

# THAT SINKING FEELING



Source: Turner Drake Economic Intelligence Unit & Google Earth.

In common with many Atlantic Canadian cities, Halifax's Lower Water Street is just 2.4 metres (8 ft.) above the tidal benchmark known as chart datum. During spring tides, water enters the basements and crawl spaces of the older buildings lining the street. These high tides occur every fourteen days when the Sun, Moon and Earth are in a straight line and the gravitational pull of the Moon is reinforced by that of the Sun. Halifax's waterfront is a national treasure, its boardwalk along the water's edge is a window on one of the world's most interesting harbours. The fast convoys formed up here during the last World War before running the gauntlet of German U-Boats, waiting to pounce in the Atlantic. Today cruise and container ships jostle with pleasure craft, and the waterfront is thronged with tourists from June to October. On 28th September 2003, a very different visitor came to call; Juan a "marginal" Category 2 Hurricane rode in on a spring tide, created a storm surge, and wrecked the waterfront. It was a 100 year event, which could happen again tomorrow ... and will happen with increasing frequency as the Earth warms up. Climate change is the topic of the day, but what does it mean for coastal communities in Atlantic Canada? We set our Economic Intelligence Unit to work to find out.

## Climate Change

First, forget your visions of a banana tree in the backyard: climate change does not necessarily mean global warming. In fact, Atlantic Canada has actually seen a slight cooling trend over the past fifty years and a new study which links human activity, i.e. greenhouse gas emissions, to rainfall patterns, indicates that should present trends continue, Canada's overall increase in precipitation will come in the form of snow. Climate change is expected to exacerbate existing hazards: the most pressing concerns for Atlantic Canada are likely to be a vicious combination of

sea level rise, erosion, and increases in extreme weather events. Waterfront property owners take heed!

Provincial and municipal governments in the Maritime Provinces are making use of Geographic Information System (GIS) and Remote Sensing technologies to predict what effect climate change will have in the region. Airborne LIDAR is used to image coastal areas, creating highly accurate 3-D Digital Elevation Models (DEMs) which show changes in elevation such as building heights and topography. Scientists then use a GIS to model the effects of sea level rise to predict and visualize which areas are at risk of flooding. DEMs have been completed for Charlottetown, the North Shore of PEI and areas along the coast of south-eastern New Brunswick. A project is currently underway in Halifax to predict what effect climate change will have on the 1,300 km<sup>2</sup> area in and around the harbour. City planners will use the maps to determine the elevation at any given point so they can develop planning strategies and ensure compliance with municipal by-laws put in place to mitigate flood damage. For example, last summer's updated regional plan for HRM prohibits residential development within 2.5 m elevation above the ordinary high water mark. The new maps will show exactly where that line is drawn.

Atlantic Canada has been sinking for thousands of years, at a rate of approximately 20-30 cm per century, resulting for all intents and purposes, in higher sea levels. Climate change is expected to increase the rate of sea level rise, due to melting glaciers and ice caps and thermal expansion of the oceans. While it has been said that, compared to Europe and Japan, Canada is fortunate in having low population densities and small amounts of infrastructure at risk, this is small comfort to those living in the predominantly coastal Maritimes! More than 80% of the coastlines of New Brunswick, Nova Scotia and Prince Edward Island are identified as being moderately to highly sensitive to sea level rise (Newfoundland, with its rugged, rocky coastlines, has a much lower proportion of high-sensitive coast). Global sea level is predicted to rise by 8 to 88 cm by 2100. The best estimate for the Maritimes is 50 cm ... on top of the 25 cm the land will sink. The grand total is estimated at a net increase of 75 cm in the next hundred years. If this occurs, part of the coast of Atlantic Canada will be permanently submerged and flooding will occur in areas that have never experienced it in the past. The steep slopes on which Halifax and Saint John are built will likely protect much of the downtown areas, but not so in Charlottetown, where the downtown is relatively flat.

Melting polar ice is also widely anticipated to increase the length of the ice-free season in the Northwest Passage, making it a viable shipping route, though it will probably be decades before the infrastructure is in place. Eventually though, it has the potential to adversely affect the Port of Halifax, which is currently positioned as a gateway to North America for ships sailing to and from Europe. Canada's sovereignty is not immune to climate change. Canada claims the Northwest Passage as an internal waterway. In 2006 the Federal Government declared that our military would henceforth refer to the region as "Canadian Internal Waters", a reaction to the ongoing refusal of the United States to recognize Canadian sovereignty there. Other countries, including China and Russia, have recently been heard murmuring about the region as international waters, as well. As the viability of utilising the Passage as a shipping route increases, expect the debate over Canada's sovereignty to heat up as well.

The frequency and impact of extreme weather events are expected to increase with climate change, with 100 year events becoming 50 year events and rising sea levels causing more severe storm surges. (A storm surge is measured as the difference between the observed water level and the highest predicted tide. When combined with a very high tide, the effect is acute).

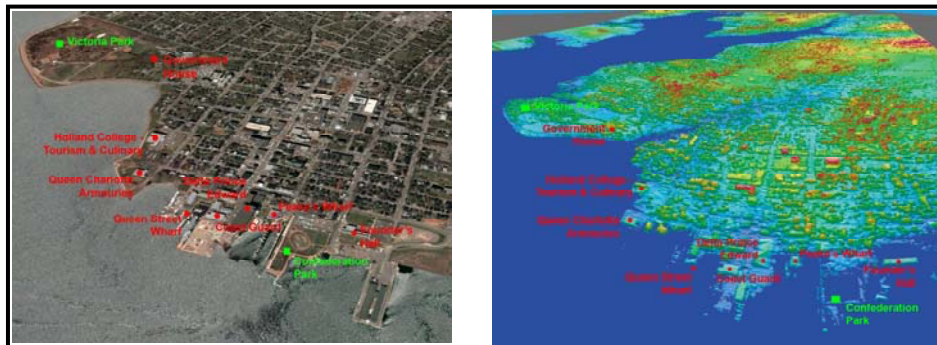
Increased erosion due to climate change is expected to result from a variety of factors, including reduced amounts of sea ice, which protect beaches from winter storms; more extreme weather events; and sea level rise. Marine geological surveys of the north shore of Prince Edward Island indicate an average coastline retreat of 50 cm per year for the past several thousand years; data collected since the 1930s indicates that the coastline has changed during that time; retreating in some areas, but recovering in others. Between 1935 and 1990, the value of land in the area lost to erosion was \$879,000. Future erosion rates factoring in climate change and sea level rise are predicted to be up to twice the mean rates of erosion between 1935 and 1990. The coast most sensitive to climate change is commonly low-lying, with salt marshes, barrier beaches (though in some instances, erosion can actually serve to protect beaches by adding enough material to them to keep them above water) and lagoons. A comparison of two beaches on the Eastern Shore of Nova Scotia shows that the low-lying beach has retreated landward by an average of 8 meters per year in the past fifteen years, whereas the high-crested beach shows little retreat at all. The two beaches are only separated by a few kilometres. With waterfront properties in high demand, purchasers would do well to consider their options carefully and opt for land likely to be there in 60 years' time...or invest in a houseboat.

## The Bottom Line

Property owners can expect extreme weather conditions to occur with much greater frequency. In urban areas, storm water systems are unlikely to be adequate to deal with the more extreme rainfalls that will occur. The flooding in the United Kingdom this year has ignited debate there on the adequacy of sewer systems created for a more gentle environment. There is a realisation that greater capacity is now required. The Maritime Provinces face a dual problem: their land mass is sinking; sea levels are rising. The impact of hurricanes such as Juan, cause a storm surge due to (1) lower central pressure which causes the water to bulge up and (2) wind pressure which pushes the water upwards. Once that mass of rushing water meets the coast it piles up. The actual height of the storm surge is dictated by the speed of the storm, the angle at which it hits the coast, and the shape of the seabed (coastal bathymetry). We have utilised the data generated by Juan, together with historical data on the rate the land mass is sinking, and projections on the rise in sea levels due to climate change, to identify those areas of Halifax that will become increasingly at risk to flooding over the next century.

Hurricane Juan created a storm surge of 1.5 metres and increased the water level in Halifax Harbour to a record 2.9 metres above chart datum. If Juan had co-incided with a spring tide, a lunar perigee (i.e. the Sun and Moon on the same side of the Earth, in line with it), and the twice daily high tide, the flooding would have been much worse. However Juan missed the twice daily high tide by two hours; and the higher of the twice daily tides altogether. The former would have added 0.45 metres to the water level, the latter 0.60 metres. Based on historical data we can expect the city to sink by 0.20 to 0.30 metres over the next 100 years. During that period, sea levels are expected to rise by 0.50 metres due to climate change. When another Juan visits Halifax one hundred years hence, the water level in the harbour will be 3.65 metres above chart datum ... unless it arrives on one of the twice daily high tides, in which unhappy event the water level will be 4.10 to 4.25 metres above chart datum. Properties located above the 5 metre contour are therefore probably safe from flooding ... those situated below it are less fortunate. We have plotted the 5 metre contour on the satellite photograph at the beginning of this article. Not all of the property to the east (harbour side) of the red 5 metre contour line will necessarily flood however. If there is a barrier between the low lying land and the harbour, and provided that all culverts discharging into the harbour have working back flow preventer valves, the properties will be protected. 100 years too is a long time, however storm surges above 0.6 metres do occur about twice a year in Halifax. If sea levels too were 0.75 metres higher than at present, it would only require a storm surge equivalent to that of a demi-Juan to cause a similar amount of flooding.

Low lying Charlottetown is particularly vulnerable to rising sea levels: storm surges occur about eight times a year. In January 2000, a storm surge in Charlottetown harbour resulted in sea levels 0.4 metres above the previous record. The resultant flooding caused an estimated \$1 million worth of damage. Not very much, but add another 0.75 metres to Charlottetown's highest predicted tide, and throw in another 0.57 metres of storm surge, and losses are estimated to balloon to \$172 million. A storm surge of 1.04 metres would mean \$190 million of property damage, and a storm surge of 1.27 metres would result in losses of \$202 million. Dr. Tim Webster and S. Dickie of the Applied Geomatics Research Group, Centre of Geographic Sciences (GOGS), Middleton, Nova Scotia studied Charlottetown's vulnerability to flooding in 2004. The survey was undertaken with D.L. Forbes (Geological Survey of Canada, Dartmouth, N.S.) and R. Shreenan (Terra Remote Sensing Inc., Sidney, B.C.). It utilised airborne scanning laser altimetry (a laser hung from a helicopter) to map Charlottetown in 3-D. A geographic information system (GIS) was then used to model the potential flooding arising from a storm surge sea level increase. The image below was created by Tim Webster and is reprinted and used with the permission of the Canadian Aeronautics and Space Institute. It was originally published in the Canadian Journal of Remote Sensing (2004). The area shown coloured dark blue is water and assumes a flood level 4.93 metres above chart datum. For orientation purposes we have also shown the current Google Earth satellite photograph, without the flooding.



## Conclusion

Purchasers are under pricing the risk of flooding in Atlantic Canada due to the “availability heuristic”, a term coined by the Wharton Business School to describe the disaster myopia exhibited by financial institutions in the 1980s, which ultimately led to the collapse of commercial property markets worldwide at the end of that decade. Cognitive psychology has established that decision makers, even trained statisticians, formulate opinions on “*the ease with which the decision maker can imagine the event will occur*” ... and that, in turn, is heavily influenced by the “recency” of a similar event. The market meltdown of the commercial property market hit Atlantic Canada in 1990. During the subsequent five years it was virtually impossible to finance commercial property purchases because conventional lenders exited the market and “long term” holders of real estate such as pension plans, rushed to liquidate their portfolios at knock down prices. During the next five years lenders created new ways to finance property e.g. conduit financing, and investment in real estate proceeded at a tepid pace. By 2005, the events of 1990 had been forgotten; financial institutions had found ways of selling their risk forward and purchasers such as Real Estate Investment Trusts (REITS) and pension plans, were investing in real estate at yields below that of the 1980s. The tenure of the “availability heuristic” therefore appears to be 10 to 15 years after the triggering event: it is priced into the risk at 10 years, but the risk premium decays and is totally eliminated after 15 years. Parts of Charlottetown flooded in 2000; Hurricane Juan destroyed the Halifax waterfront in 2003: neither event was of significant magnitude to impact property values. Commercial properties located in the vicinity to the waterfront do not yet carry a risk premium and indeed are often viewed as being more desirable because they command higher rents and lease more readily than their non-waterfront competitors. Hurricane Juan was categorised as a “100 year” event, and whilst statistically it could occur tomorrow, investors will believe it when it happens.

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