# Sea-Level Extremes At Four New Zealand Tide Gauge Locations And The Impact Of Future Sea-Level Rise

**Research conducted for**

**Office of the Parliamentary Commissioner for the Environment**

**Wellington, New Zealand**

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# 1 Introduction

The work described in this document was commissioned by the Office of the Parliamentary Commissioner for the Environment (OPCE), Wellington, New Zealand, in July 2015 (see Appendix A). Summarising, the key tasks were to:

1. Calculate the Gumbel scale parameter of storm-tide extremes from the tide-gauge data provided.
2. Calculate the best estimate and standard deviation of sea-level rise during this century, based on the projections of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) for RCP4.5 and RCP8.5.
3. Calculate sea-level planning allowances to accommodate future sea-level rise.
4. Calculate future average recurrence intervals (ARIs, also known as return periods), based on a range of present-day ARIs, each of which is prescribed by a specific vertical height. This includes the peak heights of a number of nominated recent storm events.

The study follows closely the techniques described by Hunter (2012) and Hunter et al (2013).

# 2 Caveats

The methodology presented here is subject to a number of caveats:

a. These sea-level planning allowances only relate to the effect of sea-level rise on *inundation* and *not* on the recession of soft (e.g. sandy) shorelines or on other impacts.

b. While these allowances include the effects of vertical land motion due to changes in the Earth's loading and gravitational field, caused by past and ongoing changes in land ice (glacial isostatic adjustment (GIA) and the 'gravitational fingerprint' contribution, respectively), they do not include effects due to tectonic motion or local land subsidence (produced, for example, by groundwater withdrawal); *separate allowances may need to be applied to account for these latter effects.*

c. These allowances are based on the assumption that the statistics of the storm tides will not change in time. This is supported by the fact that present evidence (Bindoff et al, 2007, Lowe et al, 2012, Menéndez and Woodworth, 2010, Woodworth and Blackman, 2004) suggests that the rise in mean sea level is generally the dominant cause of any observed increase in the frequency of inundation events. In addition, using model projections of storm tides in southeast Australia to 2070, McInnes et al (2009) showed that the increase in the frequency of inundation events was dominated by sea-level rise.

d. These allowances include no contribution due to possible changes in wave setup or runup.

e. These allowances include no contribution due to the change in tides caused by sea-level rise, which are generally small and confined to quite specific locations in shelf seas.

f. These allowances depend on an assumed probability distribution for the uncertainty of the sea-level rise projections. Here, a normal or Gaussian distribution has been used, which represents a pragmatic compromise between a tightly confined distribution, and one with a fat upper tail (i.e. one in which there is a low probability of having a very high sea-level rise relative to the best estimate of that rise). The allowances represent a practical solution to planning for sea-level rise while preserving an acceptable level of inundation likelihood, in cases where 'getting the allowance wrong' is manageable. However, in cases where the consequence of inundation would be 'dire' (in the sense that the consequence of inundation would be unbearable, no matter how low the likelihood, as in case of the Netherlands), a precautionary approach would be *not* to use the allowances presented here, but to base an allowance on the best estimate of the maximum possible rise.

g. Two versions of each allowance and average recurrence interval are given: one denoted 'very likely' and the other denoted 'likely'. The 'very likely' version involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' version is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty. The arguments supporting the 'likely' assumption were presented by the Fourth and Fifth Assessment Reports ('AR4' and 'AR5', respectively) of the Intergovernmental Panel on Climate Change ('IPCC'), but the author does not find these entirely convincing. However, a precautionary approach would be to use the 'likely' versions, which give slightly larger allowances and smaller ARIs than the 'very likely' version.

# 3 The Derivation of Sea-Level Planning Allowances

The derivations described here summarise those of Hunter (2012) and Hunter et al (2013) (which are almost identical), although the ordering of the equations has been changed somewhat to relate more closely to the present study.

The method assumes that the sea-level extremes (from both tides and storm surges) can be described by a Gumbel distribution, which is the the simplest of the generalised extreme-value distributions (GEVs) and was used here because (1) it fits most sea-level extremes quite well (e.g. van den Brink and Können, 2011) and (2) it yields a sea-level planning allowance that is independent of the required level of precaution. The Gumbel distribution relates the average recurrence interval, $R$, to the physical height, $z_P$, (e.g. the height of a critical part of a coastal asset) by:

$$R = \exp\left(\frac{z_P - \mu}{\lambda}\right) \tag{1}$$

where $\mu$ is a 'location parameter' and $\lambda$ is a 'scale parameter'.

The method assumes that there is no change in the variability of the extremes relative to mean sea level, which implies that the value of the scale parameter, $\lambda$, does not change with a rise in sea level. It is also assumed that there is no change in wave climate (and therefore in wave setup and runup).

In this report, the ARI, $R$, is given in years. The location parameter, $\mu$, is therefore the height at which the ARI is exactly one year.

If mean sea level rises by a best estimate (or central value), $\Delta z$, plus an uncertain amount, $z'$, (which has a statistical distribution with zero mean and standard deviation, $\sigma_u$), the ARI becomes:

$$R' = \exp\left(\frac{z_P - \mu - \Delta z - z'}{\lambda}\right) \tag{2}$$

The form of the distribution of $z'$ is not well known but, for the present work, a normal or Gaussian distribution has been assumed. This represents a pragmatic compromise between a tightly confined distribution, and one with a fat upper tail (i.e. one in which there is a low probability of having a very high sea-level rise relative to the best estimate of that rise).

Because of the presence of $z'$ in Eq. 2, $R'$ can take many values for any single value of the best estimate $\Delta z$. However, an 'effective' estimate, $R''$, may be derived by calculating the average frequency of flooding events (i.e. the average value of $1/R'$) over all $z'$ and taking the reciprocal of the result[1], giving:

$$R'' = \exp\left(\frac{z_P - \mu - A}{\lambda}\right) \tag{3}$$

where $A$ is an 'effective' sea-level rise, given by:

$$A = \Delta z + \frac{\sigma_u^2}{2\lambda} \tag{4}$$

(see Hunter (2012) or Hunter et al (2013) for a thorough derivation of this step).

The second term on the right-hand side of Eq. 4 is an additional amount of effective sea-level rise required to cope with the uncertainty in the sea-level rise projections. As noted above, the distribution of $z'$ is here assumed to be normal or Gaussian; other distributions yield similar equations to Eq. 4, but with a different form for the second term on the right-hand side (which still depends on the width of the distribution and on the Gumbel scale parameter, $\lambda$).

If the asset is now raised by an amount, $B$, the ARI becomes:

$$R''' = \exp\left(\frac{z_P + B - \mu - A}{\lambda}\right) \tag{5}$$

In order to preserve the average frequency of flooding events at the same value as it was originally, $R$ (Eq. 1) needs to be set equal to $R'''$ (Eq. 5), requiring that $B = A$. The asset

[1]Note that, for statistical reasons, the relevant variable to average is the *frequency of flooding events* rather than its reciprocal (the ARI).

therefore needs to be raised by an amount equal to the 'effective' sea-level rise, $A$. This ($A$, as given in Eq. 4) is therefore an appropriate sea-level planning allowance.

In the present work, two different estimates of $\sigma_u$ are used, one denoted 'very likely' and the other denoted 'likely'. The 'very likely' estimate involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. This is equivalent to setting:

$$\sigma_u = \sigma_m \tag{6}$$

The 'likely' version is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty. For a normal or Gaussian distribution, this is equivalent to setting:

$$\sigma_u = 1.724\sigma_m \tag{7}$$

The arguments supporting the 'likely' assumption were presented by the IPCC AR4 and AR5, but the author does not find these entirely convincing. However, a precautionary approach would be to use the 'likely' versions, which give slightly larger allowances and smaller ARIs than the 'very likely' version.

To summarise, the application of the above sea-level planning allowance ensures that the expected, or average, number of extreme (inundation) events in a given period is preserved under sea-level rise. In other words, any asset raised by this allowance would experience the same frequency of inundation events under sea-level rise as it would without the allowance and without sea-level rise. It is important to note that this allowance only relates to the effect of sea-level rise on *inundation* and not on the recession of soft (e.g. sandy) shorelines or on other impacts.

In the terminology of risk assessment (e.g. ISO, 2009), the expected number of inundation events in a given period is known as the *likelihood*. If a specific cost may be attributed to one inundation event, then this cost is termed the *consequence*, and the combined effect (generally the product) of the likelihood and the consequence is the *risk* (i.e. the total effective cost of damage from inundation over the given period). The allowance is therefore the height that an asset needs to be raised under sea-level rise in order to keep the inundation risk the same.

An important property of the allowance is that it is *independent of the required level of precaution.* In the case of coastal infrastructure, an appropriate height should first be selected, based on *present* conditions and an acceptable degree of precaution (e.g. an average of one inundation event in 100 years). If this height is then raised by the allowance calculated for a specific period, the required level of precaution will be sustained until the end of this period.

The planning allowances and future effective average recurrence intervals (EARIs) derived here are based on the following information:

1. the IPCC AR5 regional projections of sea-level rise for RCP4.5 and RCP8.5, and

2. the statistics of storm tide extremes (specifically the Gumbel scale parameter) for tide-gauge observations at Auckland, Dunedin, Lyttleton and Wellington.

# 4 The Input Data

## 4.1 Sea-Level Rise Projections

This study used the regional projections of the IPCC AR5, which were forced by *atmospheric concentrations* of greenhouse gases and aerosols, rather than by the *emission scenarios* used by the AR4. The atmospheric concentrations are characterised by *Representative Concentration Pathways* or *RCPs*. The allowances presented here are based on RCP4.5 and RCP8.5, which are roughly equivalent to the B1 and A1FI SRES[2] emission scenarios, respectively (Wayne, 2013). The world is broadly following A1FI at present (Le Quéré et al, 2009)). RCP8.5 is the highest-emission RCP presented in the AR5.

The AR5 presented regional projections of *relative sea-level rise*[3], including the effects of past and future changes of ice on land (glacial isostatic adjustment (GIA) and the 'gravitational fingerprint' contribution, respectively). As an example, Figure 1 shows regional projections of sea-level rise between 1986-2005 and 2081-2100 from the AR5, based on the RCP4.5 Representative Concentration Pathway (Church et al, 2013).

The results presented here were based on annual time series of the AR5 sea-level projections for RCP4.5 and RCP8.5 over the 21st century, defined on a 1° longitude × 1° latitude grid. They were downloaded from:

`http://icdc.zmaw.de/thredds/catalog/ftpthredds/ar5_sea_level_rise/catalog.html`

on 22/7/2014.

Figure 2 shows New Zealand with the locations of the sea-level projections shown as black dots. Also shown are the tide-gauge locations (red dots).

The AR5 sea-level rise projections were interpolated to the four tide-gauge locations using variants of linear interpolation, depending on the number of 'model' points surrounding each coastal point. One component of the total sea-level rise, the *glacial isostatic adjustment* or *GIA*, was treated in a slightly different way, because it is available over the whole Earth (i.e. at the black dots shown in Figure 2 *plus* the remaining locations that would complete the 'checker-board' pattern). GIA can therefore be interpolated at the coastal locations using all four nearest neighbours and bilinear interpolation. Two sets of coastal sea-level projections have therefore been computed:

1. projections based on linear interpolation of the regional sea-level projections, *using ocean points only*, and

[2]Special Report on Emission Scenarios; Nakicenovic et al, 2000.
[3]'Relative sea-level rise' is the sea-level rise relative to the land.

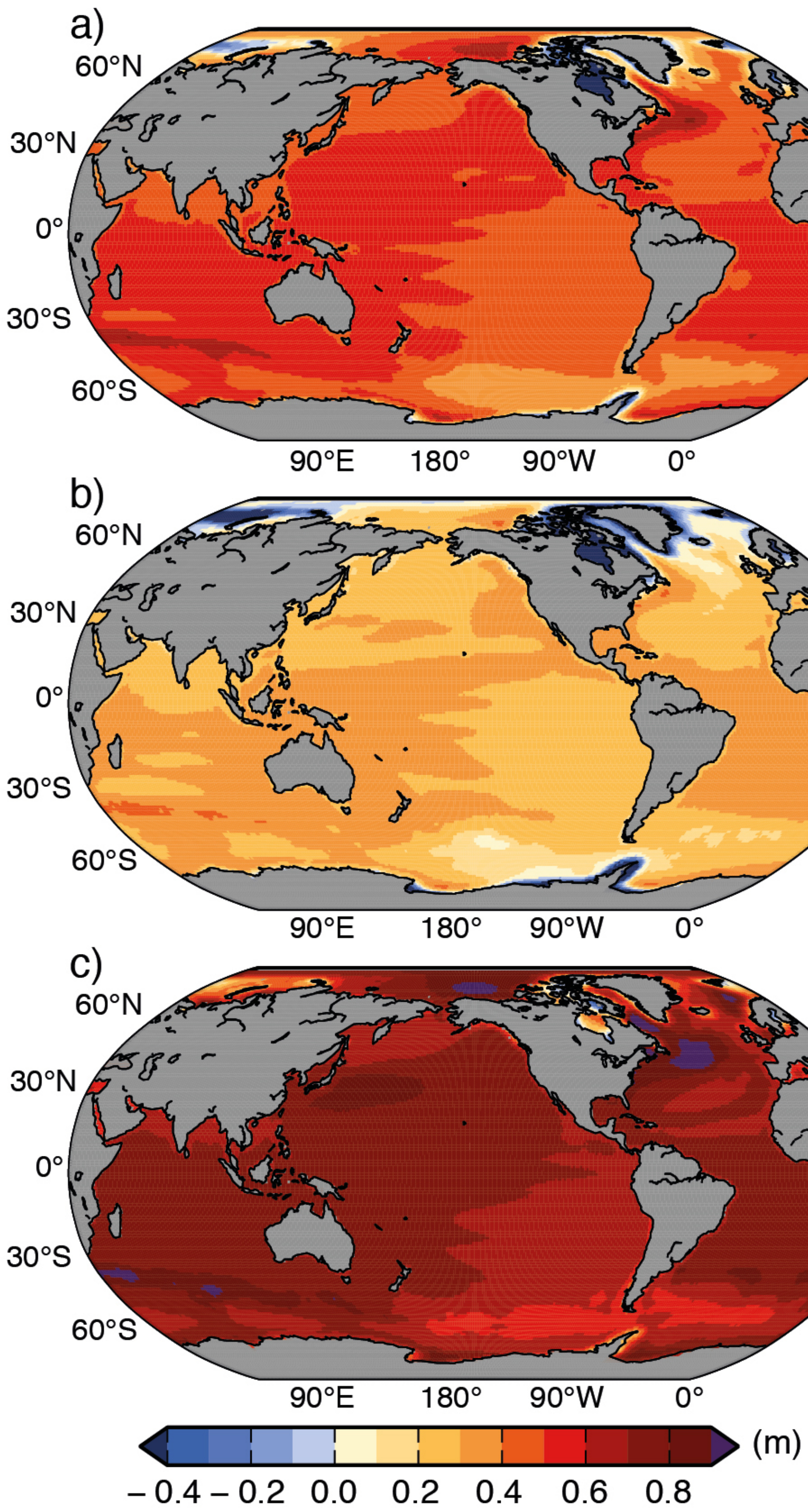


Figure 1: Regional projections of sea-level rise between 1986-2005 and 2081-2100 from the AR5, based on the RCP4.5 Representative Concentration Pathway. (a) is the global mean, (b) the 5-percentile lower bound and (c) the 95-percentile upper bound. From Church et al (2013), Figure 13.19.

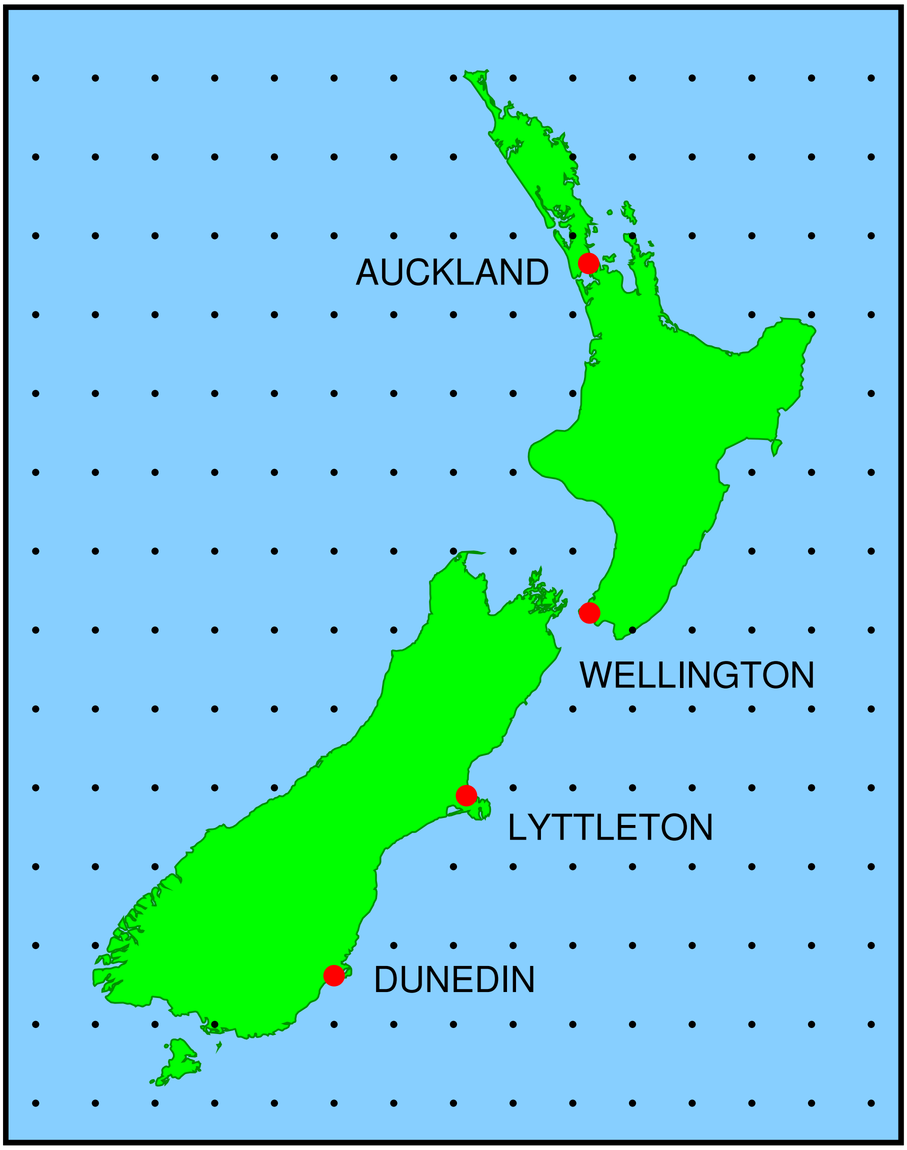


Figure 2: Locations of grid points of IPCC AR5 sea-level projections (black) and tide-gauge sites (red).

2. projections based of linear interpolation of the regional sea-level projections *without GIA*, *using ocean points only*, plus bilinear interpolation of GIA projections, *using ocean and land points.*

The coastal projections (2) are generally better than (1) because the interpolation uses more data (the GIA points over the land). Also, the difference in the resulting allowances is small (i.e. at the millimetre level) and for the results presented here, the *corrected* projections (2) have been used.

## 4.2 Tide-Gauge Data

Tide-gauge records for Auckland, Dunedin, Lyttleton and Wellington were provided by OPCE in *CSV* format via dropbox[4] on 7/7/2015. Table 1 summarises the tide-gauge data.

| Location | Longitude | Latitude | Start date | End date | Gumbel location parameter, $\mu$ (m) | Gumbel scale parameter, $\lambda$ (m) |
|---|---|---|---|---|---|---|
| Auckland | 174°46' E | 36°51'S | 26/10/1903 | 08/08/2014 | 1.966 | 0.0954 |
| Dunedin | 170°30' E | 45°53'S | 31/12/1899 | 31/12/2013 | 1.494 | 0.0813 |
| Lyttleton | 172°43' E | 43°36'S | 1/1/1924 | 31/12/2012 | 1.660 | 0.0653 |
| Wellington | 174°47' E | 41°17'S | 1/1/1944 | 31/12/2013 | 1.121 | 0.0625 |

Table 1: Summary of tide-gauge data and derived Gumbel parameters.

## 4.3 Historic Events

Heights of historic sea-level events were provided by OPCE by email in the spreadsheet `NIWA_Historic_events.xlsx` on 21/7/2015. Maximum heights of 16 events (3 for Auckland, 4 for Dunedin, 5 for Lyttleton and 4 for Wellington) were recorded under the tab 'Historic events'. Two heights were recorded for each event in columns headed 'Sea-level (m)' and 'Sea level with historic sea-level rise removed (m)'. All these heights were included in the analysis described in Section 5.5. It was assumed (and confirmed be email from OPCE on 22/7/2015) that the vertical datums used for these heights were the same as those used for the respective tide gauges.

# 5 Results

## 5.1 Introduction

As advised by OPCE by email on 28/7/2015, the 'present day' is taken to be the start of 2015. This is the date to which the tide-gauge data and sea-level rise projections were referenced.

[4] `https://www.dropbox.com/sh/b6rvgrmk3hxrtt9/AACk_0ros-szzDlmHBCyQxk6a?dl=0`

## 5.2 Extremes Analysis

The tide-gauge records were initially detrended about the 'present day' (i.e. the start of 2015) using linear regression. Annual maxima of the tide-gauge records were then estimated using a declustering algorithm such that any extreme events closer than 3 days were counted as a single event, and any gaps in time were removed from the record. These annual maxima were then fitted to a Gumbel distribution (see Section 3) using the *ismev* package (Coles 2001, p. 48) implemented in the statistical language *R* (R Development Core Team 2008). This yielded the location and scale parameters, $\mu$ and $\lambda$ (see Eq. 1), for each of the four records; these values are shown in Table 1. The ARIs as a function of height are shown in Figs. 3-6. All locations show a good fit to a Gumbel distribution, with the majority of annual maxima (the dots) falling within the 95% confidence limits.

## 5.3 Sea-Level Rise Projections

The IPCC AR5 regional projections of sea-level rise are shown in Tables 2-5 (for RCP4.5) and Tables 14-17 (for RCP8.5). The second column shows the 'very likely' (5-95%) range of the model projections, and the third column shows the equivalent mean and standard deviation, based on the assumption that the uncertainty distribution is normal or Gaussian.

## 5.4 Sea-Level Planning Allowances

The planning allowances ($A$ of Eq. 4), using the 'very likely' and 'likely' assumptions are shown in the fourth column of Tables 2-5 (for RCP4.5) and Tables 14-17 (for RCP8.5). The allowances are similar during the early part of this century, but diverge significantly by 2100. As indicated in Section 3, the work of the IPCC AR5 suggests that the larger of these (the 'likely' allowance) should be used.

## 5.5 Future Average Recurrence Intervals

Future ARIs were calculated using Eqs. 3 and 4, with $\mu$ and $\lambda$ taken from Table 1, $A$ taken from Tables 2-5 (for RCP4.5) and Tables 14-17 (for RCP8.5) and $z_P$ equal to the specified height. The heights consist of the extremes associated with the historic events (see Section 4.3) plus additional ones selected every 0.10 m. The heights are ranked in ascending order across the Tables.

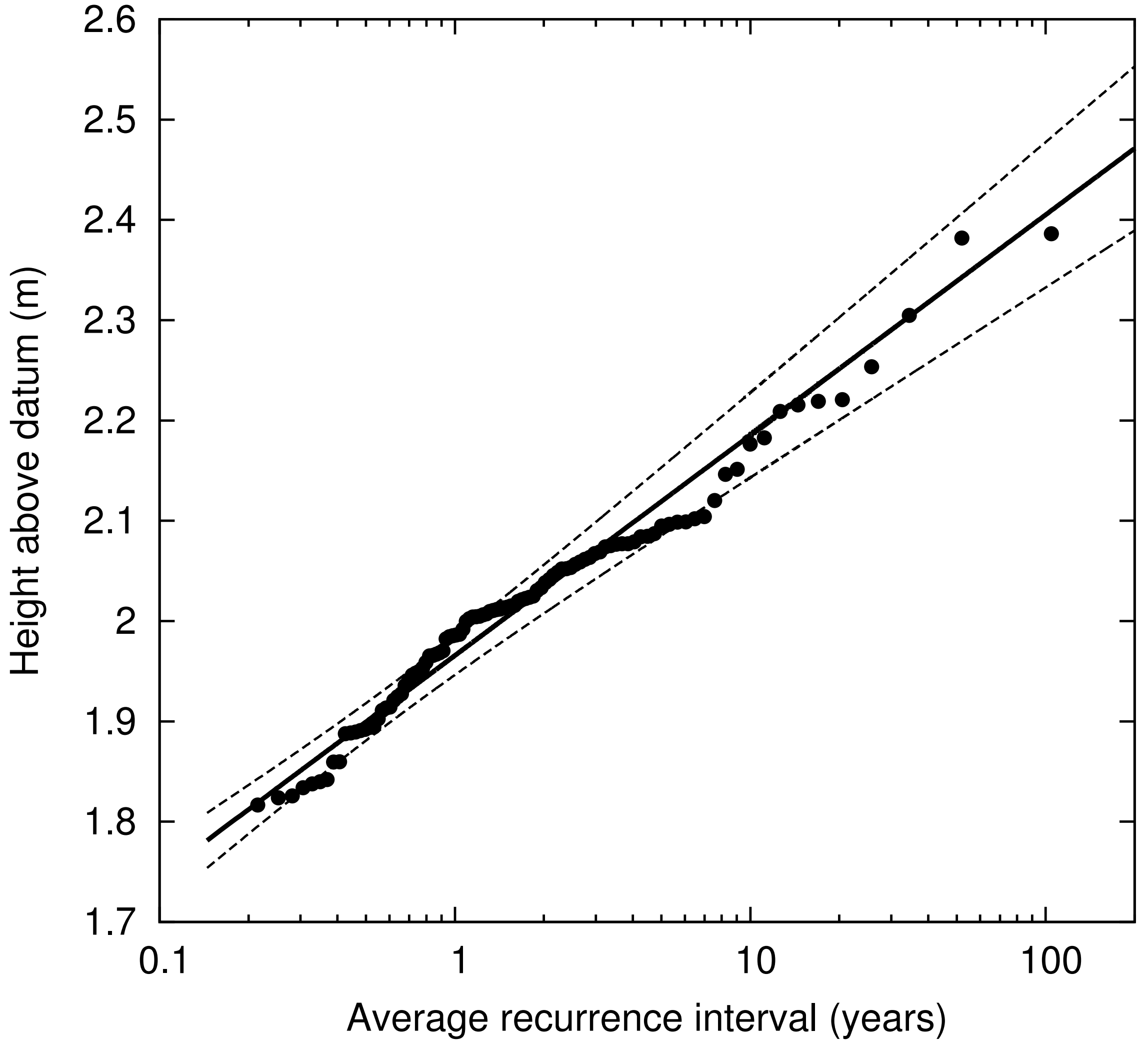


Figure 3: Average recurrence intervals (ARIs) and heights for Auckland for 2015. Continuous line is best estimate and dashed lines are 95% confidence intervals. Dots indicate individual annual maxima. The heights are above the local datum, which is the same as the datum of the local tide-gauge record.

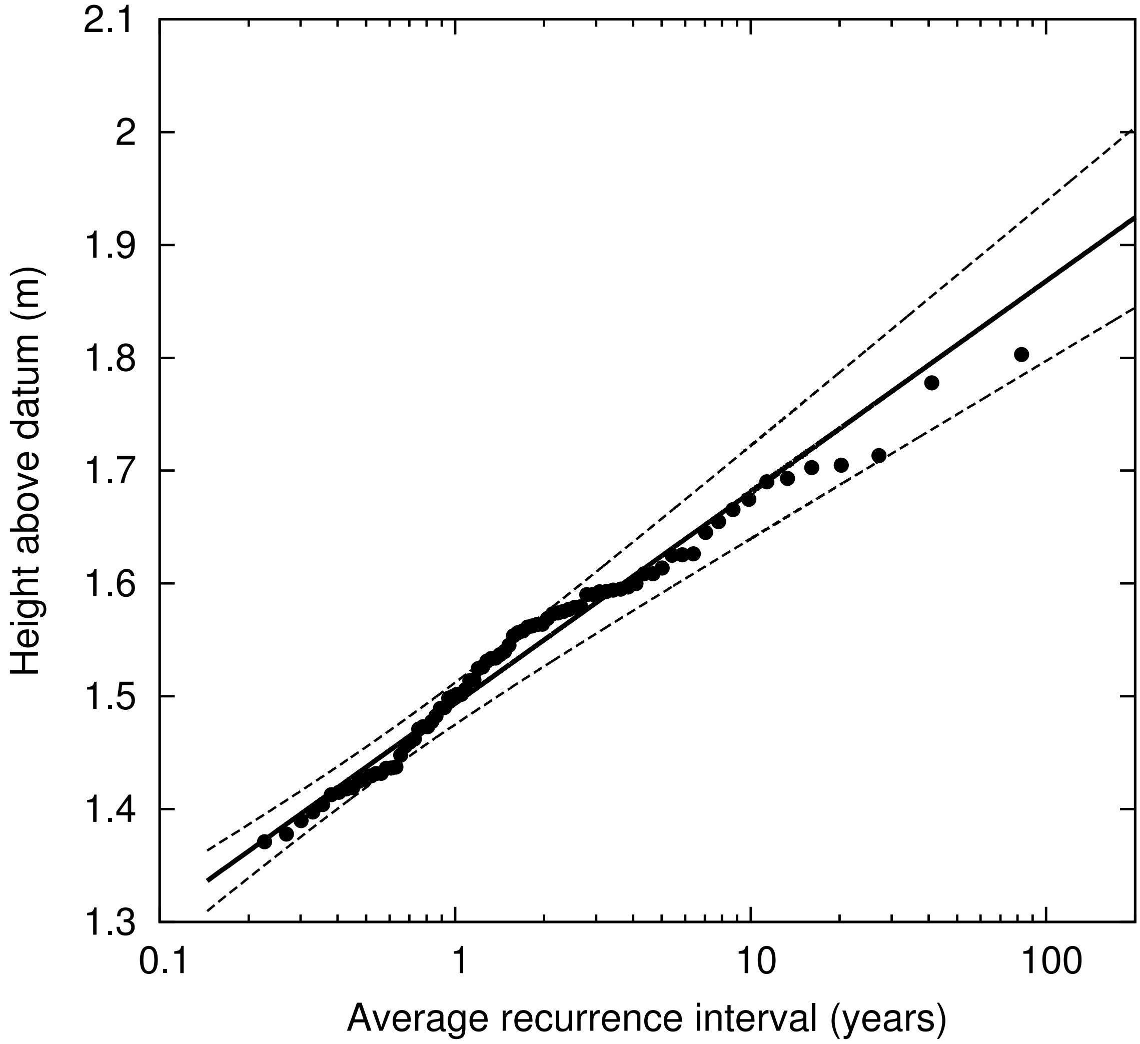


Figure 4: Average recurrence intervals (ARIs) and heights for Dunedin for 2015. Continuous line is best estimate and dashed lines are 95% confidence intervals. Dots indicate individual annual maxima. The heights are above the local datum, which is the same as the datum of the local tide-gauge record.

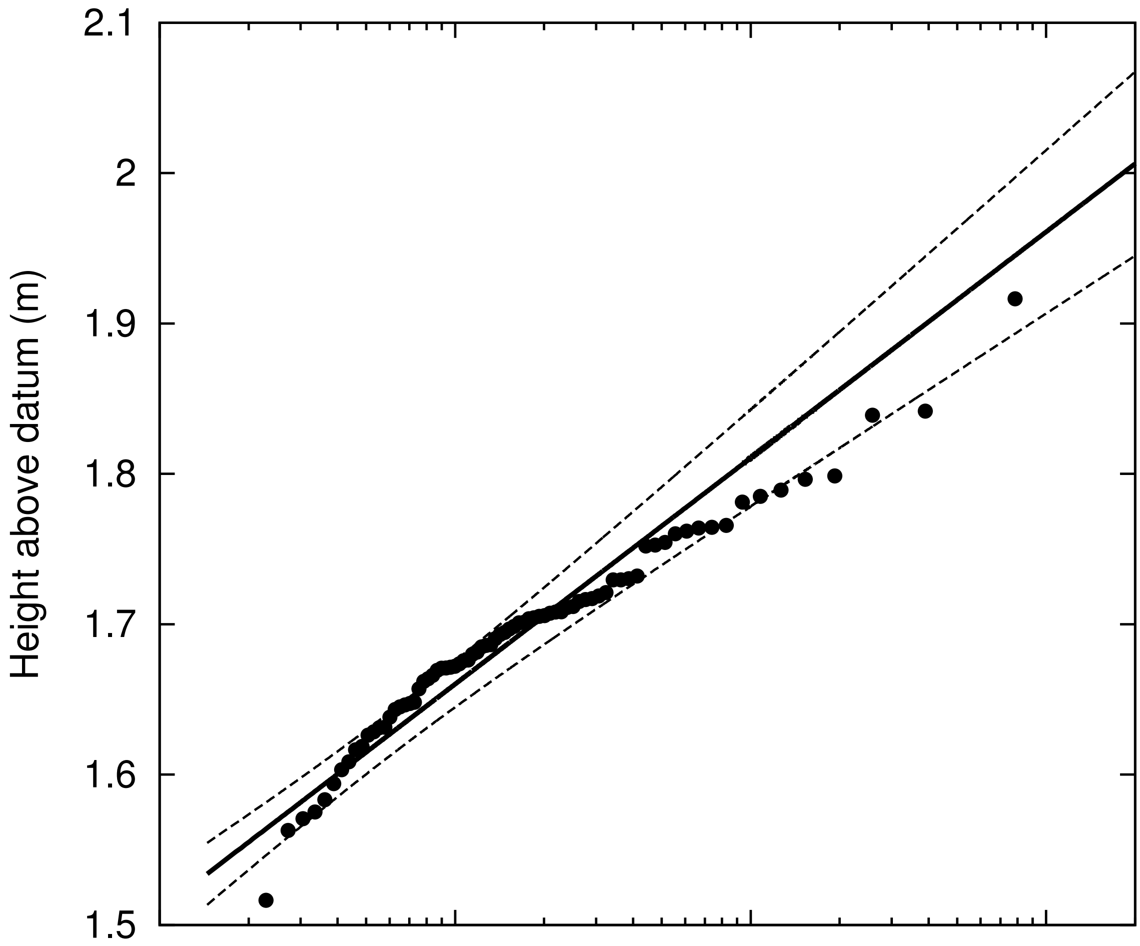


Figure 5: Average recurrence intervals (ARIs) and heights for Lyttleton for 2015. Continuous line is best estimate and dashed lines are 95% confidence intervals. Dots indicate individual annual maxima. The heights are above the local datum, which is the same as the datum of the local tide-gauge record.

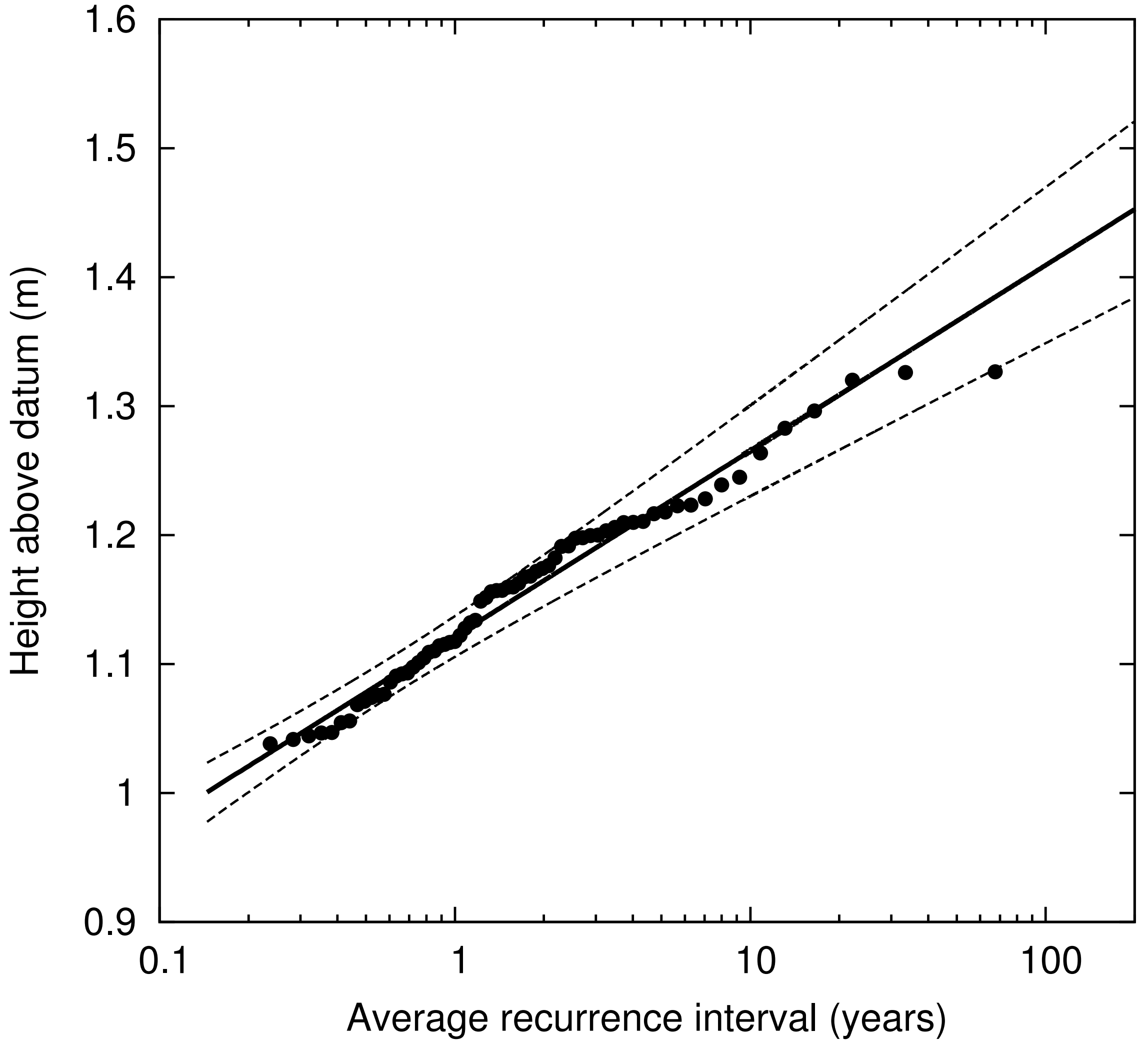


Figure 6: Average recurrence intervals (ARIs) and heights for Wellington for 2015. Continuous line is best estimate and dashed lines are 95% confidence intervals. Dots indicate individual annual maxima. The heights are above the local datum, which is the same as the datum of the local tide-gauge record.

| Year | Model projection 'very likely' range 5,95% (metres) | Model projection $\Delta z$, $\sigma_m$ (metres) | Allowance, $A$ 'very likely', 'likely' (metres) |
|---|---|---|---|
| 2015 | 0.000, 0.000 | 0.000, 0.000 | 0.000, 0.000 |
| 2020 | 0.015, 0.018 | 0.017, 0.001 | 0.017, 0.017 |
| 2025 | 0.036, 0.051 | 0.043, 0.005 | 0.043, 0.044 |
| 2030 | 0.058, 0.085 | 0.072, 0.008 | 0.072, 0.073 |
| 2035 | 0.085, 0.123 | 0.104, 0.011 | 0.105, 0.106 |
| 2040 | 0.108, 0.160 | 0.134, 0.016 | 0.136, 0.138 |
| 2045 | 0.130, 0.186 | 0.158, 0.017 | 0.160, 0.163 |
| 2050 | 0.129, 0.239 | 0.184, 0.034 | 0.190, 0.202 |
| 2055 | 0.135, 0.301 | 0.218, 0.051 | 0.231, 0.258 |
| 2060 | 0.165, 0.335 | 0.250, 0.052 | 0.264, 0.291 |
| 2065 | 0.193, 0.359 | 0.276, 0.050 | 0.289, 0.315 |
| 2070 | 0.202, 0.415 | 0.309, 0.065 | 0.331, 0.374 |
| 2075 | 0.222, 0.447 | 0.335, 0.069 | 0.359, 0.408 |
| 2080 | 0.236, 0.480 | 0.358, 0.074 | 0.387, 0.444 |
| 2085 | 0.250, 0.532 | 0.391, 0.086 | 0.430, 0.506 |
| 2090 | 0.255, 0.592 | 0.424, 0.102 | 0.478, 0.587 |
| 2095 | 0.280, 0.633 | 0.457, 0.107 | 0.517, 0.635 |
| 2100 | 0.300, 0.678 | 0.489, 0.115 | 0.558, 0.694 |

Table 2: Model sea-level projections, and allowances for Auckland under RCP4.5. The third column shows the range of model projections expressed as the best estimate (central value), $\Delta z$, and standard deviation, $\sigma_m$. The 'very likely' allowance, $A$, involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' allowance, $A$, is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.

| Year | Model projection 'very likely' range 5,95% (metres) | Model projection $\Delta z$, $\sigma_m$ (metres) | Allowance, $A$ 'very likely', 'likely' (metres) |
|---|---|---|---|
| 2015 | 0.000, 0.000 | 0.000, 0.000 | 0.000, 0.000 |
| 2020 | 0.020, 0.024 | 0.022, 0.001 | 0.022, 0.022 |
| 2025 | 0.033, 0.063 | 0.048, 0.009 | 0.048, 0.050 |
| 2030 | 0.055, 0.101 | 0.078, 0.014 | 0.079, 0.081 |
| 2035 | 0.070, 0.138 | 0.104, 0.021 | 0.106, 0.112 |
| 2040 | 0.102, 0.167 | 0.134, 0.020 | 0.137, 0.141 |
| 2045 | 0.121, 0.197 | 0.159, 0.023 | 0.162, 0.168 |
| 2050 | 0.129, 0.248 | 0.189, 0.036 | 0.197, 0.212 |
| 2055 | 0.136, 0.300 | 0.218, 0.050 | 0.233, 0.263 |
| 2060 | 0.167, 0.331 | 0.249, 0.050 | 0.264, 0.294 |
| 2065 | 0.179, 0.357 | 0.268, 0.054 | 0.286, 0.322 |
| 2070 | 0.189, 0.406 | 0.297, 0.066 | 0.324, 0.377 |
| 2075 | 0.206, 0.462 | 0.334, 0.078 | 0.371, 0.444 |
| 2080 | 0.236, 0.489 | 0.362, 0.077 | 0.399, 0.471 |
| 2085 | 0.242, 0.532 | 0.387, 0.088 | 0.435, 0.529 |
| 2090 | 0.241, 0.587 | 0.414, 0.105 | 0.482, 0.617 |
| 2095 | 0.278, 0.636 | 0.457, 0.109 | 0.530, 0.673 |
| 2100 | 0.291, 0.675 | 0.483, 0.117 | 0.567, 0.732 |

Table 3: Model sea-level projections, and allowances for Dunedin under RCP4.5. The third column shows the range of model projections expressed as the best estimate (central value), $\Delta z$, and standard deviation, $\sigma_m$. The 'very likely' allowance, $A$, involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' allowance, $A$, is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.

| Year | Model projection 'very likely' range 5,95% (metres) | Model projection $\Delta z$, $\sigma_m$ (metres) | Allowance, $A$ 'very likely', 'likely' (metres) |
|---|---|---|---|
| 2015 | 0.000, 0.000 | 0.000, 0.000 | 0.000, 0.000 |
| 2020 | 0.004, 0.011 | 0.007, 0.002 | 0.007, 0.008 |
| 2025 | 0.024, 0.049 | 0.037, 0.008 | 0.037, 0.038 |
| 2030 | 0.045, 0.092 | 0.069, 0.014 | 0.070, 0.073 |
| 2035 | 0.072, 0.126 | 0.099, 0.016 | 0.101, 0.105 |
| 2040 | 0.098, 0.145 | 0.122, 0.014 | 0.123, 0.126 |
| 2045 | 0.111, 0.185 | 0.148, 0.022 | 0.152, 0.160 |
| 2050 | 0.133, 0.221 | 0.177, 0.027 | 0.183, 0.194 |
| 2055 | 0.145, 0.263 | 0.204, 0.036 | 0.214, 0.233 |
| 2060 | 0.176, 0.304 | 0.240, 0.039 | 0.251, 0.274 |
| 2065 | 0.185, 0.336 | 0.261, 0.046 | 0.277, 0.308 |
| 2070 | 0.193, 0.368 | 0.281, 0.053 | 0.302, 0.345 |
| 2075 | 0.218, 0.425 | 0.322, 0.063 | 0.352, 0.411 |
| 2080 | 0.237, 0.450 | 0.344, 0.065 | 0.376, 0.439 |
| 2085 | 0.256, 0.496 | 0.376, 0.073 | 0.416, 0.497 |
| 2090 | 0.262, 0.546 | 0.404, 0.087 | 0.461, 0.575 |
| 2095 | 0.296, 0.594 | 0.445, 0.091 | 0.508, 0.632 |
| 2100 | 0.285, 0.634 | 0.460, 0.106 | 0.546, 0.716 |

Table 4: Model sea-level projections, and allowances for Lyttleton under RCP4.5. The third column shows the range of model projections expressed as the best estimate (central value), $\Delta z$, and standard deviation, $\sigma_m$. The 'very likely' allowance, $A$, involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' allowance, $A$, is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.

| Year | Model projection 'very likely' range 5,95% (metres) | Model projection $\Delta z$, $\sigma_m$ (metres) | Allowance, $A$ 'very likely', 'likely' (metres) |
|---|---|---|---|
| 2015 | 0.000, 0.000 | 0.000, 0.000 | 0.000, 0.000 |
| 2020 | 0.016, 0.023 | 0.020, 0.002 | 0.020, 0.020 |
| 2025 | 0.032, 0.053 | 0.043, 0.006 | 0.043, 0.043 |
| 2030 | 0.053, 0.093 | 0.073, 0.012 | 0.074, 0.076 |
| 2035 | 0.066, 0.130 | 0.098, 0.020 | 0.101, 0.107 |
| 2040 | 0.101, 0.154 | 0.128, 0.016 | 0.130, 0.134 |
| 2045 | 0.117, 0.189 | 0.153, 0.022 | 0.157, 0.165 |
| 2050 | 0.124, 0.221 | 0.173, 0.030 | 0.180, 0.193 |
| 2055 | 0.133, 0.257 | 0.195, 0.038 | 0.207, 0.229 |
| 2060 | 0.167, 0.299 | 0.233, 0.040 | 0.246, 0.272 |
| 2065 | 0.185, 0.329 | 0.257, 0.044 | 0.272, 0.302 |
| 2070 | 0.205, 0.364 | 0.285, 0.048 | 0.303, 0.340 |
| 2075 | 0.213, 0.416 | 0.315, 0.062 | 0.345, 0.406 |
| 2080 | 0.242, 0.429 | 0.336, 0.057 | 0.362, 0.413 |
| 2085 | 0.240, 0.495 | 0.368, 0.077 | 0.416, 0.510 |
| 2090 | 0.257, 0.532 | 0.394, 0.084 | 0.450, 0.561 |
| 2095 | 0.280, 0.582 | 0.431, 0.092 | 0.498, 0.631 |
| 2100 | 0.294, 0.623 | 0.458, 0.100 | 0.538, 0.697 |

Table 5: Model sea-level projections, and allowances for Wellington under RCP4.5. The third column shows the range of model projections expressed as the best estimate (central value), $\Delta z$, and standard deviation, $\sigma_m$. The 'very likely' allowance, $A$, involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' allowance, $A$, is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.50 | 1.60 | 1.70 | 1.80 | 1.86 | 1.90 | 1.92 | 2.00 | 2.07 | 2.10 | 2.20 | 2.23 | 2.30 | 2.38 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 1.4 | 3.0 | 4.1 | 11.6 | 16.0 | 33.2 | 76.8 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.5 | 1.2 | 2.5 | 3.4 | 9.8 | 13.4 | 27.9 | 64.6 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.9 | 1.9 | 2.6 | 7.4 | 10.1 | 21.1 | 48.8 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.7 | 1.4 | 1.9 | 5.5 | 7.5 | 15.6 | 36.1 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.5 | 1.0 | 1.4 | 3.9 | 5.3 | 11.1 | 25.6 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.7 | 1.0 | 2.8 | 3.9 | 8.0 | 18.6 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.6 | 0.8 | 2.2 | 3.0 | 6.2 | 14.4 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.6 | 1.6 | 2.2 | 4.5 | 10.5 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.0 | 1.4 | 2.9 | 6.8 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.7 | 1.0 | 2.1 | 4.8 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.6 | 0.8 | 1.6 | 3.7 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.4 | 0.5 | 1.0 | 2.4 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.8 | 1.8 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.6 | 1.3 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | 0.9 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |

Table 6: Effective average recurrence intervals (EARIs) for Auckland under RCP4.5 using the 'very likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.50 | 1.60 | 1.70 | 1.80 | 1.86 | 1.90 | 1.92 | 2.00 | 2.07 | 2.10 | 2.20 | 2.23 | 2.30 | 2.38 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 1.4 | 3.0 | 4.1 | 11.6 | 16.0 | 33.2 | 76.8 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.5 | 1.2 | 2.5 | 3.4 | 9.8 | 13.4 | 27.9 | 64.6 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.9 | 1.9 | 2.6 | 7.4 | 10.1 | 21.0 | 48.7 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.7 | 1.4 | 1.9 | 5.4 | 7.4 | 15.5 | 35.8 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.5 | 1.0 | 1.3 | 3.8 | 5.2 | 10.9 | 25.2 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.7 | 1.0 | 2.7 | 3.8 | 7.8 | 18.1 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.5 | 0.7 | 2.1 | 2.9 | 6.0 | 14.0 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 1.4 | 1.9 | 4.0 | 9.3 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.8 | 1.1 | 2.2 | 5.2 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.6 | 0.8 | 1.6 | 3.6 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.6 | 1.2 | 2.8 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.7 | 1.5 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.5 | 1.1 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.7 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |

Table 7: Effective average recurrence intervals (EARIs) for Auckland under RCP4.5 using the 'likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.18 | 1.20 | 1.28 | 1.30 | 1.40 | 1.42 | 1.50 | 1.53 | 1.60 | 1.67 | 1.70 | 1.76 | 1.80 | 1.90 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.1 | 1.6 | 3.7 | 8.8 | 12.7 | 26.5 | 43.3 | 148.2 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.8 | 1.2 | 2.8 | 6.7 | 9.6 | 20.1 | 32.9 | 112.6 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.6 | 0.9 | 2.0 | 4.8 | 7.0 | 14.6 | 23.9 | 81.7 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | 0.6 | 1.4 | 3.3 | 4.8 | 10.0 | 16.4 | 56.0 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.0 | 2.4 | 3.4 | 7.2 | 11.7 | 40.0 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.7 | 1.6 | 2.4 | 4.9 | 8.1 | 27.5 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 1.2 | 1.7 | 3.6 | 5.9 | 20.2 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.8 | 1.1 | 2.4 | 3.9 | 13.2 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 0.7 | 1.5 | 2.5 | 8.4 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.5 | 1.0 | 1.7 | 5.7 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.4 | 0.8 | 1.3 | 4.4 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.5 | 0.8 | 2.7 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.5 | 1.5 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 1.1 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.7 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.4 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |

Table 8: Effective average recurrence intervals (EARIs) for Dunedin under RCP4.5 using the 'very likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.18 | 1.20 | 1.28 | 1.30 | 1.40 | 1.42 | 1.50 | 1.53 | 1.60 | 1.67 | 1.70 | 1.76 | 1.80 | 1.90 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.1 | 1.6 | 3.7 | 8.8 | 12.7 | 26.5 | 43.3 | 148.2 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.8 | 1.2 | 2.8 | 6.7 | 9.6 | 20.1 | 32.9 | 112.6 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.6 | 0.9 | 2.0 | 4.8 | 6.9 | 14.4 | 23.6 | 80.6 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.4 | 0.6 | 1.4 | 3.2 | 4.7 | 9.7 | 15.9 | 54.5 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.9 | 2.2 | 3.2 | 6.7 | 11.0 | 37.6 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.6 | 1.5 | 2.2 | 4.6 | 7.6 | 26.0 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 1.1 | 1.6 | 3.3 | 5.5 | 18.7 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.6 | 0.9 | 1.9 | 3.2 | 10.9 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.5 | 1.0 | 1.7 | 5.8 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.7 | 1.2 | 4.0 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.5 | 0.8 | 2.8 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.4 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.6 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.5 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 9: Effective average recurrence intervals (EARIs) for Dunedin under RCP4.5 using the 'likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.37 | 1.40 | 1.50 | 1.52 | 1.55 | 1.60 | 1.66 | 1.68 | 1.70 | 1.71 | 1.72 | 1.74 | 1.80 | 1.90 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 1.0 | 1.4 | 1.8 | 2.1 | 2.5 | 3.4 | 8.5 | 39.3 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.9 | 1.2 | 1.6 | 1.9 | 2.2 | 3.0 | 7.6 | 35.0 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.6 | 0.8 | 1.0 | 1.2 | 1.4 | 1.9 | 4.8 | 22.3 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.5 | 0.6 | 0.7 | 0.9 | 1.2 | 2.9 | 13.4 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.7 | 1.8 | 8.4 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 1.3 | 6.0 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.8 | 3.8 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.5 | 2.4 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 1.5 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.8 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 10: Effective average recurrence intervals (EARIs) for Lyttleton under RCP4.5 using the 'very likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.37 | 1.40 | 1.50 | 1.52 | 1.55 | 1.60 | 1.66 | 1.68 | 1.70 | 1.71 | 1.72 | 1.74 | 1.80 | 1.90 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 1.0 | 1.4 | 1.8 | 2.1 | 2.5 | 3.4 | 8.5 | 39.3 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.9 | 1.2 | 1.6 | 1.9 | 2.2 | 3.0 | 7.6 | 35.0 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.6 | 0.8 | 1.0 | 1.2 | 1.4 | 1.9 | 4.8 | 22.0 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.6 | 0.7 | 0.8 | 1.1 | 2.8 | 12.8 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.7 | 1.7 | 7.9 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 1.2 | 5.7 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.7 | 3.4 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.4 | 2.0 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 1.1 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.6 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 11: Effective average recurrence intervals (EARIs) for Lyttleton under RCP4.5 using the 'likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 0.78 | 0.80 | 0.84 | 0.90 | 0.99 | 1.00 | 1.05 | 1.10 | 1.11 | 1.12 | 1.20 | 1.30 | 1.31 | 1.32 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.7 | 0.8 | 1.0 | 3.5 | 17.4 | 20.4 | 24.0 |
| 2020 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 0.6 | 0.7 | 2.6 | 12.7 | 14.9 | 17.5 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.4 | 0.5 | 1.8 | 8.8 | 10.3 | 12.1 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 1.1 | 5.3 | 6.3 | 7.3 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.7 | 3.5 | 4.1 | 4.8 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.4 | 2.2 | 2.6 | 3.0 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 1.4 | 1.7 | 1.9 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 1.0 | 1.2 | 1.4 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 0.7 | 0.9 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.4 | 0.5 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.3 | 0.3 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 12: Effective average recurrence intervals (EARIs) for Wellington under RCP4.5 using the 'very likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 0.78 | 0.80 | 0.84 | 0.90 | 0.99 | 1.00 | 1.05 | 1.10 | 1.11 | 1.12 | 1.20 | 1.30 | 1.31 | 1.32 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.7 | 0.8 | 1.0 | 3.5 | 17.4 | 20.4 | 24.0 |
| 2020 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 0.6 | 0.7 | 2.6 | 12.7 | 14.9 | 17.5 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.4 | 0.5 | 1.8 | 8.7 | 10.2 | 11.9 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 1.0 | 5.1 | 6.0 | 7.1 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.6 | 3.1 | 3.7 | 4.3 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.4 | 2.0 | 2.4 | 2.8 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 1.3 | 1.5 | 1.7 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.8 | 0.9 | 1.1 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 | 0.5 | 0.6 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.3 | 0.3 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 13: Effective average recurrence intervals (EARIs) for Wellington under RCP4.5 using the 'likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| Year | Model projection 'very likely' range 5,95% (metres) | Model projection $\Delta z$, $\sigma_m$ (metres) | Allowance, $A$ 'very likely', 'likely' (metres) |
|---|---|---|---|
| 2015 | 0.000, 0.000 | 0.000, 0.000 | 0.000, 0.000 |
| 2020 | 0.005, 0.039 | 0.022, 0.010 | 0.022, 0.024 |
| 2025 | 0.034, 0.065 | 0.050, 0.009 | 0.050, 0.051 |
| 2030 | 0.064, 0.091 | 0.078, 0.008 | 0.078, 0.079 |
| 2035 | 0.085, 0.125 | 0.105, 0.012 | 0.106, 0.107 |
| 2040 | 0.133, 0.165 | 0.149, 0.010 | 0.149, 0.150 |
| 2045 | 0.140, 0.211 | 0.175, 0.022 | 0.178, 0.183 |
| 2050 | 0.167, 0.258 | 0.213, 0.028 | 0.217, 0.225 |
| 2055 | 0.200, 0.319 | 0.260, 0.036 | 0.266, 0.280 |
| 2060 | 0.223, 0.373 | 0.298, 0.046 | 0.309, 0.331 |
| 2065 | 0.263, 0.443 | 0.353, 0.055 | 0.369, 0.400 |
| 2070 | 0.296, 0.522 | 0.409, 0.069 | 0.434, 0.483 |
| 2075 | 0.307, 0.587 | 0.447, 0.085 | 0.485, 0.560 |
| 2080 | 0.358, 0.647 | 0.503, 0.088 | 0.543, 0.623 |
| 2085 | 0.382, 0.730 | 0.556, 0.106 | 0.614, 0.730 |
| 2090 | 0.407, 0.832 | 0.619, 0.129 | 0.707, 0.880 |
| 2095 | 0.460, 0.899 | 0.680, 0.133 | 0.773, 0.957 |
| 2100 | 0.503, 1.009 | 0.756, 0.154 | 0.880, 1.124 |

Table 14: Model sea-level projections, and allowances for Auckland under RCP8.5. The third column shows the range of model projections expressed as the best estimate (central value), $\Delta z$, and standard deviation, $\sigma_m$. The 'very likely' allowance, $A$, involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' allowance, $A$, is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.

| Year | Model projection 'very likely' range 5,95% (metres) | Model projection $\Delta z$, $\sigma_m$ (metres) | Allowance, $A$ 'very likely', 'likely' (metres) |
|---|---|---|---|
| 2015 | 0.000, 0.000 | 0.000, 0.000 | 0.000, 0.000 |
| 2020 | -0.010, 0.046 | 0.018, 0.017 | 0.020, 0.024 |
| 2025 | 0.030, 0.068 | 0.049, 0.011 | 0.050, 0.051 |
| 2030 | 0.062, 0.078 | 0.070, 0.005 | 0.070, 0.071 |
| 2035 | 0.098, 0.118 | 0.108, 0.006 | 0.108, 0.108 |
| 2040 | 0.123, 0.165 | 0.144, 0.013 | 0.145, 0.147 |
| 2045 | 0.125, 0.229 | 0.177, 0.031 | 0.183, 0.195 |
| 2050 | 0.153, 0.272 | 0.212, 0.036 | 0.221, 0.237 |
| 2055 | 0.196, 0.312 | 0.254, 0.035 | 0.262, 0.277 |
| 2060 | 0.222, 0.376 | 0.299, 0.047 | 0.312, 0.339 |
| 2065 | 0.267, 0.434 | 0.351, 0.051 | 0.366, 0.398 |
| 2070 | 0.288, 0.523 | 0.405, 0.071 | 0.436, 0.498 |
| 2075 | 0.306, 0.595 | 0.450, 0.088 | 0.498, 0.591 |
| 2080 | 0.359, 0.654 | 0.506, 0.090 | 0.556, 0.653 |
| 2085 | 0.390, 0.725 | 0.557, 0.102 | 0.621, 0.746 |
| 2090 | 0.399, 0.838 | 0.619, 0.133 | 0.728, 0.944 |
| 2095 | 0.455, 0.897 | 0.676, 0.135 | 0.787, 1.007 |
| 2100 | 0.494, 1.010 | 0.752, 0.157 | 0.904, 1.202 |

Table 15: Model sea-level projections, and allowances for Dunedin under RCP8.5. The third column shows the range of model projections expressed as the best estimate (central value), $\Delta z$, and standard deviation, $\sigma_m$. The 'very likely' allowance, $A$, involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' allowance, $A$, is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.

| Year | Model projection 'very likely' range 5,95% (metres) | Model projection $\Delta z$, $\sigma_m$ (metres) | Allowance, $A$ 'very likely', 'likely' (metres) |
|---|---|---|---|
| 2015 | 0.000, 0.000 | 0.000, 0.000 | 0.000, 0.000 |
| 2020 | 0.014, 0.023 | 0.019, 0.003 | 0.019, 0.019 |
| 2025 | 0.045, 0.051 | 0.048, 0.002 | 0.048, 0.048 |
| 2030 | 0.079, 0.079 | 0.079, 0.000 | 0.079, 0.079 |
| 2035 | 0.102, 0.115 | 0.108, 0.004 | 0.108, 0.109 |
| 2040 | 0.130, 0.169 | 0.150, 0.012 | 0.151, 0.153 |
| 2045 | 0.129, 0.225 | 0.177, 0.029 | 0.183, 0.196 |
| 2050 | 0.149, 0.268 | 0.209, 0.036 | 0.219, 0.239 |
| 2055 | 0.189, 0.316 | 0.252, 0.039 | 0.264, 0.286 |
| 2060 | 0.229, 0.355 | 0.292, 0.038 | 0.303, 0.325 |
| 2065 | 0.263, 0.420 | 0.342, 0.048 | 0.359, 0.393 |
| 2070 | 0.295, 0.506 | 0.400, 0.064 | 0.432, 0.494 |
| 2075 | 0.312, 0.551 | 0.432, 0.073 | 0.472, 0.552 |
| 2080 | 0.373, 0.616 | 0.495, 0.074 | 0.536, 0.619 |
| 2085 | 0.388, 0.704 | 0.546, 0.096 | 0.617, 0.756 |
| 2090 | 0.434, 0.790 | 0.612, 0.108 | 0.702, 0.879 |
| 2095 | 0.465, 0.880 | 0.673, 0.126 | 0.795, 1.035 |
| 2100 | 0.508, 0.963 | 0.736, 0.138 | 0.882, 1.170 |

Table 16: Model sea-level projections, and allowances for Lyttleton under RCP8.5. The third column shows the range of model projections expressed as the best estimate (central value), $\Delta z$, and standard deviation, $\sigma_m$. The 'very likely' allowance, $A$, involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' allowance, $A$, is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.

| Year | Model projection 'very likely' range 5,95% (metres) | Model projection $\Delta z$, $\sigma_m$ (metres) | Allowance, $A$ 'very likely', 'likely' (metres) |
|---|---|---|---|
| 2015 | 0.000, 0.000 | 0.000, 0.000 | 0.000, 0.000 |
| 2020 | 0.030, 0.037 | 0.033, 0.002 | 0.033, 0.034 |
| 2025 | 0.061, 0.062 | 0.061, 0.000 | 0.061, 0.061 |
| 2030 | 0.074, 0.093 | 0.083, 0.006 | 0.084, 0.084 |
| 2035 | 0.098, 0.117 | 0.107, 0.006 | 0.108, 0.108 |
| 2040 | 0.118, 0.175 | 0.146, 0.017 | 0.149, 0.154 |
| 2045 | 0.128, 0.217 | 0.173, 0.027 | 0.178, 0.190 |
| 2050 | 0.156, 0.253 | 0.205, 0.029 | 0.211, 0.225 |
| 2055 | 0.173, 0.321 | 0.247, 0.045 | 0.264, 0.295 |
| 2060 | 0.220, 0.350 | 0.285, 0.040 | 0.297, 0.322 |
| 2065 | 0.261, 0.427 | 0.344, 0.050 | 0.364, 0.405 |
| 2070 | 0.278, 0.509 | 0.394, 0.070 | 0.433, 0.510 |
| 2075 | 0.314, 0.540 | 0.427, 0.069 | 0.465, 0.539 |
| 2080 | 0.348, 0.624 | 0.486, 0.084 | 0.543, 0.654 |
| 2085 | 0.379, 0.686 | 0.533, 0.093 | 0.603, 0.740 |
| 2090 | 0.418, 0.762 | 0.590, 0.105 | 0.677, 0.850 |
| 2095 | 0.455, 0.855 | 0.655, 0.122 | 0.773, 1.006 |
| 2100 | 0.486, 0.961 | 0.723, 0.144 | 0.890, 1.219 |

Table 17: Model sea-level projections, and allowances for Wellington under RCP8.5. The third column shows the range of model projections expressed as the best estimate (central value), $\Delta z$, and standard deviation, $\sigma_m$. The 'very likely' allowance, $A$, involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' allowance, $A$, is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.50 | 1.60 | 1.70 | 1.80 | 1.86 | 1.90 | 1.92 | 2.00 | 2.07 | 2.10 | 2.20 | 2.23 | 2.30 | 2.38 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 1.4 | 3.0 | 4.1 | 11.6 | 16.0 | 33.2 | 76.8 |
| 2020 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.4 | 0.5 | 1.1 | 2.4 | 3.2 | 9.2 | 12.6 | 26.3 | 60.8 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.8 | 1.8 | 2.4 | 6.9 | 9.4 | 19.7 | 45.4 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.6 | 1.3 | 1.8 | 5.1 | 7.0 | 14.7 | 33.9 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.5 | 1.0 | 1.3 | 3.8 | 5.3 | 11.0 | 25.4 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.6 | 0.9 | 2.4 | 3.3 | 6.9 | 16.1 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.5 | 0.6 | 1.8 | 2.5 | 5.1 | 11.9 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.4 | 1.2 | 1.6 | 3.4 | 7.9 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.7 | 1.0 | 2.0 | 4.7 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 0.6 | 1.3 | 3.0 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.7 | 1.6 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | 0.8 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 18: Effective average recurrence intervals (EARIs) for Auckland under RCP8.5 using the 'very likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.50 | 1.60 | 1.70 | 1.80 | 1.86 | 1.90 | 1.92 | 2.00 | 2.07 | 2.10 | 2.20 | 2.23 | 2.30 | 2.38 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 1.4 | 3.0 | 4.1 | 11.6 | 16.0 | 33.2 | 76.8 |
| 2020 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.4 | 0.5 | 1.1 | 2.3 | 3.2 | 9.1 | 12.5 | 26.0 | 60.1 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.8 | 1.7 | 2.4 | 6.8 | 9.3 | 19.5 | 45.0 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.6 | 1.3 | 1.8 | 5.1 | 7.0 | 14.6 | 33.7 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.5 | 1.0 | 1.3 | 3.8 | 5.2 | 10.8 | 25.0 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.6 | 0.8 | 2.4 | 3.3 | 6.9 | 15.9 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.6 | 1.7 | 2.3 | 4.9 | 11.3 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.1 | 1.5 | 3.2 | 7.3 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.6 | 0.8 | 1.8 | 4.1 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.4 | 0.5 | 1.0 | 2.4 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.5 | 1.2 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 19: Effective average recurrence intervals (EARIs) for Auckland under RCP8.5 using the 'likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.18 | 1.20 | 1.28 | 1.30 | 1.40 | 1.42 | 1.50 | 1.53 | 1.60 | 1.67 | 1.70 | 1.76 | 1.80 | 1.90 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.1 | 1.6 | 3.7 | 8.8 | 12.7 | 26.5 | 43.3 | 148.2 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.8 | 1.2 | 2.9 | 6.8 | 9.9 | 20.7 | 33.9 | 115.9 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.6 | 0.8 | 2.0 | 4.7 | 6.9 | 14.3 | 23.4 | 80.2 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.5 | 0.7 | 1.6 | 3.7 | 5.3 | 11.1 | 18.2 | 62.3 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.0 | 2.3 | 3.4 | 7.0 | 11.5 | 39.3 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.6 | 1.5 | 2.1 | 4.5 | 7.3 | 25.0 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | 0.9 | 1.3 | 2.8 | 4.6 | 15.6 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.6 | 0.8 | 1.8 | 2.9 | 9.8 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.4 | 0.5 | 1.1 | 1.7 | 5.9 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.6 | 0.9 | 3.2 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.5 | 1.6 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.7 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 20: Effective average recurrence intervals (EARIs) for Dunedin under RCP8.5 using the 'very likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.18 | 1.20 | 1.28 | 1.30 | 1.40 | 1.42 | 1.50 | 1.53 | 1.60 | 1.67 | 1.70 | 1.76 | 1.80 | 1.90 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.1 | 1.6 | 3.7 | 8.8 | 12.7 | 26.5 | 43.3 | 148.2 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.8 | 1.2 | 2.8 | 6.6 | 9.5 | 19.8 | 32.4 | 111.0 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.6 | 0.8 | 2.0 | 4.6 | 6.7 | 14.1 | 23.0 | 78.7 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.5 | 0.7 | 1.6 | 3.7 | 5.3 | 11.1 | 18.2 | 62.1 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 1.0 | 2.3 | 3.3 | 7.0 | 11.4 | 39.1 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.6 | 1.4 | 2.1 | 4.4 | 7.1 | 24.4 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.8 | 1.1 | 2.4 | 3.9 | 13.4 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 0.7 | 1.4 | 2.4 | 8.1 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.9 | 1.4 | 4.9 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.7 | 2.3 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 1.1 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 21: Effective average recurrence intervals (EARIs) for Dunedin under RCP8.5 using the 'likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.37 | 1.40 | 1.50 | 1.52 | 1.55 | 1.60 | 1.66 | 1.68 | 1.70 | 1.71 | 1.72 | 1.74 | 1.80 | 1.90 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 1.0 | 1.4 | 1.8 | 2.1 | 2.5 | 3.4 | 8.5 | 39.3 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.7 | 1.0 | 1.4 | 1.6 | 1.9 | 2.5 | 6.4 | 29.4 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 0.7 | 0.9 | 1.0 | 1.2 | 1.6 | 4.1 | 18.9 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.6 | 0.6 | 0.7 | 1.0 | 2.5 | 11.8 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 1.6 | 7.5 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.8 | 3.9 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.5 | 2.4 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 1.4 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.7 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 22: Effective average recurrence intervals (EARIs) for Lyttleton under RCP8.5 using the 'very likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.37 | 1.40 | 1.50 | 1.52 | 1.55 | 1.60 | 1.66 | 1.68 | 1.70 | 1.71 | 1.72 | 1.74 | 1.80 | 1.90 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 1.0 | 1.4 | 1.8 | 2.1 | 2.5 | 3.4 | 8.5 | 39.3 |
| 2020 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.7 | 1.0 | 1.4 | 1.6 | 1.9 | 2.5 | 6.3 | 29.3 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.5 | 0.7 | 0.9 | 1.0 | 1.2 | 1.6 | 4.1 | 18.9 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.6 | 0.6 | 0.7 | 1.0 | 2.5 | 11.8 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 1.6 | 7.5 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.8 | 3.8 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.4 | 1.9 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 1.0 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.5 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 23: Effective average recurrence intervals (EARIs) for Lyttleton under RCP8.5 using the 'likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 0.78 | 0.80 | 0.84 | 0.90 | 0.99 | 1.00 | 1.05 | 1.10 | 1.11 | 1.12 | 1.20 | 1.30 | 1.31 | 1.32 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.7 | 0.8 | 1.0 | 3.5 | 17.4 | 20.4 | 24.0 |
| 2020 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 0.6 | 2.1 | 10.2 | 12.0 | 14.0 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.3 | 0.4 | 1.3 | 6.5 | 7.7 | 9.0 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.9 | 4.6 | 5.4 | 6.3 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.6 | 3.1 | 3.6 | 4.3 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 1.6 | 1.9 | 2.2 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 1.0 | 1.2 | 1.4 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 0.7 | 0.8 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.3 | 0.4 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 24: Effective average recurrence intervals (EARIs) for Wellington under RCP8.5 using the 'very likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

| | Effective average recurrence interval (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height (m) | 0.78 | 0.80 | 0.84 | 0.90 | 0.99 | 1.00 | 1.05 | 1.10 | 1.11 | 1.12 | 1.20 | 1.30 | 1.31 | 1.32 |
| Year | | | | | | | | | | | | | | |
| 2015 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.7 | 0.8 | 1.0 | 3.5 | 17.4 | 20.4 | 24.0 |
| 2020 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 0.6 | 2.1 | 10.2 | 11.9 | 14.0 |
| 2025 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.3 | 0.4 | 1.3 | 6.5 | 7.7 | 9.0 |
| 2030 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.9 | 4.5 | 5.3 | 6.2 |
| 2035 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.6 | 3.1 | 3.6 | 4.2 |
| 2040 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 1.5 | 1.7 | 2.0 |
| 2045 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.8 | 1.0 | 1.1 |
| 2050 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.5 | 0.6 | 0.7 |
| 2055 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.2 |
| 2060 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| 2065 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2070 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2075 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2080 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2085 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2090 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2095 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 25: Effective average recurrence intervals (EARIs) for Wellington under RCP8.5 using the 'likely' assumption. (The 'very likely' EARI involves the assumption that the 'very likely' (5-95%) range of model uncertainty approximates the 'very likely' (5-95%) range of projection uncertainty. The 'likely' EARI is a more conservative estimate, involving the assumption that not all the uncertainty is captured by the models so that the 'very likely' (5-95%) range of model uncertainty approximates the 'likely' (17-83%) range of projection uncertainty.)

# 6 Glossary of Terms

**AR4** Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

**AR5** Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

**ARI** Average recurrence interval.

**EARI** Effective ARI, obtained by taking the reciprocal of the result of averaging the reciprocal ARI over the range of projected sea-level rise.

**GIA** Glacial isostatic adjustment (the continuing response of the ocean surface and Earth's crust to the end of the last glaciation).

**IPCC** Intergovernmental Panel on Climate Change.

**OPCE** Office of the Parliamentary Commissioner for the Environment, Wellington, New Zealand

**RCP** Representative Concentration Pathway (prescribed concentrations of greenhouse gases and aerosols that are used to force the climate models described by the IPCC AR5).

**Relative sea-level rise** The sea-level rise relative to the land.

**Sea-level planning allowance** The vertical distance that a coastal entity needs to be raised in order to cope with the projected sea-level rise.

**SRES** Special Report on Emission Scenarios (Nakicenovic et al, 2000).

**Storm tide** The combination of tide and storm surge.

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# Appendix A Copy of Contract

Dr John Hunter
West Hobart,
Tasmania 7000
Australia

Dear John,

**CONSULTANCY CONTRACT TO PERFORM AN ASSIGNMENT FOR THE PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT**

**Background**

In 2014 the Commissioner released a report concerning the general science of sea level rise. A follow up report is now in preparation that looks more closely at how a rising sea interacts with local coastal characteristics, and what this may mean for property and infrastructure in New Zealand. The Commissioner would like to present estimates of return periods for various sized events (i.e. 1 year ARI, 10 year ARI, etc.), given projected sea level rise. The outcome of this analysis is to provide a range of exceedance values under various IPCC Representative Concentration Pathways (RCPs). The Commissioner wishes to contract expert advice to produce these exceedance values.

**Contact**
Your first contact in relation to this contract should be Stefan Gray. Stefan's contact details are Stefan.Gray@pce.parliament.nz or 021 856 791.

**Offer**
I offer you a contract to analyse the impact of sea level rise on Auckland, Wellington, Lyttleton and Dunedin, as described below. You would also be required to draft a short technical report describing the methodology employed.

This work would be according to the terms set out below and in the attached Standard Terms of Contract to Provide Consultancy Services to the Parliamentary Commissioner for the Environment.

**Assignment/Project Outline**
The core elements of the assignment are to:

1. Calculate the Gumbel scale parameter of storm-tide extremes from the tide gauge data provided.
2. Select the best estimate of the sea-level rise over the period.
3. Calculate the standard deviation of the uncertainty of the sea-level rise over the period (for RCP4.5 and RCP8.5).
4. Calculate future return periods, based on a range of present day return periods, each of which is prescribed by a specific vertical height. This range will include the peak heights of a number of nominated recent storm events.
5. Calculate allowance values to accommodate future sea level rise risk

**Time frame**
The work should be completed by 31 July, 2015. This timeframe may be extended by mutual agreement.

**Payment**
The fee for satisfactory completion of the project shall be at a rate of AUD $1500 per day (exclusive of GST) for up to 3 days, however the time taken to complete the contract may increase slightly. In such an event, you will seek prior approval from the PCE to agree on any associated additional daily costs.

Please indicate your agreement to the terms of this contract by signing this letter, initialling the attachment, and returning a copy of both to the Commissioner by Friday 17 July 2015.

Quentin Duthie
Executive Manager – Research & Analysis
Parliamentary Commissioner for the Environment

I agree to the terms of this contract as set out in this letter and the attachment.

JR Hunter

Dr John Hunter 15 July 2015

**STANDARD TERMS OF CONTRACT TO PROVIDE CONSULTANCY SERVICES TO THE PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT**

# 1 Performance of the project

The consultant will perform the project in a timely and efficient manner and to a professional standard satisfactory to the Commissioner. In performing the project the consultant will demonstrate the degree of skill, care, diligence, and integrity generally expected of a competent professional. Should it become evident that the project timetable cannot be met the consultant will immediately advise the Commissioner. It shall be within the discretion of the Commissioner to either terminate the contract or negotiate an amended timetable.

### 2 Contact

Any correspondence or communication concerning the project should be addressed to Stefan Gray.

### 3 Personnel

a) Where the consultant has submitted a proposal in respect of the project which identifies the staff of the consultant who will be allocated to the project, the consultant shall not replace those staff members without the agreement of the Commissioner, and shall notify the Commissioner as soon as practicable if any identified staff member leaves the consultant's employment.

b) The consultant shall not subcontract or assign this contract, or any part of it, to any other person without the prior agreement in writing of the Commissioner.

### 4 Payment

The fee for the satisfactory completion of the project set out in the contract letter shall be paid exclusive of GST. If the consultant is registered for GST it will be paid upon presentation of a GST invoice.

### 5 Disbursements

The Commissioner will meet all reasonable out of pocket expenses of the consultant incurred in undertaking the project provided that the prior written approval of the Commissioner is obtained before expenses are incurred in excess of **$<u>50</u>** per item or relating to travel or accommodation.

### 6 Progress Reports

The consultant shall provide the Commissioner with progress reports on the work at such times as the Commissioner shall specify.

### 7 Termination

a) Where this contract is for services of a continuing nature, either party may terminate this contract by providing one month's written notice to the other.

b) The Commissioner may terminate the contract by one month's notice in writing to the consultant if:

1. the consultant fails to comply with any of the terms of this agreement and/ or fails to carry out the project in an expeditious manner and with reasonable diligence and competence;
2. the consultant breaches any term of this agreement and fails to remedy the breach within 14 days of receiving notice from the Commissioner requiring the breach to be remedied.

JRM.

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c) The Commissioner may terminate the contract immediately by advising the consultant of termination if the consultant breaches any term of this contract specified as being an essential term in the contract letter, and may reject the report and withhold payment for the work if the standard of the report or the work is not of a professional quality as determined by the Commissioner.
d) Notice of termination shall be in writing and may be sent to the Commissioner, marked for the attention of the officer responsible for the project at PO Box 10-241, Wellington 6143.
e) In the event of termination, the consultant shall not be entitled to any compensation or damages other than payment for work actually done at the date of termination.

**8 Unforeseen circumstances**
In the event that any occurrence beyond the control of either the Commissioner or the consultant prevents the completion of the project or makes completion of the project redundant, this contract shall be terminated and no party shall be liable to the other, except that the consultant shall be entitled to payment for services actually performed and for reimbursement of disbursements already incurred.

**9 Conflicts of Interest**
The consultant shall not undertake any work which may cause a conflict of interest to arise in the carrying out of the project and shall advise the Commissioner, immediately upon becoming aware of any conflict of interest which arises in the course of the project.

**10 Disputes**
Any dispute which arises between the Commissioner and the consultant concerning this agreement shall be referred to mediation if the parties can agree on a mediator, and failing satisfactory resolution by mediation, to an arbitrator if one can be agreed upon, otherwise to two arbitrators, one to be appointed by each party. Such arbitrators may appoint a further arbitrator if they consider it necessary in order to reach a decision.

**11 Copyright**
The Commissioner shall own the copyright in the final report and in any written material produced by the consultant in the performance of the project.

**12 Confidentiality**
a) The consultant shall not divulge to any person any information concerning
- the office of the Commissioner; or
- the operations of the office of the Commissioner;
- the contents of any draft report; or
- any other information belonging to the Commissioner

which she/he has obtained in undertaking the project.

b) The consultant acknowledges that the Commissioner is subject to the Official Information Act 1982, and is therefore unable to enter into an agreement to withhold any information from publication. The consultant also acknowledges that the Commissioner is of the opinion that the Commissioner cannot be required to make information available under the Official Information Act because of ss 18(c)(i) and 52(3)(b) of that Act and ss 20 and 22A of the Environment Act 1986.

c) The consultant's attention is drawn to section 20 of the Environment Act 1986 which requires the Commissioner and all persons holding office or appointment under the Commissioner to maintain secrecy in respect of the matters that come to their knowledge in the exercise and performance of their powers and functions under that Act, except for purposes connected with the administration or implementation of that Act.

### 13 Return of resources on completion

Upon completion or termination of the contract the consultant shall return to the Commissioner all working papers, reports and other papers and information relating to the contract.

### 14 Other conditions

a) The consultant is an independent contractor and is responsible for its own tax liabilities and for any levies payable under the Injury Prevention, Rehabilitation, and Compensation Act 2001 and its amendments.
b) New Zealand law governs this contract and the New Zealand courts have jurisdiction in respect of this contract.
c) All references to money in this contract are in New Zealand dollars and are exclusive of GST unless otherwise indicated.

### 15 Amendments

Any amendments to this contract must be in writing and signed by both parties.