STATE OF CLIMATE CHANGE RESEARCH IN THE GREAT LAKES REGION

March 2015

Essex Region Source Protection Area

Updated Assessment Report

APPROVED

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***Note:** The information contained in this section of the Essex Region Assessment Report was approved in 2011. Updates in this version have been restricted to grammatical corrections.

6.0 Climate Change Research in the Great Lakes Region

Climate change research in the Great Lakes Region has been conducted by various organizations over the past two decades (Chiotti and Lavender, 2008; Croley, 2006; Croley et al, 1996; Kutzbach et al, 2005; Mortsch and Quinn, 1996; Quinn, 2002). These studies have agreed that there may be greater and more frequent extremes in the Great Lakes Region for both temperature and precipitation.

During the past century, mean annual temperatures in the Essex Region have cooled by about 0.5° C while annual precipitation has increased by 10% to 20%, with an increase in the amount of intense precipitation. Results of current research predicts increases in both low and high temperatures as well as increases in overall precipitation during the next 100 years. The minimum temperature (winter and/or night time) is expected to increase more than the maximum temperature, by 0.5°C to 1°C, and precipitation is likely to increase by 10% to 30%.

Despite these increases in precipitation, corresponding increases in temperature and changes in cloud cover and wind are expected to cause an overall increase in evapotranspiration. This increase may result in soil moisture deficits, reduction in base flows in streams, periods of lower lake levels (and greater fluctuations) and more droughts throughout the area. In addition, precipitation intensity will increase such that a higher percentage of rainfall will become runoff rather than infiltration and groundwater recharge, resulting in less water available as soil moisture for plants.

Increased evapotranspiration and similar reductions in soil moisture, coupled with increased winds due to more frequent and intense storms, could worsen soil erosion and sedimentation, with corresponding high sediment and nutrient loading in streams and drains.

More frequent strong wind events will lead to more intense wave action in the shallow nearshore areas, which may also lead to increases in the re-suspension of sediment from the lake bed. This may result in greater occurrences and/or higher concentrations of pollutants in the water column.

Greater frequency and severity of drought conditions may lead to potential increases in irrigation and a corresponding investment requirement in water infrastructure to support increased agricultural needs for water.

Warmer winter temperatures may well be the most significant change for water resources in the Lake Erie Region. More winter precipitation in the form of rain, smaller snowpacks, higher evaporation over open water which is frozen for shorter periods of time, and a weaker and earlier freshet in the spring are some of the possible changes which may result from these warmer winters. Less lake ice cover resulting from warmer temperatures will also increase the amount of wave action in the shallow nearshore areas, which will lead to an increase in sediment re-suspension.

Net water supplies over the Great Lakes System are projected to decrease due to decreases in infiltration, higher surface water temperatures and greater evapotranspiration. Another factor to be considered is that climate change may likely create drier conditions in other parts of the continent and an increased demand for fresh water could lead to increased pressures to divert water from the Great Lakes System. There is a likelihood of future disputes over water diversion if drier conditions become more frequent.

6.1 Potential Effects of Climate Change on Water Quantity and Quality

With respect to water quantity, climate change will likely shift the timing of seasonal events, such as the spring freshet, and cause water levels in Lake Erie to fluctuate at varying temporal scales due to such factors as increased water surface temperatures.

Increases in evaporation over ice-free lakes together with more frequent droughts may intensify seasonal water shortages during low flow periods. The potential for water use conflicts due to growing water shortages in other areas of the continent, as mentioned in **Section 6.0**, may also be a serious matter.

In terms of water quality, increases in air temperature and more extreme precipitation events may lead to degraded water quality, including lower dissolved oxygen rates and higher water temperatures. Higher sediment and nutrient loadings, due to more intense runoff events, with corresponding increases in water temperature are likely to affect water-borne organisms, favouring more toxic forms of water-borne algal blooms, such as cyanobacteria and dinoflagellates. These blooms may lead to more taste and odour problems in drinking water, a higher risk of water-borne diseases and increased treatment costs to water plants.

6.2 Potential Effects of Climate Change on Lake Levels

Periods of low water levels, especially in shallow lake basins, such as Lake St. Clair and the western basin of Lake Erie, will result in less dilution with respect to sewage treatment effluent. Combining this with the projected increases in future population may affect the ability of wastewater systems to meet their criteria.

Impacts to Lake Erie, Lake St. Clair and the Detroit River may include greater fluctuations in water levels due to increased precipitation, higher evaporation and increases in water temperature. Net basin water supplies may be diminished through climate change. Lake ice formation will likely continue to decrease and may be missing entirely in some years, causing a corresponding increase in the lake-effect storm season, increased evaporation and more precipitation falling as rain rather than snow, as well as an increase in wave action in nearshore areas. Seasonal variations in lake levels will likely be more pronounced, especially in Lake St. Clair and the shallow western basin of Lake Erie. Some sources predict that average lake reductions could be as great as 1.9 metres from the International Great lakes Datum of 1985 of 174.18 meters. These shallow basins are quite possibly the most vulnerable areas of the Great Lakes System with respect to climate change, since they have the lowest water volumes of any of the lakes and are more at risk to changes in lake levels and temperature. Reductions in lake level to Lakes Erie and St. Clair, and the Detroit River connecting channel could result in increased expenses to municipalities due to their drinking water intakes requiring pipe extensions.

Some model results for Lake Erie show reductions in annual runoff of 19% to 54%, mean outflow reductions of 23% to 40%, increases in mean annual surface water temperature of 3°C to 5°C, and increases in overland precipitation of 30-55% (Mortsch and Quinn, 1996).

The intakes on Lake St. Clair are both located just over one kilometre from shore, with Lakeshore recently constructing a new water treatment plant in the Belle River area, which may result in a slightly decreased risk to short-term climatic events. The Windsor intakes, though located in the Detroit River, are heavily influenced by Lake St. Clair and therefore are likely to be similarly susceptible to climate change. Increased runoff from the Canard River may affect the water quality at the Amherstburg intake as described in this chapter. The Lake Erie intakes are generally located in deeper water than those in Lake St. Clair, but may also be susceptible to climatic changes due to the possible detrimental effects mentioned above.

6.3 Effect of Projected Climate Changes on Assessment Report

Although further research is needed before any definitive conclusions can be reached, there are some possible effects on some of the findings of the Assessment Report. As described in previous sections, climate change may affect nearshore water quality and stream water quality, and possibly exacerbate 'issues' which have been identified for source water quality at the various water treatment plants in the region. In addition, if there are found to be more frequent periods of shallower waters in the Great Lakes System, this may affect nearshore water quality and vulnerability scores for some intakes, which may alter the 'scoring' of the types of potential drinking water threats that may occur as a result. Finally, increased drought conditions and higher evapotranspiration rates may result in increased stress levels to both surface water streams and groundwater, although this would not affect municipal water sources.

6.4 Future Work for Further Updates of Assessment Report

A few studies have been undertaken by researchers in the area which may provide information with respect to climate change for specific projects and subwatersheds in the Essex Region. There has also been made available, to our Source Water Protection staff, regional data which may be used to analyze future climate trends for the area. It would be advantageous to do a more in-depth analysis of climate change using these resources, since our water intake pipes are located in some of the shallowest waters of the Great Lakes system and may be adversely affected by potential climate change effects such as reduced water levels, more intense storms and wind events, and increased evapotranspiration.

6.5 References

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