The potential impact of climate change on the Lake Huron shoreline at Oliphant.

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In the late1990s and early 2000s, water levels in Lake Huron declined almost one metre in a few years and approached record lows set in the mid-1960s. Such lows caused severe impacts, including impaired shipping and navigation as well as changes to shoreline properties and beaches. In the mid-1960s, record lows were set due to a period of low precipitation which began around 1961 and ended at around 1965 (Changnon, 1993). The low lake levels of the early 2000s were caused by a number of factors, including climate. In the late 1990s, Canada experienced warmer than average temperatures. The summer of 1998 was the warmest on record in Canada, the national average being 1.8^{o}C above normal (Environment Canada, 2002c). Lake Huron is part of the Great Lakes Basin (Figure 1.1), and within the Lake Huron region, temperature was only 1^{o}C above normal, but precipitation was 20% drier than normal (Lake Huron Centre for Coastal Conservation, 2003). As climate change continues, Lake Huron's water level will be affected.

Climate and Other Factors Affecting Lake Huron's Water Level

Lake Huron's water levels fluctuate according to natural and human factors. Natural factors include temperature, precipitation, evaporation, and runoff. Human factors, on the other hand, include water diversions, water control structures, dredging, and water use or consumption. When these two categories are compared, natural factors play a much larger role in affecting Lake Huron's water levels.

Research Study

Therefore, how will potential future climate change affect Lake Huron's water levels? This research attempts to investigate the potential future coastal zone impacts caused by different water level scenarios at a specific site along Lake Huron's shoreline. Through the use of complex climate change and basin hydrologic models, and multiple geographic information system models, potential future coastal zone impacts along Lake Huron's shoreline were assessed and visualized in map form.

Oliphant

The community of Oliphant, Ontario, is located along the western shores of the Bruce Peninsula. Oliphant was chosen as the research site because the shoreline environment and community are greatly influenced by fluctuations in Lake Huron's water levels. Oliphant's coastal zone is characterized by very low profile beaches, a shallow bathymetry, coastal wetlands, marine recreation and shoreline cottages. Thus, extensive areas can be impacted by lake level changes. There are also numerous offshore islands referred to as the Fishing Islands at this site. Figures 1 and 2 are examples of the Oliphant's shoreline environment.

Figure 1: *Exposed Sand Flat During Low Level Conditions on Lake Huron*

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Figure 2: *Recreational Activities During Seasonal High Level Conditions on Lake Huron*

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Research Method

To better understand potential future impacts, a specific methodology was developed to investigate shoreline impacts on the town of Oliphant. Datasets that provided bathymetry, topography, and aerial information were used to create maps and digital elevation models (DEM) that display potential future coastal zone impacts in Oliphant. A raster bathymetry DEM was created to survey the impact from a serious drop in lake level on navigation, as well as other subsequent coastal issues. Also, a triangulated irregular network model called the Lake Level Change Model was designed to project possible impacts from a different shoreline configuration. Water level scenarios (Table 1) used in the GIS models are the result of the combination of published general circulation model (GCM) results and a hydrologic model. In addition to the published water level scenarios, four arbitrary scenarios were used to provide a more complete visualization of possible water levels. It is these water level scenarios or lake projected water level change values that were plugged into the GIS models to create a new shoreline configuration. With different shoreline configurations, potential coastal zone impacts can be estimated.

Table 1: *GCM Water Level Scenarios (CCCma & Hadley data from Mortsch et al, 2000).*

GCM Scenario	Base Case Period	Base Case Water Level (m)	Projected Water Level Change (m)	Projected Lake Level (m)
CCCma 2030	1961-1990	176.62	-0.72	175.90
CCCma 2050	1961-1990	176.62	-1.01	175.61
Hadley 2030	1961-1990	176.62	+0.05	176.67
Hadley 2050	1961-1990	176.62	+0.03	176.65
Arbitrary 1	1961-1990	176.62	-0.50	176.12
Arbitrary 2	1961-1990	176.62	-1.25	175.37
Arbitrary 3	1961-1990	176.62	-2.00	174.62
Arbitrary 4	1961-1990	176.62	-2.75	173.87

Potential Impacts

Map results showed a variety of shoreline changes throughout the coastal zone, and therefore, potential impacts.

Wider Shoreline

The greatest initial impact will be a wider shoreline. Figure 3 displays the average shoreline location between 1961 and 1990. However, according to the CCCma 2050 scenario, the shoreline may look something like what is seen in Figure 4. According to map results, the change in shoreline area from the 1961/1990 average to the year 2050 will be 7.4 km^2.

Figure 3: *Lake level is 176.62 metres IGLD, based on a 1961-1990 mean.*

Figure 4: *CCCma 2050 Scenario. Lake level is 175.61 metres IGLD, and -1.01 metres below the 1961 to 1990 mean.*

Aeolian Sediment Transport

Newly exposed fine textured sands are susceptible to entrainment and transport by wind. This will cause an increase in aeolian (airborne) sediment transport off the flat beachfront. Due to a north-south orientation of the shoreline, the prevailing westerly winds will cause much sediment to be transported across Shoreline Avenue onto many cottage owners' properties.

Oliphant Fen Wetland – Migration and/or Dewatering

Potential future low lake levels may disrupt the natural pattern of the fen's water supply. This will cause the fen's vegetation to migrate towards both groundwater and surface water supplies (likely lakeward). Unfortunately, in some locations, the wetland is behind Shoreline Avenue, and is therefore isolated from a surface water connection. Therefore, vegetation in these wetland areas will have a greater chance of drying up and dying. Figures 5 and 6 show the distribution of the Oliphant Fen Wetland (according to 1989 data) during different water level conditions.

Figure 5: *Wetlands are light green areas. Lake level is 176.62 metres IGLD.*

Figure 6: *1989 Fen Wetlands in the CCCma 2050 Scenario. Lake level is 175.61 metres IGLD.*

Marine Navigation – Dredging and Small Craft Harbour

Components of marine navigation will be greatly impacted. The small craft harbour will require renovation or possible relocation. Dredging practices will become more frequent and costly. As well, there could be the possibility of new navigation channels to support marine travel. Figure 7 shows the location of the current navigation channels during the CCCma 2050 water level scenario.

Figure 7: *Location of the Smokehouse and Gut Channels during the CCCma 2050 Scenario. Lake level is 175.61 metres IGLD.*

Shoreland Policy and Ownership Debates

When Lake Huron's water level declines, there is the possibility that many new shoreland policies, regulations, and/or bylaws will be required to inform shoreline property owners of their title rights. New shoreline management practices for the newly exposed land will become an important issue, causing the possibility of many debates and public meetings.

Potential Adaptation Measures

Natural Resources Canada (2002) defines adaptation, in the context of this research, as "activities that minimized the negative impacts of climate change and position us to take advantage of new opportunities that may be present." In order for residents, cottagers, and tourists to cope with the future lake level declines

along Oliphant's coastal zone, they will have to examine a number of strategies. Adaptation provides an opportunity to reduce environmental and socioeconomic impacts.

Wider Shoreline

Since society cannot control the level of water in Lake Huron, there is little that can be done to reduce the impacts of a wider shoreline. Still, shoreline management practices will have to be developed to protect the new beachfront from unwanted activities, such as the use of motorized vehicles, for example.

Aeolian Sediment Transport

Traditionally, aeolian sediment transport has been combated by either trapping sediment or blocking the path of flow. The most environmentally sound method of doing so is to encourage the development of sand dunes along the shoreline. Large boulders along certain locations of Shoreline Avenue, although installed to prevent flooding and wave uprush, have also acted as a blockade for sediment transport. In some locations, sediment blown particles have filled in the small pockets between rocks and boulders. Still, the likelihood of these barriers developing to actual sand dunes is unlikely.

Oliphant Fen Wetland – Migration and/or Dewatering

Generally speaking, wetlands will naturally adapt to a changing environment or sudden harsh conditions. Still, in order to assist the wetland's chance of survival, adaptation measures such as wetland vegetation planting in moist locations, and delineating wetland boundaries with signage, will need to be implemented. In the case of isolated wetlands, culverts can be inserted or altered to encourage surface water connections, or channels can be created from the waterline and connected to isolated wetland areas.

Marine Navigation – Dredging and Small Craft Harbour

Since impacts on marine navigation will be very costly, adaptation measures will be important. One method of adapting could be the installation of floating docks. However, this method only works when there is a source of water. In this case, the relocation of the small craft harbour and dredged channels will be likely. When relocating, consultants will need to review bedfloor materials in order to assess the best location for channels.

Shoreland Policy and Ownership Debates

There will be a need to identify and inform stakeholders of the impacts, appropriate shoreline management policies, and possible adaptation measures. At the local level, new shoreline management regulations will be required, such as plans that will control where development is permitted. In order that residents of Oliphant have their questions answered, they will need to have meetings with the township, the Grey Sauble Conservation Authority and themselves as a cottage association. What society must not do is allow shoreline properties to develop closer to the new waterline. Even small stone patios with fire pits are not recommended. These measures, as well as others, need to be presented to the residents of Oliphant.

Summary

Oliphant is a sensitive environment, which is easily impacted by changes in Lake Huron's water levels. Therefore, potential future effects from climate change will have a negative impact on Oliphant coastal zone.

References

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