3. Modelling tsunami inundation

3.1. Model mesh topography and bathymetry

A single model mesh was developed to model the two source scenarios of a distant source tsunami (South American origin) and a Tonga-Kermedec source (Figure 2). The grid was refined for Whangarei Harbour and the adjacent land to 50 m above MSL (Mean Sea Level) at a resolution of approximately 20 m point spacing (Figure 3). Bathymetric data were derived from several sources. For the EEZ area (Coastal Ocean floor), existing data were used. Digitised RNZN bathymetric charts were used for various bays and harbours, depths were adjusted from Chart Datum to MSL (+ 1.60 m). The One Tree Point datum was assumed to be at MSL for the purposes of modelling. The land topography was taken from LIDAR data provided by NRC. As for the last study (Northland Regional Council Tsunami Modelling Study 3), these data are referenced to One Tree Point in the vertical, which was assumed to represent approximately MSL for the entire Northland coast (based on surveying by NRC (Bruce Howse, pers. comm.)).

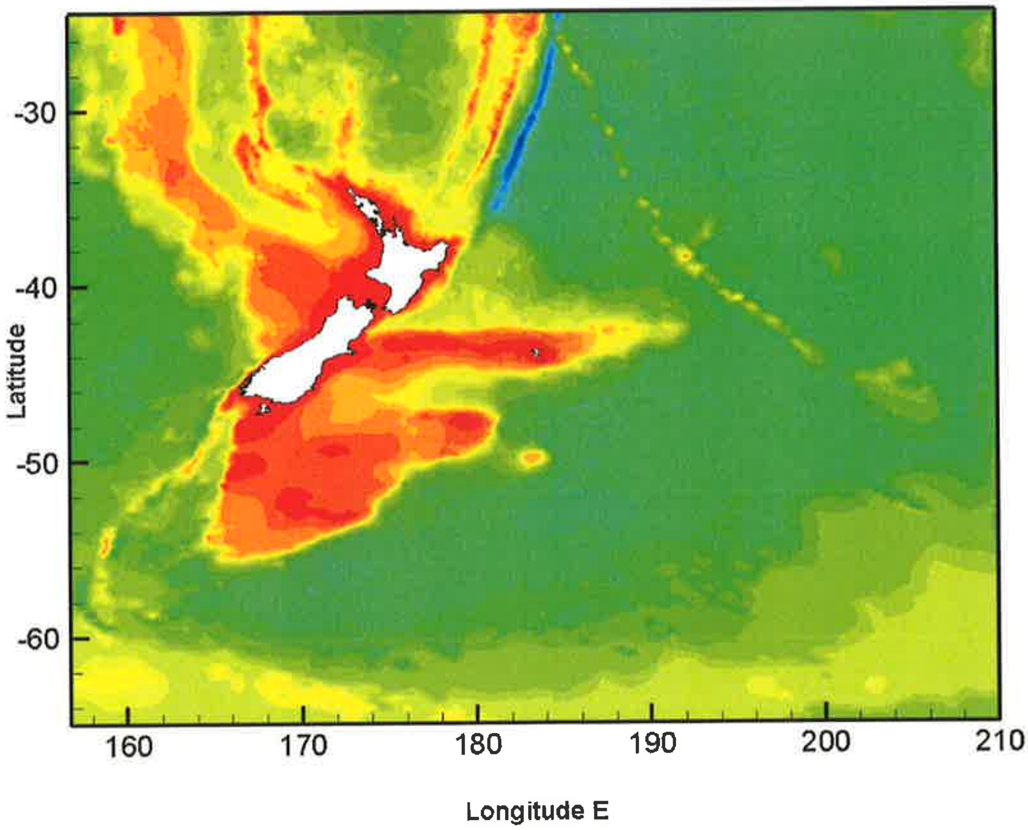

Figure 2: Tsunami model mesh extent. Colour indicates water depth (red, shallower; violet, deeper).

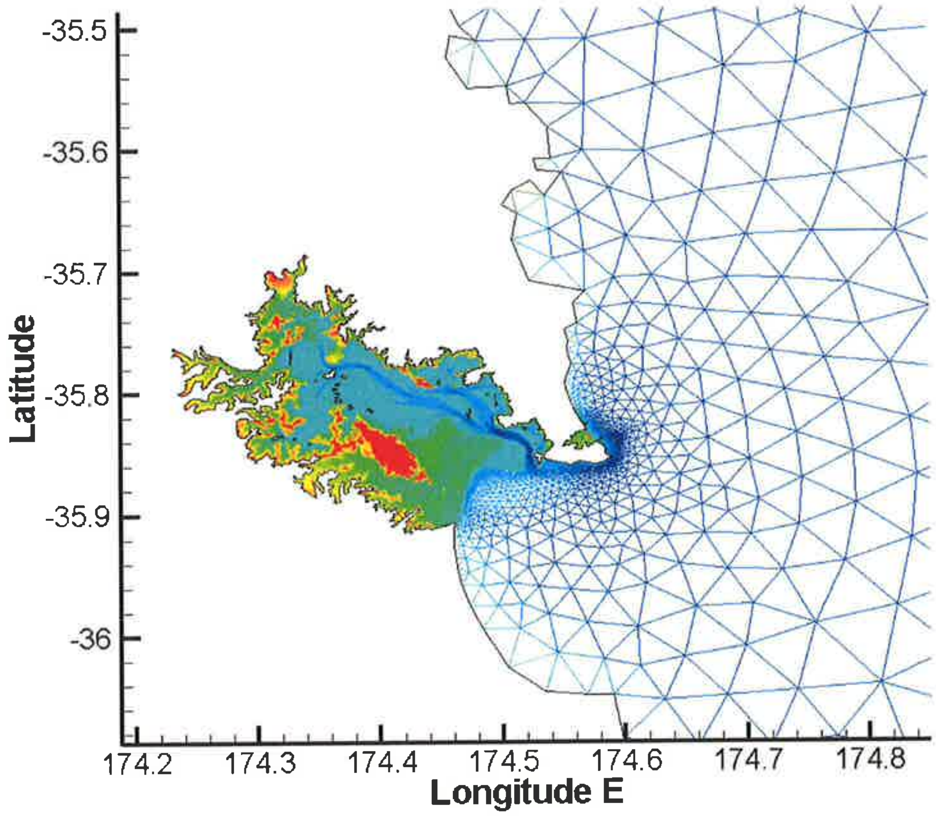

Figure 3: Close-up of the grid around Whangarei Harbour. Water depth increases from red to blue and grid elements decrease in size towards the complex coastline.

3.2. Numerical model

The numerical model used in this study is RiCOM (River and Coastal Ocean Model), a general-purpose hydrodynamics and transport model. It has been developed and refined over several years, with continual re- evaluation and verification (Walters and Casulli, 1998; Walters, 2005; Walters et al., 2006a; 2006b). We used the hydrodynamic components of this model to derive the results presented in this report.

The model is based on a standard set of equations; the Reynolds-averaged Navier-Stokes equation (RANS), and the incompressibility condition. In this study, the hydrostatic approximation is used so the equations reduce to the shallow water equations.

An unstructured grid of triangular elements of varying size and shape across the continental shelf comprised the finite model mesh elements. Smaller grid element sizes closer to the coast quantified the changes in depth that increasingly influence wave propagation in shallower waters.

The time intervals that the model solves for are handled by a semi-implicit numerical scheme that avoids stability constraints on wave propagation. The advection scheme is semi-Lagrangian, which is robust, stable, and efficient (Staniforth and Côté, 1991). Wetting and drying of intertidal or flooded areas occurs naturally with this formulation and is a consequence of the finite volume form of the continuity equation and method of calculating fluxes (flows) through the triangular element faces. At open (sea) boundaries, a radiation condition is enforced, so that out-going waves will not reflect back into the study area, but, instead, are allowed to realistically continue "through" this artificial boundary and into the open sea. The equations are solved with a conjugate-gradient iterative solver. Details of numerical approximations, required robustness and efficiency are described in Walters and Casulli (1998) and Walters (2005).