Extreme Storm Surges on Lake Huron
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ABSTRACT
A two-phase storm surge study is presented, documenting both a deterministic approach and a probabilistic approach for storm surge analysis. The analysis considers extreme storm surge events on the eastern shore of Lake Huron. The deterministic analysis considers a suite of conservative scenarios developed to determine the maximum credible surge level. The probabilistic analysis develops a hazard curve, relating water levels to quantified annual exceedance probabilities, with consideration for both aleatory and epistemic uncertainty. Together the two approaches provide a robust framework for understanding the flooding risk due to extreme storm surges.

KEY WORDS: Storm Surge; Modeling; Uncertainty; Probabilistic; Hazard Curves; Flood Hazards; Joint Probability Analysis.

INTRODUCTION
Extreme storm surges can constitute significant flooding hazards for coastal locations, including locations on the coast of large inland lakes. This study concerns an area on the eastern shoreline of Lake Huron (Fig. 1). Although the methods presented are applicable for estimating storm surges on other parts of Lake Huron, the results discussed are only for a particular stretch of shoreline.

In order to provide a robust understanding of the potential for extreme storm surges on the eastern shoreline of Lake Huron, a study was undertaken to provide both a deterministic analysis and a probabilistic analysis for extreme surges in this area.

The deterministic approach for storm surge analyses developed a maximum credible surge level, representing a conservative upper bound for storm surge levels. The maximum credible surge level is based on multiple hydrodynamic modeling scenarios with conservative atmospheric storm forcing parameters.

The probabilistic approach for storm surge analysis produced a hazard curve, relating surge levels to annual exceedance probabilities. The hazard curve is based on publicly available data from water level gages on Lake Huron, as well as reconstructed paleo lake level data from the literature. Consideration is given to sources of both aleatory and epistemic uncertainty in the analysis.

The individual storm surge event amplitudes and exceedance probabilities were represented with several different types of probabilistic distributions, providing a robust understanding for surge levels. Lake levels were characterized with a novel method that was developed for this study to provide a stochastic representation of mean lake levels with inclusion of paleo lake level data.

This paper is structured in two halves, with the deterministic analysis outlined in the first half and the probabilistic analysis outlined in the second half. The analyses are followed by a short conclusions section.