Impacts of Climate Change on Urban Infrastructure & the Built Environment

A Toolbox

Tool 2.2: Overview of Sea Level Rise and Storm Surge Tools

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1. Introduction

Sea levels are rising and will continue to rise over the 21st century and beyond, primarily because of thermal expansion within the oceans and the loss of ice sheets and glaciers on land. Over the past century (1900–2000), sea level rose at a rate of 1.6±0.2 mm/yr across New Zealand's four main ports (Hannah 2004). Adding an estimated 0.5 mm/yr for crustal rebound in the New Zealand region means an estimate of the absolute (eustatic) sea level rise in New Zealand is around 2.1 mm/yr.

Changes in storm surge (produced by low barometric pressures and adverse winds) will depend on changes in the frequency, intensity and/or tracking of low-pressure systems, and occurrence of stronger winds associated with these systems. Due to uncertainties over changes to storms in New Zealand by 2100, it is often assumed that climate-change will have only a minor effect on storm surges. Since tidal characteristics on the open coast are also expected to remain largely unchanged by future sea level rise, storm tide characteristics are expected to remain similar. Therefore, to predict future extreme storm tides, sea level rise can simply added to the present-day storm tide analysis.

The Tools in Bin 2.2 of this Toolbox demonstrate methods that can be used to derive present-day and future levels of the sea using tidal harmonic analysis and extreme value analysis of sea level records to produce sea level estimates such as the mean high water springs (MHWS10) tide and the 100-year ARI storm tide, how data from these statistical analyses can be used in combination with high resolution digital terrain data to produce useful maps of potential land inundation from the sea.

2. Description of the Sea Level Rise and Storm Surge Tools

Table 2.1 outlines the Sea Level Rise and Storm Surge Tools in this Toolbox. The Tools build on the guidance material in MfE (2008 and 2009) and provide some worked examples based on tidal data from Charleston (near Westport) and Sumner Head, Christchurch [see Toolbox Overview and Case Study Examples]. The methods and statistical models described in the Tools are used for demonstration purposes only. It is recognised that other methods and models are available which can be used to perform functions similar to those described here.

Table 2.1: Tools associated with the evaluation of coastal inundation

Tool Name	Tool Reference	Purpose of the Tool
Guidance on assessing sea level rise in New Zealand	[Tool 2.2.1]	To summarise the MfE (2009) coastal hazards and climate change guide, as well as drawing from the source document (MfE, 2008). Topics covered include historic and recent sea level rise; planning timeframes; and guidance on selecting appropriate sea level rise values.
Causes of sea level variation	[Tool 2.2.2]	To describe the "drivers" of sea-level variability, including waves, climate (e.g. El Niño Southern Oscillation), astronomical effects (e.g. tides), and storm surge. Demonstrates the use of tidal harmonic analysis to estimate practical levels of the sea (e.g. Mean High Water Springs 10) for use in coastal inundation assessments.
Guidance on assessing extreme sea level in New Zealand	[Tool 2.2.3]	To provide a background to extreme sea-level analysis so that a reader can: 1) Understand how an extreme sea-level analysis works; 2) Select an appropriate method to analyse available data; 3) Understand the advantages and disadvantages of various extreme sea-level analysis methods; and 4) Interpret the output of an extreme sea-level analysis.
Inundation mapping of future high tides, SLR and storm surge	[Tool 2.2.4]	The purpose of this tool is to demonstrate a simple GIS-based method for the spatial mapping of coastal inundation, based on sea level rise projections and estimates of the MHWS10 [from Tool 2.2.2] and 100-yr ARI storm surge [from Tool 2.2.3].
Linkages to risk assessment, adaptation options and decision tools	[Tool 2.2.5]	To identify the next stages in an assessment of coastal innundation impacts due to climate change; particularly the assessment of risk [Tools 3.2, 3.3 and 3.5] and adaptation options [Tools 4.2, 4.3 and 4.4].

3. References

MfE (2008). Coastal hazards and climate change: A guidance manual for local government in New Zealand. 2nd Edition. Revised by D. Ramsay and R. Bell (NIWA). Ministry for the Environment Publication No. ME 892, 127 pp.

MfE (2009). Preparing for coastal change: A guide for local government in New Zealand. Ministry for the Environment Publication No. ME 907, 30 pp. + 6 factsheets. http://www.mfe.govt.nz/publications/climate/preparing-for-coastal-change-guide-for-local-govt/