CLIMATE CHANGE INFLUENCES ON THE LAKES AND RIVERS - GREAT LAKES BASIN OF CANADA

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ABSTRACT

This paper attempted to study the impact of climate change on water resources of Great Lakes of Canada. The historic trends in temperature, precipitation, and streamflow in the Great Lakes are examined by using simple Regression analysis. Future changes in precipitation are predicted by using the fitted regression line and is then compared with the GCM scenarios. For the recent past, all hydrologic variables show an increasing trend for each of the five Great Lakes. The results of precipitation trend lines were compared with those of among GCMs outputs for lake of Superior.

Key words: Climate change, Global Climate Models (GCMs), Great Lakes, Precipitation

1. INTRODUCTION

The Great Lakes of North America, namely Lake Superior, Huron, Michigan, Erie and Ontario, represent one of the most important water resources in the world, and provide water for multipurposes for more than fifty million people in eastern North America. Combined, the Great Lakes and their connecting channels comprise the largest fresh surface water system on earth, holding approximately 20 percent of the world's fresh surface water supply (Beeton, 2002). As an indication of the enormous size of the lakes, the estimated cumulative volume of the five lakes is 6 x 10^{15} (six quadrillion) gallons which is sufficient water to flood North America to a depth of 1 metre(GLIN, 2005).

The diversity of uses and the magnitude of the Great Lakes system interactions are testimony to the enormous importance of this freshwater system. However, the Great Lakes Basin represents a drainage area of 770,000 km^2 in the United States and Canada while the water surface area is 244,000 km^2 (Croley, 2004) ; it follows that the Great Lakes drain land areas only twice that of their surface area.

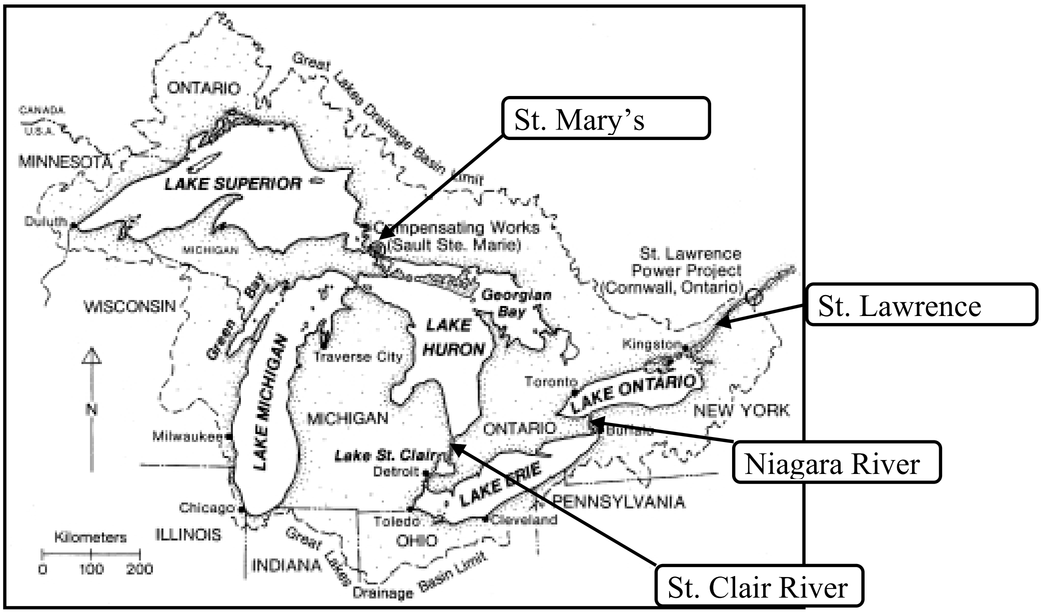


Figure 1: The Great Lakes Basin (*Adapted from Croley , 2004*)

Hence, while enormous in size, imposed stresses have the potential to greatly influence the viability and continued performance of the Great Lakes in a sustained manner. Specifically, stresses include:

(i) Climate Change - Global climate changes in terms of precipitation and temperature may influence the water budget for the Great Lakes; and,

(ii) Diversions - The potential exists for water diversions to be constructed to divert flow from the Great Lakes, to export water to dry areas of North America such as the mid-western states of the USA. Issues of sustainability of, and diversions from, the Great Lakes will intensify in the future decades particularly if global warming intensifies.

As a result of the above, while there are enormous volumes of water in the Great Lakes, the relatively modest contributing drainage area translates to enormous detentions times for the Great Lakes. Hence, while the dimensions of the Great Lakes imply at first “glance” that they might support diversion of large quantities of water out of the watershed, any changes arising from climate change or water diversions will create longterm repercussions on water levels and water budgets (Dulmer et al.,2003). The result is that the implications of climate change are enormous.

2. METHOD

One of the most useful parametric models to detect the trend is the “Simple Linear Regression” model. The method of linear regression requires the assumptions of normality of residuals, constant variance, and true linearity of relationship (Helsel and Hirsch, 1992).

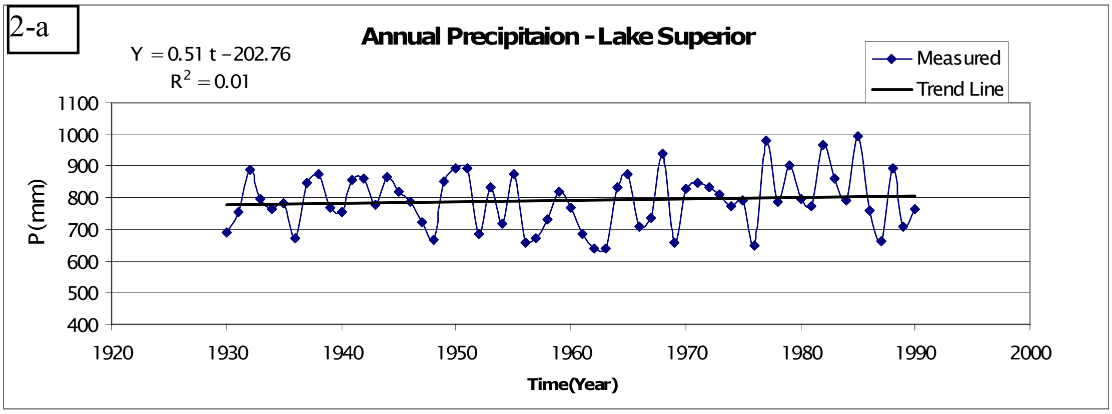
In the paper, climate change impacts on the Great Lakes are described in two dimensions, namely:

(i) a review of historical trends of precipitation, temperatures and flows(Adamowski, et al. 2003), and extrapolation of these historical trends to assess potential future scenarios and,

(ii) comparison of these projected trends with global climate model (GCM) predictions (Lofgren et al.,2002) .

3. RESULTS AND DISCUSSION

As indications of the results, the changes in precipitation phenomena are depicted in Figure 2, as an example of the trends over time. Similarly, flows have been increasing over comparable time periods, as indicated in Figure 3, as an example.



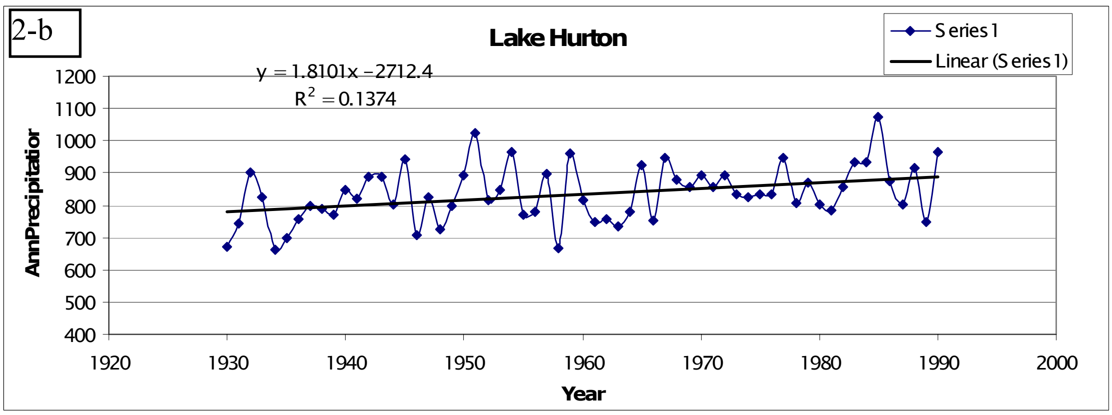
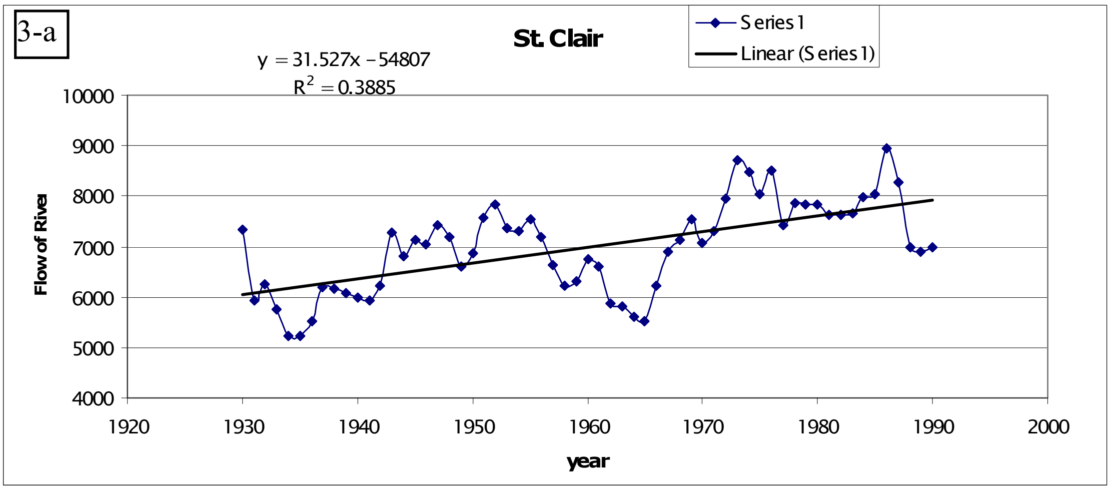


Figure 2(a,b): Indication of Trends in Annual Precipitation Over Time – lakes Hurton and Superior



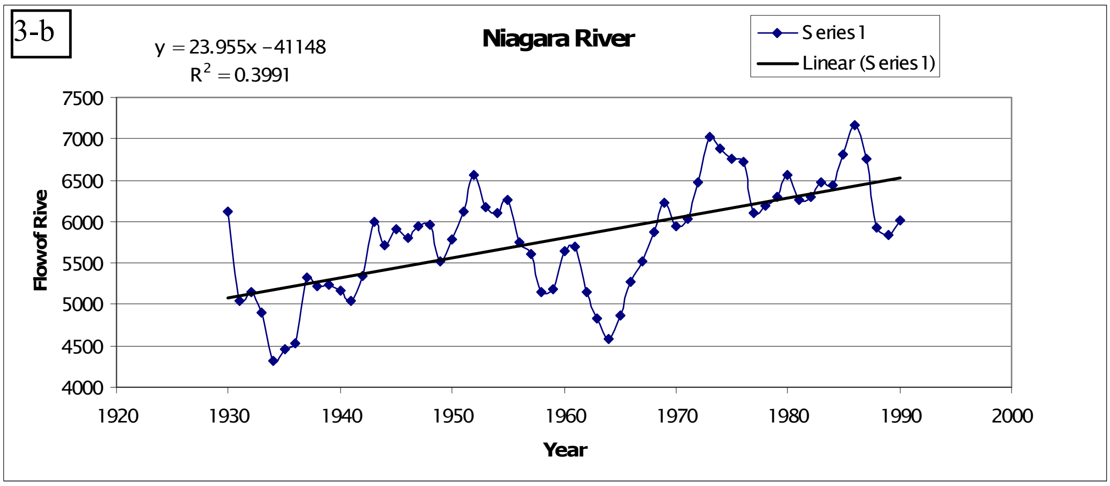


Figure 3(a,b) - Changes in Flows within the Great Lakes System over Time

The result is that both precipitation and streamflows are demonstrating an increasing trend for the recent 70 year period. The trends of precipitation are statistically significant (at 5% level) for the Lakes Michigan, Huron, Erie, and Ontario, but not for the Lake Superior. Flows in the connecting channels St. Clair River, Niagara River, and St. Lawrence River also show a statistically significant (at 5% level) trend.

A comparison of the trends from the historical trend projections as a comparison with the GCMs is provided in Figure 4. Different GCM predictions (Lofgren et al.,2002) vary among themselves by substantial amount, indicating there are high levels of uncertainty associated with such predictions.

The net result of the assessment is that climate change is influencing the sustainability of the Great Lakes system. It will be necessary, however, to ensure that appropriate precautions are extended to not commence significant water takings from the Great Lakes system without sufficient evaluation of the very long term consequences on the water balance of the lakes and rivers which comprise the Basin.

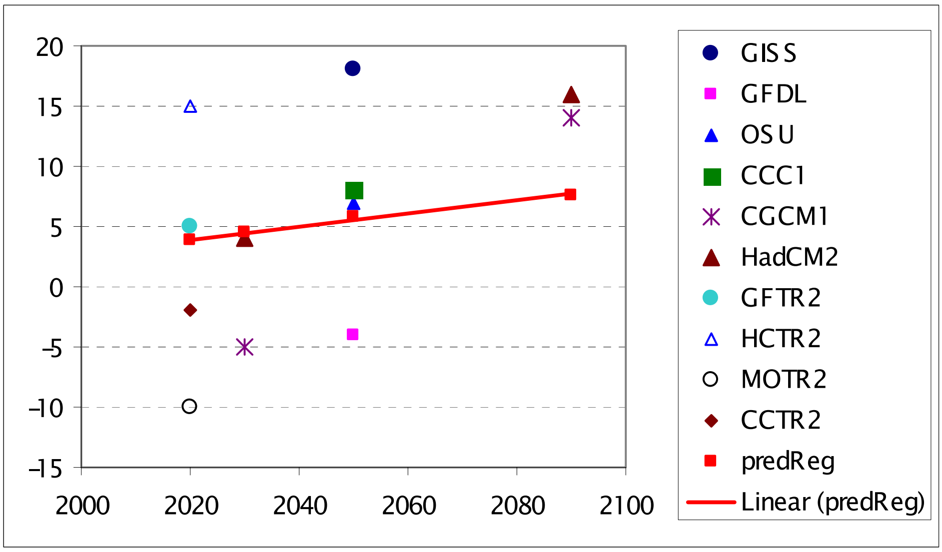


Figure 4 - Comparison of results of GCMs models with predicted model in Lake Superior

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