SEA LEVEL RISE & STORM EVENTS

THE **2009 STATE OF NOVA SCOTIA'S COAST** REPORT

HOW DO WE PROTECT NOVA SCOTIANS FROM HAZARDS CAUSED BY SEA LEVEL RISE AND STORM EVENTS?

Like the rest of the world, sea level in Nova Scotia is rising at an accelerated rate. Mean sea level has been rising globally since the peak of the last ice age 20,000 years ago. It's also rising in the province because of regional land subsidence, which is the sinking of land relative to sea level.

But climate warming is accelerating the rate of sea level rise. The increased rate is caused by the thermal expansion of ocean water *(the water volume gets larger as it warms)* and the melting of land-based ice or glaciers.

Researchers expect climate warming to result in more frequent and intense storms in Nova Scotia. These storms are often accompanied by storm surges, which occur when waves driven by high winds and low pressure pile onshore.

Combining the relative rise in sea level with more intense storms means that storm surges will be larger. This means more risks of damage to people, property, infrastructure, wildlife, and ecosystems along the province's 13,300 kilometres of coastline.

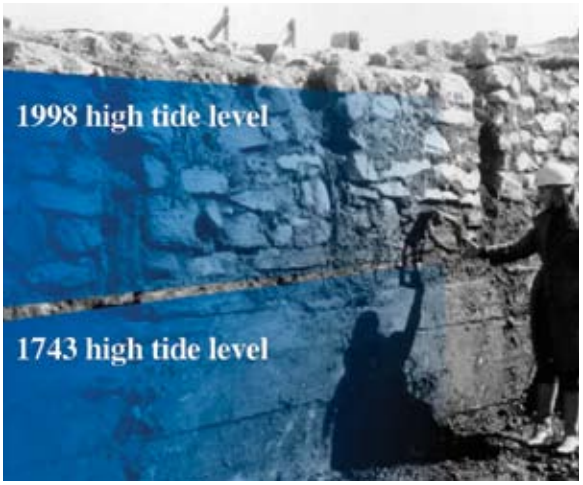
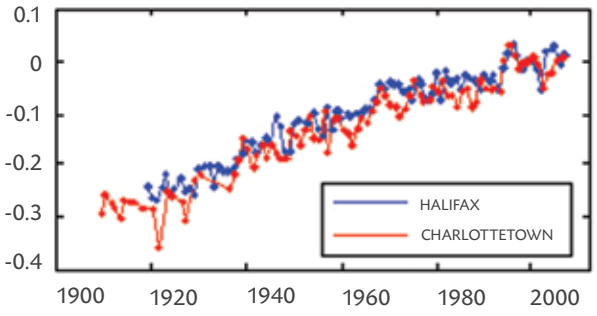


Figure 1: Sea level rise at Fortress of Louisbourg. (Source: Taylor et al., 2000)

FACTS AND FIGURES



During the twentieth century, sea level in Nova Scotia rose approximately 30 centimetres. Researchers expect an additional increase from 70 to 140 cm over the next century. The increase will depend on global greenhouse gas emission levels, ice-cap melting rates, regional sea level response, and land subsidence. Researchers also expect that sea level rise will carry tides and storm surges farther inland.

Figure 2: Historical mean annual water levels at Halifax and Charlottetown. (Source: Marine Environmental Data Service, Ottawa, 2008)

Based on averages from 1981 to 2000, the number of tropical storms in the North Atlantic has been above normal in nine of the last 11 years. This culminated in the record-breaking storm season of 2005. Storm events with extreme water levels similar to Hurricane Juan in 2003 could become more common by the end of the century.



Figure 3: Images, left to right: Recent storm damage in Nova Scotia. Large waves from Hurricane Bill at Cherry Hill Beach, Queens County (Source: Tim S. Conrad, 2009); Damage in Prospect, HRM, from Hurricane Juan (Source: Doug Mercer, 2003); Debris across road at Lawrencetown Beach due to Hurricane Bill, Lawrencetown, HRM.

But there is debate in the scientific community over the link between climate change and tropical storm frequency. Because these storms tend to behave in a cyclical way, it's also possible that they will decrease in number over the next 10 to 20 years.

Winter storms, such as nor'easters, can also cause extensive damage, mainly due to erosion and flooding from storm surges. The highest storm surges around Nova Scotia usually occur along the upper Bay of Fundy and the Northumberland Shore. Sea level rise also increases the risk of flooding by increasing tidal ranges. The Bay of Fundy has 243 km of dykes that protect an estimated 17,500 hectares of valuable land. Within the next 50 years, climate change is not only expected to cause more intense storm events, but also to accelerate the loss of coastal ice cover in the Gulf of St. Lawrence. This will expose shorelines to increased damage and erosion from storm surges and waves during the winter months.

Over the last 10 years, Nova Scotians have claimed $3.3 million for storm-surge damage from the federally run program, *Disaster Financial Assistance Arrangements*. These include claims from private property owners, small business operators, people in the fisheries, and not-for-profit organizations. The amount claimed doesn't include damage to public infrastructure. Hurricane Juan alone is estimated to have caused a total loss of $130 million, although this is more from wind damage rather than direct storm surge. Gross repair costs to provincial coastal infrastructure, mostly roads and shoreline structures, were a further $2 million.

WHAT NOVA SCOTIANS ARE DOING NOW

Generally, coastal risks need to be dealt with at the municipal level, with support, including much of the necessary research, undertaken by the federal and provincial levels of government. The following are some current and recent programs:

FEDERAL LEVEL

- forecasts, including for storm surges, by Environment Canada's Atlantic Storm Prediction Centre
- coastal erosion monitoring by the Geological Survey of Canada
- tidal gauge program by the Canadian Hydrographic Service
- GPS-monitoring of land subsidence by the Bedford Institute of Oceanography

PROVINCIAL LEVEL

- legislation addressing coastal risks, such as the *2007 Environmental Goals and Sustainable Prosperity Act* and the *2009 Climate Change Action Plan*
- mapping that classifies coastal hazards, such as the *Coastal Hazard Assessment Project*, St. Margaret's Bay
- a pilot project that assesses climate-change risk and land-use planning in Central Antigonish County
- data collection by a tide and meteorological station at the Windsor Causeway on the Avon River
- environmental assessments and flood-risk models that support plans to twin Highway 101

MUNICIPAL LEVEL

- flood-risk models by Halifax Regional Municipality for the *Halifax Harbour Plan*
- a study on Annapolis Royal's tidal surge, conducted in 1998 by a citizen-based group called the *Clean Annapolis River Project*

WHERE ARE THE INFORMATION GAPS?

- high-resolution topographic mapping of flood-prone areas
- erosion rates and type of geology in local high-risk areas
- socio-economic value of exposed property, infrastructure, and natural systems
- uncertainties in rates of land subsidence and relative sea level rise

THE FUTURE: SOME WAYS TO PLAN FOR HIGHER SEA LEVELS AND MORE INTENSE STORMS

Nova Scotians need to consider the hazards associated with sea level rise and more intense storm events when we plan for the future. These hazards include both biophysical and socio-economic effects. Biophysical effects include damage from flooding, land instability and erosion, changes to biophysical systems, and salt water seeping into freshwater aquifers. Socio-economic effects include damage to property, infrastructure, and human lives. The greatest risks are to low-lying areas, especially those susceptible to high storm-surge levels, such as the Northumberland Shore, upper Bay of Fundy, and dykelands areas.

To deal with these risks, we can use a combination of the following

1. PROTECTION
    - *hard methods, such as building physical structures such as dykes, seawalls, and breakwaters*
    - *soft methods, such as using wetlands and vegetation strips as buffers to erosion, and nourishing eroded beaches by replacing sand and other sediments*

2. ACCOMMODATION
    - *upgrade infrastructure, raise buildings, and improve emergency response systems*

3. RETREAT
    - *establish setback limits for coastal development*

Planners and decision makers must be kept up-to-date with the latest scientific knowledge to make the best decisions. Some methods that can help ensure that scientific data in the province is accurate and available include:

1. CREATING HIGHER-RESOLUTION TOPOGRAPHIC MAPS FOR BETTER FLOOD FORECASTING

- Detailed maps of low-lying areas can be combined with estimates of future extreme water levels to make better flood forecasts.

2. FILLING IN DATA GAPS

- Researchers in the field can fill identified data gaps in flood-prone areas by surveying areas with missing ground elevation data, and by determining historical erosion rates. These erosion rates, however, will tell us only which areas are vulnerable under current climate conditions, not necessarily those areas at risk under future conditions.

3. CREATING A PUBLIC DATABASE ON COASTAL RISKS

- Existing data on coastal risks are presently scattered across various government levels and universities. The data could be collected and made publicly available on a central archive or website.

Further Reading

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References

Figure 2: Historical mean annual water levels at Halifax and Charlottetown. (Source: Marine Environmental Data Service, Ottawa, 2008)