Coastal Hazard Assessment Maps of St. Margarets Bay (NTS 11D/12 and 21A/09), Nova Scotia

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Background

Changes in the physical environment of Nova Scotia's coastline due to rising sea level directly affect the safety of coastal residents and also have significant impacts on associated coastal infrastructure. Geologists with the Nova Scotia Department of Natural Resources have the expertise to address geological responses to rising sea level and its affects on rates of erosion, coastline migration, sediment movement, slope stability and flooding. A benchmark publication by Shaw *et al.* (1998) used a modified 'sensitivity index' approach to classify all of Canada's coastline into areas of high, moderate and low sensitivity to an accelerated rise in sea level due to global warming. Based on the scale at which data were collected, and uncertainties in the relative effects of variables controlling coastal erosion, the map "must be considered as a generalized depiction of coastal sensitivity" (Shaw *et al.,* 1998).

The main objective of this project is to produce more detailed hazard assessment maps of St. Margarets Bay that will meet many of the requirements needed for detailed municipal planning purposes. This project is designed to map and access coastal hazards over increments of hundreds of metres to several kilometres. An accompanying report and/or map notes will provide additional information, specific examples of differing hazards or issues, and allow more detailed understanding of the information presented on the 1:10 000 scale maps. The project is being undertaken as part of a new Environmental Geology Program under the auspices of the Geological Services Division, Nova Scotia Department of Natural Resources (cf. Goodwin *et al.,* this volume, p. 35-37).

Data Collection and Analysis

Field investigations were completed along highways #329, #3, and #333 during July and August, 2007. These highways closely follow the outline of the bay and allow good access for 1:10 000 scale mapping. Mapping the coastline from only the land, however, does not provide the required overall view or perspective. To obtain this perspective the coastline was also surveyed and photographed from a boat. In addition to the summer period of mapping, site specific observations and 'before - after' photographs have been taken sporadically over a period of several years. So far, data have been compiled on base maps and interpreted for the area from Owl's Head at the southerly end of the Aspotogan Peninsula to French Village on the Peggys Cove Road.

The coastal classification scheme on the maps attempts to consider in a qualitative and semi-quantitative manner a combination of natural attributes both fixed in time (e.g. rock type or susceptibility of coastal soils to erosion) and variable over time (e.g. net sea level), existing infrastructure 'near' the coast, and actual or potential human modifications of the shoreline, as the primary basis for the hazard assessment.

Sea-level rise is arguably one of the most important 'hazard' factors. Over the last several thousand years, rising ocean levels coupled with sinking areas of coastline have resulted in the net present rate of submergence of Nova Scotia's coastline of between 2.5 and 4.5 mm/year (25-45 cm/100 years). Sea-level data from Nova Scotia tide gauges and world-wide rates of sea-level rise predicted by the Intergovernmental Panel on Climate Change Report (IPPC), were used to predict future sea-level rise in St. Margarets Bay to 2100. The rate of sea-level rise appears to be accelerating (IPCC, 2007) and is expected to continue to accelerate. Thus, the rate of coastal flooding or submergence (and thus erosion) is predicted to increase over the succeeding decades.

The classification described below is based on present observations of processes and characteristics (e.g. rock type and landforms), other

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well accepted geological processes, and quantitative data such as elevations and rates of sea-level rise, to name just a few. Both Post-tropical Storm Noel and Hurricane Juan affected St. Margarets Bay and provided much-needed perspective for this project.

Hazard assessment maps resulting from this project will represent the author's interpretation and synthesis of the various data described above. It is a snapshot in time that in some areas or instances may change dramatically (e.g. due to well placed armouring of a coastal highway).

Coastal Classification

The coastline of the bay and areas adjacent to the shoreline (ranging from tens of metres to a few hundred metres from the shore) are classified as discussed below. These classifications will be shown as areas defined by colour, pattern and symbols.

(1) Areas subject to flooding at present during a Hurricane Noel type of event where there is a storm surge of 1.5 to 1.7 m above high-high tide. Note that this is the water height without waves, so actual flooding due to wave action would be much more extensive. With projected sea-level rise over the next 100 years these areas would approximate a hurricane striking at a two-thirds tide.
(2) Areas that may be subject to flooding and associated wave action given predicted sea-level rise by 2100.
(3) Areas that are presently exposed to additional flooding or damage due to severe wave action and wave run-up.
(4) Areas of shore front presently subject to erosion during storms and hurricanes with modifiers indicating actual or potentially severe erosion or minor erosion.
(5) Areas along coastal highways where the shoulder of the road or the actual road is subject to erosion and undercutting during storms and hurricanes.
(6) Areas along coastal highways where the shoulders of the roads or the actual roads are predicted to be subject to erosion and undercutting during storms and hurricanes given predicted sea-level rise by 2100.
(7) Areas where 'natural armour' (e.g. boulders derived from eroded glacial sediment) protect the shore front from accelerated rates of erosion.
(8) Areas where the shore front is artificially armoured (e.g. boulders placed as walls) to reduce or prevent erosion of the shoreline, flooding, and damage to infrastructure.
(9) Areas where coastal geomorphology determines the degree of exposure to storms and hurricanes.
(10) Coastal segments and landforms that provide sediment to maintain beaches. These are potentially critical areas where the prevention of erosion may have significant impacts on other areas or shore front environments (e.g. beaches).
(11) Identification of specific sites where detailed information is available or where photographs depict features (usually geological) or human actions that are important to recognize and understand for various planning and hazard assessment activities.
(12) Observed offshore sand reservoirs.
(13) Areas where currents created by storm surges may increase the degree of hazard.
(14) Areas where the shoreline is and will be to a large degree unaffected by erosion or sea-level rise over many decades and centuries.

Map Products

Maps will be published in both a paper and digital GIS-based format. The paper and GIS-based products will differ in format, presentation and utility due to different capabilities. An 'example' map will be subject to internal and external review and comment. The maps will be produced and edited internally with a projected public release during 2009.

References

Intergovernmental Panel on Climate Change 2007: Summary for policymakers; *in* Climate Change 2007: the Physical Science Basis; Cambridge University Press, Cambridge, UK, and New York, NY, USA.

Shaw, J., Taylor, R. B., Forbes, D. L., Ruz, M. H. and Solomon, S. 1998: Sensitivity of the coasts of Canada to sea-level rise; Geological Survey of Canada, Bulletin 505.