Tauranga Harbour Sediment Study: Specification of Scenarios

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A. Parshotam
T. Hume
S. Elliott
M. Green
S. Wadhwa

NIWA contact/Corresponding author

T. Hume

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National Institute of Water & Atmospheric Research Ltd
Gate 10, Silverdale Road, Hamilton
P O Box 11115, Hamilton, New Zealand
Phone +64-7-856 7026, Fax +64-7-856 0151
www.niwa.co.nz

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Reviewed by:

D.S. Roper

Approved for release by:

D.S. Roper

Formatting checked

Executive Summary

This report defines scenarios that are to be modelled in the Tauranga Harbour Sediment Study, including the way the scenarios were derived and the assumptions that were used. Three scenarios are to be modelled, which differ in terms of landuse, which includes earthworks associated with any development, and weather. Each scenario covers 50 years into the future from the present day, which is defined as 2001.

Scenario 1 has present-day (2001) landuse with 2007 earthworks associated with development, and present-day weather. This scenario is intended as a baseline against which comparisons can be made. Scenario 2, for the period 2001 to 2051, has landuse as provided for in SmartGrowth and Change No. 2 (Growth Management) to the Regional Policy Statement Change in the Western Bay of Plenty sub-region, and present-day weather. Scenario 3, for the period 2001 to 2051, has the same landuse as scenario 2, but with weather incorporating anticipated effects of climate change.

1. Introduction

1.1 Background

Environment Bay of Plenty (EBOP) seeks to understand sedimentation in Tauranga Harbour in order to understand sediment sources and fate sufficiently to appropriately manage growth and development now and in the future. This will also assist EBOP to adapt management rules and practices appropriately and be able to make decisions concerning development of the harbour and catchment with full understanding of likely sedimentation effects. This need stems from section 5 of the Tauranga Harbour Integrated Management Study (THIMS), which describes the many effects of sediments. Although these changes are to a large extent driven by historical events when there was little control on development, there is increasing public concern about sediment-related issues, and these are expected to escalate as the catchment continues to develop and climate change becomes increasingly felt. The THIMS recommended a review of the drivers and consequences of sedimentation, including analysis of sediment yields from all sources in the catchment, peak flow monitoring, projection of sediment yields under proposed development scenarios, assessment of sediment effects in the harbour including cumulative effects, analysis of current best practices, and recommendations on how to address the findings, including appropriate policy.

EBOP contracted NIWA to conduct the Tauranga Harbour Sediment Study. The study began in April 2007 and is scheduled to run for 3 years. The main aim of the study is to develop a model or models to be used to: (1) Assess relative contributions of the various sediment sources in the catchment surrounding Tauranga Harbour, (2) Assess the characteristics of significant sediment sources, and (3) Investigate the fate (dispersal and deposition) of catchment sediments in Tauranga Harbour. The project area is defined as the southern harbour, extending from Matahui Point to the harbour entrance at Mount Maunganui. The time frame for predictions is 50 years from the present day (2001).

1.2 Study outline and modules

The study consists of 6 modules:

Module A: Specification of scenarios – Defines landuse and weather that are required for driving the various models. Three scenarios are defined in terms of landuse, which includes earthworks associated with any development, and weather. The weather is described in terms of magnitude and frequency of storms and wind climate, and needs to be specified to a degree that is sufficient for driving models. The third scenario incorporates anticipated effects of climate change.

Module B: Catchment sediment modelling - (1) Uses the GLEAMS model to predict time series of daily sediment yields from each subcatchment under each scenario, (2) Summarises these predictions to identify principal sources of sediment in the subcatchment; to compare sources of sediment under present-day landuse and under future development scenarios; and to assess sediment characteristics of significant sources, and (3) Provides sediment loads to the USC-3 model for extrapolation of harbour sedimentation over the decadal scale.

Module C: Harbour bed sediments - (1) Develops a description of the harbour bed sediments to provide sediment grainsize and composition information required for running the harbour sediment-transport model and for initialising the USC-3 model, and (2) Provides information on sedimentation rates over the past 50 years for end-of-chain model validation.

Module D: Harbour modelling - (1) Uses the DHI FM (Flexible Mesh) hydrodynamic and sediment models and SWAN wave model to develop predictions of sediment dispersal and deposition at the "snapshot" or event scale, including during and between rainstorms and under a range of wind conditions, and (2) Provides these event predictions to the USC-3 model for extrapolation of harbour sedimentation over decadal scales.

Module E: USC-3 model - Uses the USC-3 model to make predictions of sedimentation, bed-sediment composition and linkages between sources and sinks, based on division of the catchment into subcatchments and the estuary into sub-estuaries. An end-of-chain model validation will consist of comparing USC-3 model predictions of annual-average sedimentation rate to measurements, where the measurements derive from Module C.

Module F: Assessment of predictions for management – Assesses and synthesises information developed in the modelling components of the study using an expert panel approach. It will address matters including: (1) Which catchments are more important as priority areas for focusing resources to reduce sedimentation in the harbour?, (2) What are the likely effects of existing and future urban development on the harbour?, (3) How can the appropriate regulatory agencies (EBOP, WBPDC and TCC) most effectively address sedimentation issues, and what management intervention could be appropriate? and (4) Are there any reversal methods, such as mangrove control and channel dredging, that may be effective in managing sedimentation issues?

1.3 This report

This report is Technical Report A1 of the study and completes Module A and Milestone 1. It defines landuse and weather that are required for driving the various models of the Tauranga Harbour Sediment Study. It documents the scenarios, including the way they were derived and the assumptions that were used. It defines scenarios in terms of landuse, which includes earthworks associated with any development, and weather. Future landuse and weather scenarios cover 50 years into the future from the present day, which is defined as 2001.

The specification of scenarios follows discussion with EBOP and synthesis of various documents provided by EBOP. The scenarios will be formalised and signed off between NIWA and EBOP before the scenarios can be analysed.

2. Scenarios

2.1 Overview

Three scenarios are to be defined in terms of landuse (which includes earthworks associated with any development) and weather. The weather is described in terms of magnitude and frequency of rainfall and wind, and needs to be specified to a degree that is sufficient for driving models.

Scenario 1: 2001 to 2051, with present-day (2001) landuse, and present-day weather. This scenario is intended as a baseline against which comparisons can be made.

Scenario 2: 2001 to 2051, with landuse as provided for in SmartGrowth and Change No. 2 (Growth Management) to the Regional Policy Statement Change in the Western Bay of Plenty sub-region, and present-day weather.

Scenario 3: As scenario 2, but with weather incorporating anticipated effects of climate change.

A summary of scenarios is provided in Table 1.

Table 1: Scenarios defined with respect to landuse and weather that are required for driving the various models.

Scenario	Landuse	Weather
1	Present-day (2001)	Present-day
2	SmartGrowth	Present-day
3	SmartGrowth	Climate change

2.2 Description of landuses

2.2.1 Present–day

Landuse maps were prepared from the New Zealand Landcover Database 2 (LCDB2). These are based on Landsat 7 ETM + satellite imagery (70 land cover classes), and provide a snap-shot of land cover within the study area in 2001/02 (see Figure 1).

Landuses within the study area were subsequently classified into a smaller number of classes for use in the GLEAMS catchment model (Figure 2).

The spatial distribution of earthworks data associated with development within the study area is based on 2007 aerial photography.

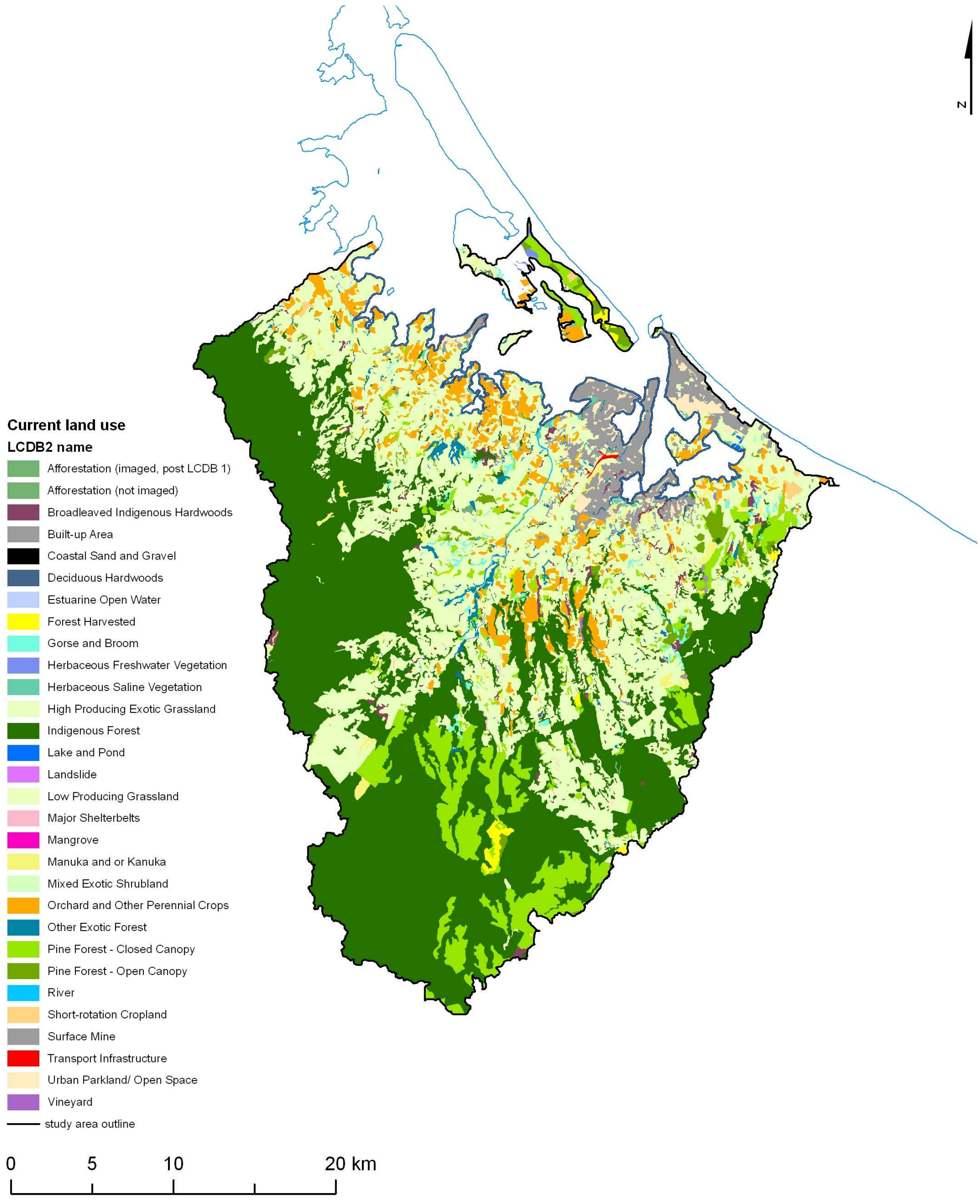

Figure 1: Map of present day (2001) landuse within the study area prepared from LCDB2.

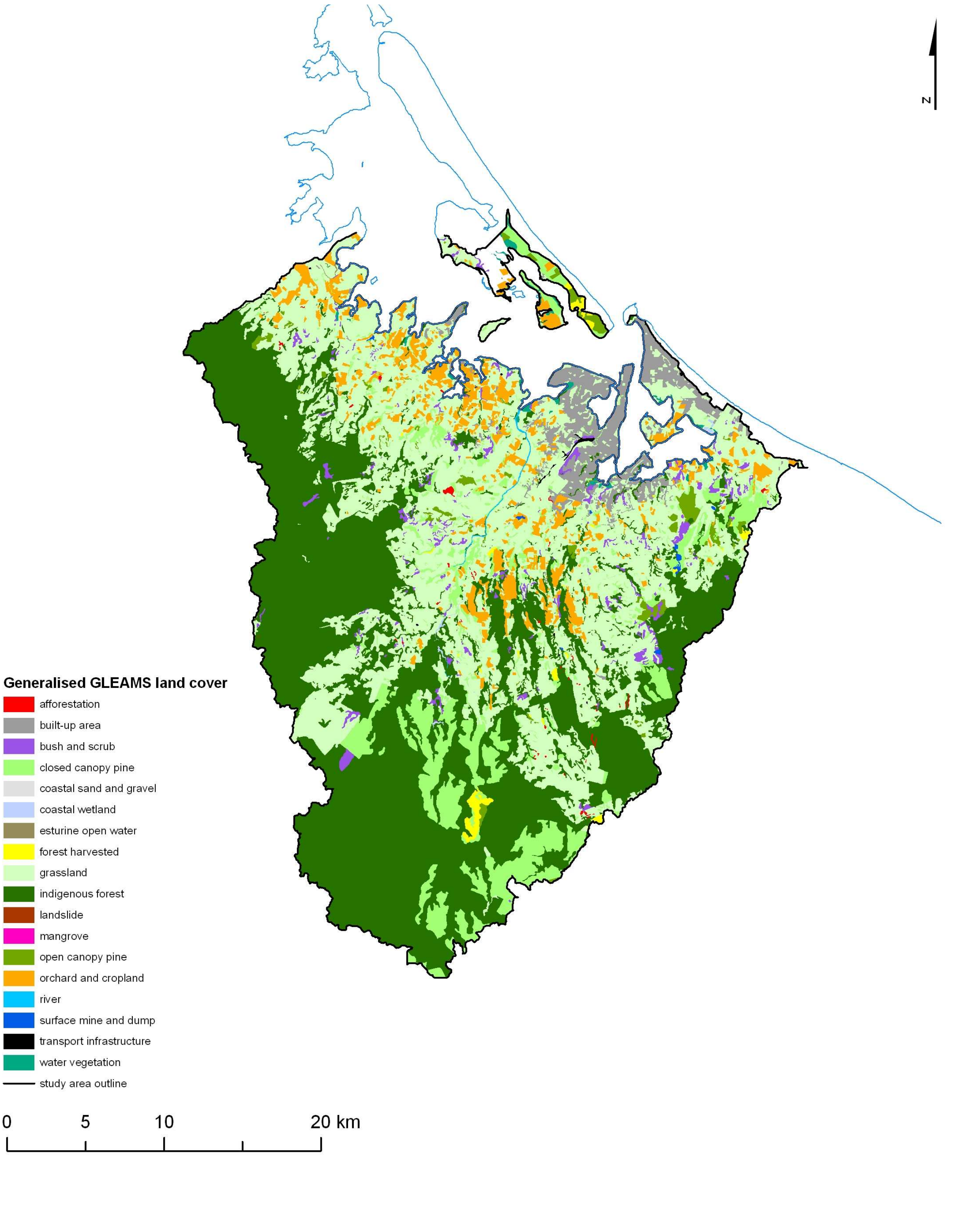

Figure 2: Map of present day (2001) generalised GLEAMS land cover within the study area.

2.2.2 SmartGrowth

The Western Bay of Plenty sub-region 50-year strategy and implementation plan on landuse scenarios is presented in SmartGrowth (2007). The SmartGrowth programme provides projected future urban boundaries for the years 2021 and 2051. For this study, we have used a version of the boundaries as amended on 21 March 2008, as provided by Environment BOP. It is assumed that there will be no rural residential growth outside of the sub-regional urban limit during the future time period. Future landuse outside of the sub-regional urban limits given in SmartGrowth (2007) is assumed to be the same as at present (2001).

For the purposes of the GLEAMS modelling and in order to achieve a smoother progression of landuse and change in sediment runoff we mapped the landuse (and defined the weather – next section) in 10-year intervals (i.e., 2011, 2021, 2031, 2041, 2051). Urban boundaries in the year 2011 were derived by interpolation between the current boundary (built-up areas and urban open space from LCDB2) and the SmartGrowth boundary for 2021. Urban boundaries in the years 2031 and 2041 were derived by interpolation between the SmartGrowth boundaries for 2021 and 2051. This interpolation was done such that the increase in areas between time intervals was consistent with increases in population as tabulated in Figure 7 of SmartGrowth (2007). The resulting urban boundaries are shown in Figure 3.

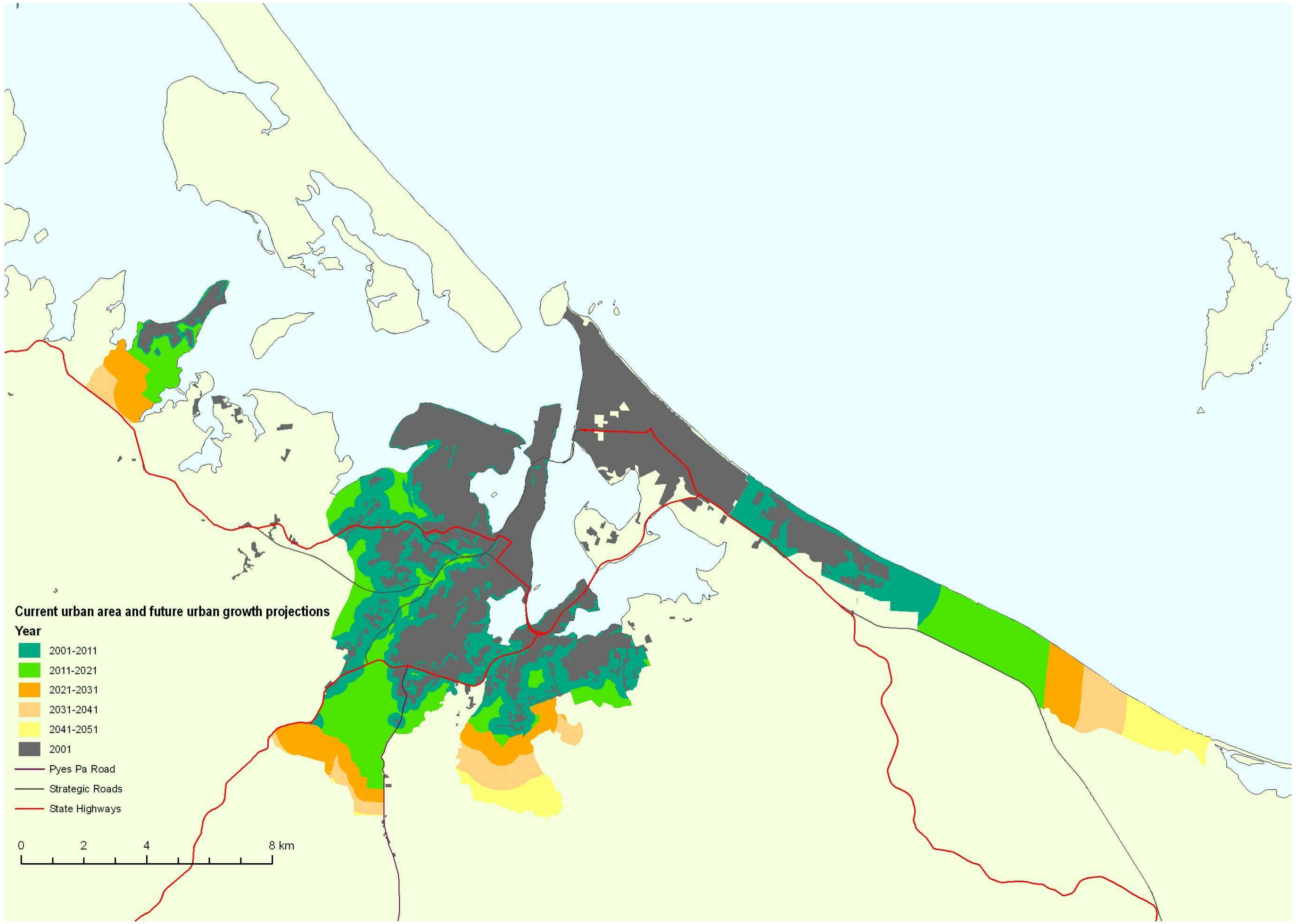

Figure 3: Map of current urban area and future urban growth projections.

2.3 Description of weather

2.3.1 Present–day

To construct present-day weather time series for driving models, long-term composite Tauranga station data (daily rainfall, min/max temperature) from Griffiths et al. (2003) will be used, supplemented with records from the Tauranga Airport AWS (Automatic Weather Station) for the period 2002 to 2007. This gives a combined record covering a period of at least 50 years. The Tauranga Airport B76621/B76624 stations are recommended temperature and rainfall reference stations within the Bay of Plenty (Griffiths et al. 2003).

The distribution of long-term median annual temperature and rainfall are obtained from NIWA's climate grids, which are interpolated from observation stations using ANUSPLINE (Tait et al. 2006) (see Figures 4 and 5).

Based on the distribution of rainfall, the study area is divided into three major climate regions, referred to as RR1, RR2 and RR3 (Figure 6). The GLEAMS model will be run with a different weather input for each of these three climate regions to predict sediment runoff.

Temperature data for climate region RR1 is taken from long-term composite data at the Tauranga Airport reference station (see Figure 6). Temperature data for climate regions RR2 and RR3 will be created by applying temperature offsets to the RR1 data. The offsets will be based on Figure 4.

Daily rainfall for RR1 is taken from the representative Tauranga Airport reference station. The daily rainfall data for RR2 and RR3 will be created by applying a factor to the Tauranga Airport data. The factor will be based on Figure 5.

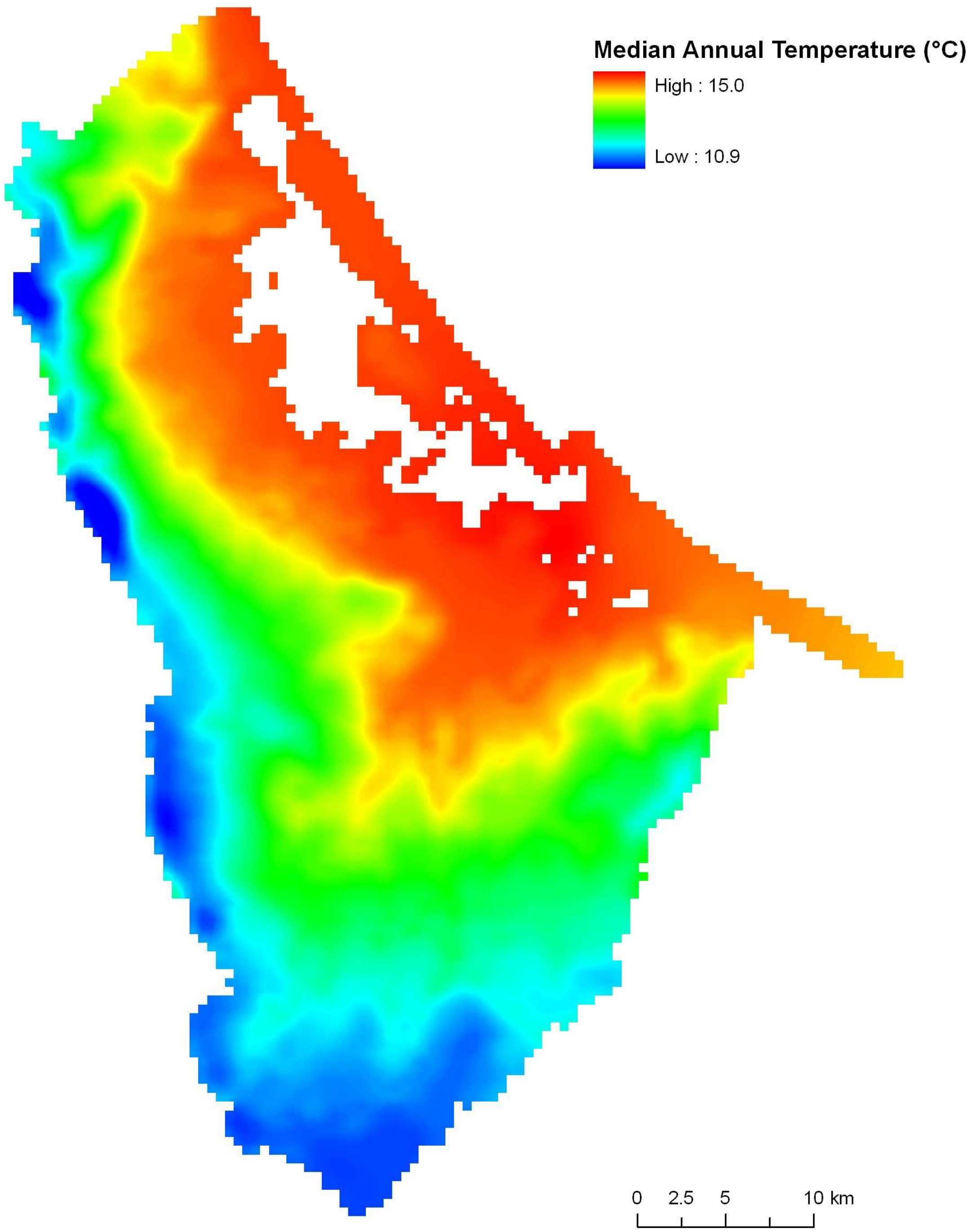

Figure 4: Map of median annual temperature.

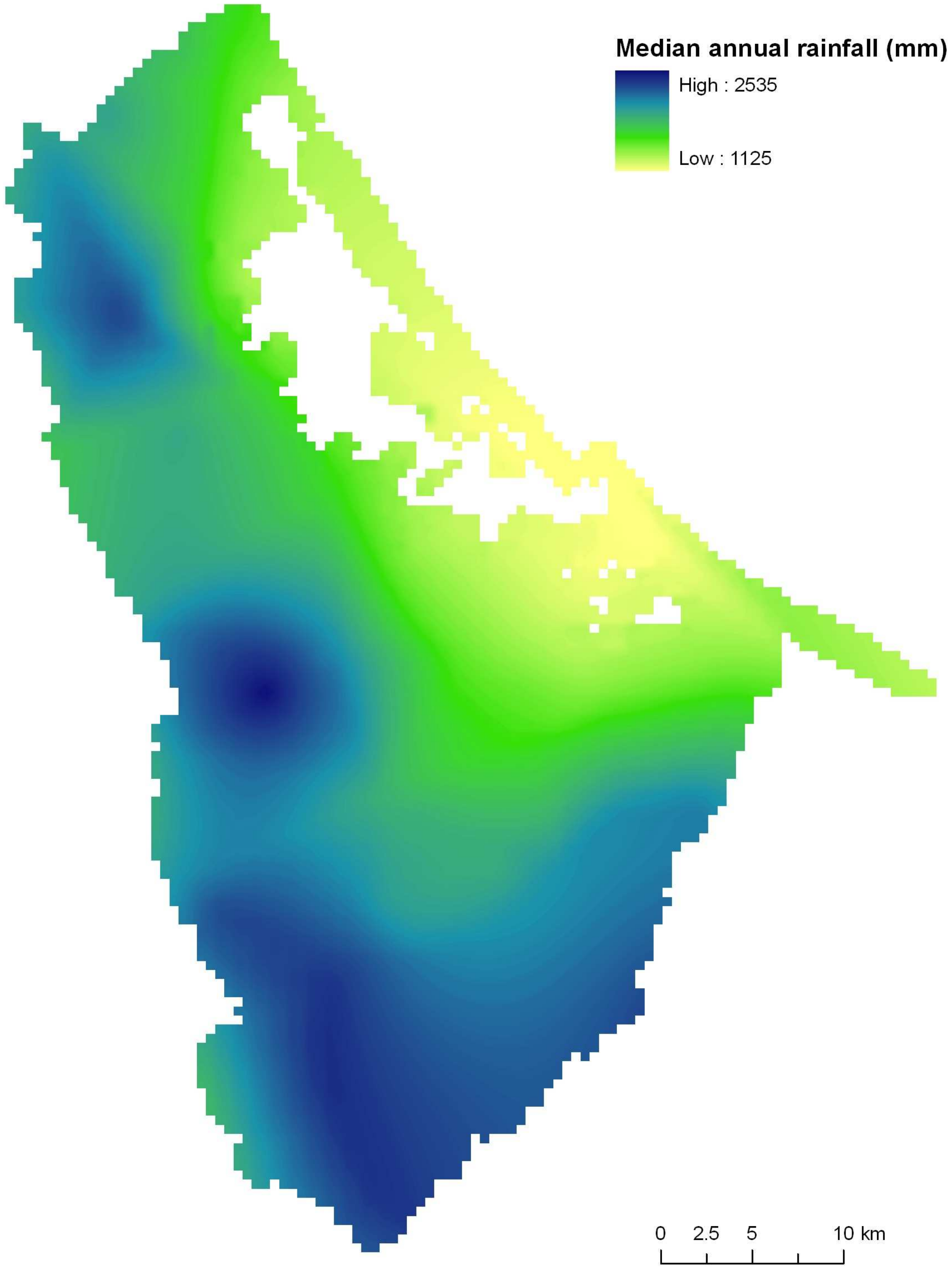

Figure 5: Map of median annual rainfall.

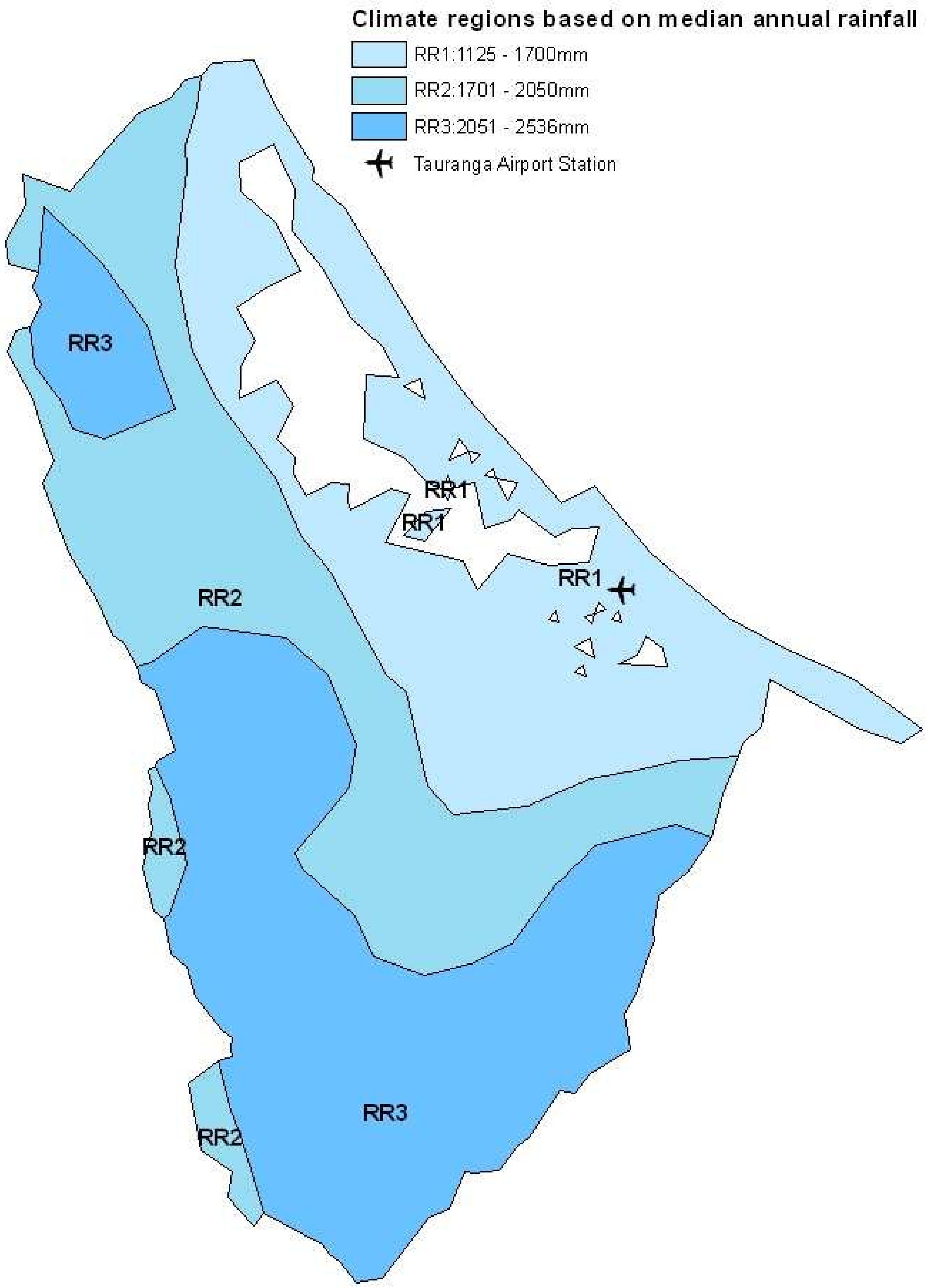

Figure 6: Map of 3 major climate regions based on median annual rainfall and location of Tauranga Airport reference station.

2.3.2 Climate change

Climate change predictions have been prepared by NIWA, based on statistically downscaled changes to mean monthly temperature and precipitation from 12 global climate models, forced by a middle-of-the-road IPCC emissions scenario (known as A1B). At least 3 predictions are available, including an average model, a wettest model and a hottest model. We will use the wettest model for this study to provide worst-case predictions of sediment runoff and sedimentation in Tauranga Harbour. EBOP may also wish to extend the project to include a range of models, to gain better insight into implications of climate model uncertainty.

Based on the climate change projection an adjustment will be applied to the rainfall observational record that accounts for:

- Monthly mean rainfall changes; and

- Redistribution of daily rainfall to increase extremes (and also increase number of dry days) according to an empirical formula based on Table 5.2 in the updated MfE Guidance Manual (Ministry for the Environment, 2008) that scales the extremes according to the extent of the annual temperature increase.

An adjustment for temperature will also be applied, based on the climate change projection.

The projections will apply to the Tauranga site; the predictions will be distributed across the climate regions as described previously.

Climate change projections are available for the years 2011, 2021, 2031, 2041 and 2051. This progression of records will be used in the climate change scenario simulation, rather than using the climate for a single future date (such as 2051).

The wind data required to run the estuary sediment dispersal and deposition model (which provides data that in turn is used in the USC-3 model) will not be adjusted, as this is beyond the capabilities of current NIWA climate-change models.

3. References

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Tait, A.B.; Henderson, R.D.; Turner, R.W. & Zheng, X. (2006). Thin plate smoothing spline interpolation of daily rainfall for New Zealand using a climatological rainfall surface. *International Journal of Climatology* *26*: 2097-2115.