also invested substantially in critical infrastructure (e.g. roads) throughout the province, much of which is located in vulnerable coastal areas. The ongoing challenge faced by the provincial and municipal governments is to ensure, with assistance from the federal government, that economic growth and development in coastal areas proceeds in a manner that minimizes the threat to people, property and infrastructure from sea-level rise and storm events.

Tourism Industry and Coastal Recreationists: Many local and international recreationists and tourists are drawn to the large areas of undeveloped and unexplored coastline in Nova Scotia. Coastal infrastructure such as boardwalks and facilities are sometimes required to access and use these areas. Therefore, there is concern from the tourism industry and recreationists over the potential for sea-level rise, storm events and the use of shoreline protection structures to reduce access and to damage or alter natural features and recreational infrastructure along the province's coast.

Insurance industry: The insurance industry has an important role to play in this issue. The increasing level of risk from coastal hazards has the potential to be one of the key factors that determine the rate insurance companies offer to coastal property owners, particularly if coastal hazard mapping and modelling become more advanced and widely available in Nova Scotia. Development along high vulnerable stretches of shoreline may not be feasible if the insurance premiums are too high or if insurance companies refuse to insure certain properties.

Environmental Non-Governmental Organizations (ENGOS): A number of ENGOS from the local (e.g. St. Margaret's Bay Stewardship Association) provincial (e.g. Ecology Action Centre) and national (e.g. Canadian Parks and Wilderness Society) to international (e.g. World Wildlife Fund) have been instrumental in highlighting threats to coastal species, habitats and ecosystems from sea-level rise and storm events. For example, if the rate of sea-level rise is greater than the rate at which salt marshes and dune systems can migrate inland to accommodate the rise, these valuable coastal habitats and ecosystems could be lost forever, along with the species that depend on them. Human interference (e.g. shoreline hardening) can increase the vulnerability of coastal habitats and ecosystems to sea-level rise and storm events. In many cases their survival

will depend on establishing management measures that give them the best opportunity to adapt to environmental change.

Policy Implications

Nova Scotia has been affected by rising sea-level and coastal storms for thousands of years. However, global climate change has caused the rate of sea-level rise to accelerate and the frequency and intensity of coastal storms in the province to increase. These changes to the natural system, along with increasing development along the province's shoreline, make sea-level rise and storm events a serious issue in the province. Given the insidious nature of sea-level rise and the short-term focus on individual severe storm events, it is tempting for policy-makers to deny this issue or direct resources to more high profile and pressing concerns. However, taking a cumulative assessment of these events, both retrospectively and prospectively, leads to the conclusion that doing nothing about this issue is not an option. This is particularly evident, given the increasing potential in the not-so-distant future for catastrophic property damage, loss of life, loss of coastal habitats and ecosystems and the severe economic impacts that would accompany these events.

Generally, policy-makers have three broad management strategies for addressing the impacts of rising sea-level and storm to choose from; retreat, protection or accommodation.

Implementing a retreat-type strategy

The retreat strategy recognizes that some coastal areas are too hazardous for development and as such, focuses on keeping development away from the shoreline in these areas. Usually, all non-essential development is prohibited within the area and existing development is abandoned over time or relocated inland. Management tools designed to implement this strategy include setbacks, zoning and land-use regulations. A steep rise in insurance premiums for coastal property would also support a retreat strategy by discouraging development adjacent to the shoreline. The retreat strategy has a number of advantages. First and foremost, it effectively eliminates the threat to people and property posed by sea-level rise and storm events by moving them out of the affected areas. Second, this strategy minimizes human impacts on sensitive ecosystems and habitats and allows them room to migrate inland and adapt naturally to changing environmental conditions. Third, this strategy can help address the coastal access and working waterfront issues by keeping land along the shoreline free from non-essential development. It also benefits coastal water quality by creating a buffer zone between coastal waters and pollution sources such as septic systems and impermeable surfaces (e.g. roads). Finally, from a policy perspective, this strategy is relatively simple to monitor and oversee as all parties are clear on where development can and cannot take place. The major disadvantages of this strategy are that it is often not economically or politically feasible along stretches of highly developed coastline and the challenges of acquiring ongoing scientific input, such as rate of shoreline erosion and predicting flooding extent, into the setting of setbacks and other restrictive zones. Given that this strategy would severely limit the type and extent of development permitted on highly valuable waterfront property, it is important ensure it is not used inappropriately. It is also essential to work collaboratively with affected interest groups such as coastal property owners and the real estate, housing and construction industries, to develop compensation-type and other appropriate

policies to alleviate the negative consequences associated with this strategy. It could be argued that implementing such equitable practices would not only reduce opposition to the strategy but would prove to be more cost-effective in the long run, by avoiding the costs associated with the social, environmental and economic hardships arising from flooding and other storm-related events in highly hazardous areas.

The retreat strategy has recently been adopted in a number of areas. A well-known example is the relocation of the Cape Hatteras Lighthouse in North Carolina in 1999. The lighthouse was moved approximately 884 metres inland because it was in danger of collapse due to severe beach erosion. Coastal retreat projects have also been planned or implemented in California and the United Kingdom.

Implementing a protection-type strategy

The protection strategy involves the use of natural or engineered protection structures to protect property and infrastructure from erosion, flooding and other storm-induced damage. This strategy is ideal along stretches of coastline with high density development, a large population and few sensitive coastal habitats and ecosystems. However, the protection strategy has many disadvantages associated with it and has the potential to worsen some of the other problems facing coastal areas of Nova Scotia. First, unlike the retreat strategy, a protection strategy does not eliminate the threat to public safety and property from sea-level rise and storm events, only reduces it. Therefore, this strategy can encourage population growth and development in highly vulnerable areas by creating a false sense of security. Second, many protection structures negatively impact sensitive coastal habitats and ecosystems. They are known to alter the natural processes operating along the coast and can even increase erosion rates in adjacent areas. Third, protection structures can prevent the inland migration of salt marshes, beaches and other coastal features; a process that is essential for these features to adapt to a rising sea-level. Fourth, although coastal protection can be a relatively cost-effective option in the short-term, there is often a high maintenance cost associated with protection structures in the long-term. Finally, while some 'hard' protection structures such as seawalls with boardwalks can do double duty by protecting the shoreline while increasing coastal access to tourists and recreationists, they can paradoxically also reduce access from the sea to the shore, thus making them less attractive as a solution for some users.



Figure 4. Large rocks were placed along the shoreline to protect these homes along Halifax Harbour from storm damage.

Source: Natural Resources Canada

The protection strategy is widely used in many parts of the world, including Nova Scotia (Figure 4). The Geological Survey of Canada estimated that 30.5 kilometres of the shoreline of Pictou County was covered by protection structures

in 2000. However, many jurisdictions have recognized the problems associated with protection structures and now use the protection strategy as an option of last resort. Some states, such as North Carolina, have even banned the use of seawalls altogether.

Implementing an accommodation-type strategy

The accommodation strategy involves allowing current land-use practices to continue by taking measures to accommodate rising sea-level such as building emergency shelters or raising the elevation of existing structures. There are many disadvantages associated with this strategy, the most obvious being it does little to protect public safety and property. This strategy is usually used in coastal jurisdictions lacking the resources or land area to implement a retreat or protection strategy. An example of a jurisdiction that has used the accommodation strategy is the country of Bangladesh. The country is low-lying, has a population density of over 1,000 people per square kilometre and frequently experiences severe flooding caused by cyclones. Since Nova Scotia has the means to implement the other two strategies, it is unlikely that the accommodation strategy would be the preferred option in Nova Scotia because it could result in unacceptable levels of risk.

Each strategy has its advantages and disadvantages and the optimal strategy for managing a coastal area will vary from location to location depending on a range of natural and human factors. In the past, many jurisdictions in the U.S. have favoured the coastal protection strategy because much of the country's coastline is already quite developed. Unlike many states in the U.S., much of Nova Scotia's coastline is still undeveloped, making the widespread implementation of the retreat strategy both feasible and appealing. For example, 15 of Nova Scotia's 18 counties (all of which are coastal) have a population density of less than 20 people per square kilometre (Figure 5).



Figure 5. Population Per Square Kilometre 2006 Census
Source: Government of Nova Scotia Community Counts

Charged with the task of identifying criteria to help in identifying the extent of coastal management areas that would be adequate to address sea-level rise and storm events, technical experts at a June 2008 workshop hosted by MAP recommended settlement patterns, physical features and natural processes as essential ones for Nova Scotia to consider. These criteria would also assist in identifying the appropriateness of each of the strategies discussed above for different parts of the province. Additionally, experts at the workshop offered the following advice:

- Determining an effective landward boundary specifically to address sea-level rise and storm event was essentially a mathematical coastal hazard modelling exercise requiring reliable data for known variables such as climatology, tides, storm surges and swells, sea-level rise estimates, physical features and other vulnerability factors.
- A crude estimation using maximum height of tides, sea-level rise, maximum storm surge and swell suggests any area less than 2-3 meters above the high water mark should be included in the management area.
- Scenario mapping could be used to determine and manage the impacts of this issue on different areas of Nova Scotia. This technique will require:
 - A consistent set of data and maps to be generated based on LIDAR technology and other tools that are available;
 - A scientifically accepted methodology for acquiring the data and a legally approved use of the techniques, recognizable by all levels of government and other decision makers in setting and implementing policies and regulations to safeguard life and infrastructure;
 - A centralized repository of the information collected from a diverse array of sources, ensuring data collection quality control and identifying an entity that is designated as responsible for coordinating the collection of data needed for coastal hazard mapping.

Concluding Comments

It is clear that different areas in Nova Scotia will require different strategies for addressing the impacts of sea-level rise and storm events. While a retreat strategy might be the strategy of choice given particular physical features and natural processes, accommodation and protection strategies may be necessary given existing settlement patterns. For example, in more urbanized coastal areas of Nova Scotia, such as the downtown districts of Halifax or Sydney, a protection strategy may be the only feasible option. The key to successful implementation of the retreat strategy in Nova Scotia is determining the most appropriate distance for the setback line. The optimal setback distance is one that greatly reduces or eliminates the threat to public safety and property but does not unnecessarily restrict land-use and activities in coastal areas. Most jurisdictions in the U.S. use historic rates of coastal erosion and flooding to calculate setback distances. The problem with this method is that it does not account for accelerated rates of sea-level rise and erosion expected in the future. Given the uncertainty associated with current estimates of sea-level rise over the next century, the government of Nova Scotia would be wise to take a precautionary approach by establishing setback distances further inland than what is currently considered sufficient for protection in the future. The challenges here are two-fold: first, to obtain accurate data on shoreline change throughout the province and generate reliable shoreline change forecasts and models to inform coastal planners and managers; and second, to work collaboratively with affected groups to ensure the achievement of the policy objectives.

This document is based on research undertaken by Christopher Burbidge and Lucia M. Fanning at the Marine Affairs Program, Dalhousie University. To enhance readability of this publication, references used to prepare the document are not included but are available upon request. Contact marine.affairs@dal.ca for details.