Coromandel East Coast Beaches:

Potential Impact of Projected Climate Change on Coastal Erosion over the next Century and Review of associated Coastal Setback

Prepared for Thames Coromandel District Council

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focus
resource management group

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Report prepared for:

Thames Coromandel District Council

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INTRODUCTION

Thames Coromandel District Council is presently reviewing its District Plan and as part of this work is required by the New Zealand Coastal Policy Statement 2010 (NZCPS, 2010) to identify areas in the coastal environment that are potentially affected by coastal hazards over at least 100 years (Policy 24). The hazard risks that must be assessed include the effects of climate change, taking into account national guidance and best available information. Council is required to adopt a precautionary approach in this assessment (Policy 3 of NZCPS 2010)

Coastal hazard provisions for eastern Coromandel beaches incorporate two coastal erosion setbacks, which are taken from Dahm and Munro (2002), and Dahm and Gibberd (2009):

- The Current Coastal Erosion Line (CCEL) (formerly known as the Primary Development Setback or PDS), which provides for the maximum likely erosion associated with existing coastal processes,
- The Future Coastal Protection Line (FCPL) (formerly known as the Secondary Development Setback or SDS), which identifies the further erosion that could occur over the next 100 years due to projected sea level rise.

The CCEL was reviewed and updated at key sites by Dahm and Gibberd (2009), but the FCPL was not reviewed. The FCPL is still therefore based on sea level rise projections at the time of the first coastal hazard assessment (Dahm & Munro, 2002).

The current report briefly reviews and updates the FCPL taking into account current national guidance in relation to projected sea level rise. The assessment considers a planning period of 100 years, which is the minimum period required by the NZCPS 2010.

It is important to appreciate that the estimated erosion is not an existing risk but one which may arise in the future with projected sea level rise.

POTENTIAL IMPACT OF PROJECTED SEA LEVEL RISE

There are a number of effects likely to accompany predicted global warming that may exacerbate coastal erosion, including:

- a rise in mean sea level
- a possible increase in the frequency and intensity of coastal storms on north-east exposed coasts of the North Island
- a possible reorientation of shorelines in response to changes in wave climate

The scale and timing of any such effects are uncertain and apart from sea level rise it is not presently possible to make any useful quantitative estimates of these effects on coastal erosion.

Accordingly, in this report, the assessment of the potential effects of climate change on coastal erosion over the next 100 years is limited to consideration of projected sea level rise.

There are many uncertainties associated with predicting the future impact of sea level rise on beach erosion. The most widely applied method for assessment of the impact of sea level rise at sandy beaches in settings similar to eastern Coromandel is based on the simple Bruun Rule. This rule predicts that as sea level rises against a shore profile in equilibrium, beach erosion takes place to provide sediments to the nearshore so that the seabed can elevate in direct proportion to the rate of sea level rise.

Bruun proposed the following simple equation to estimate the extent of shoreline retreat:

$$X = al/h$$

Where

X = shoreline retreat due to sea level rise,

a = the rise in mean sea level,

l = the horizontal distance between the foredune crest and the seaward limit of profile adjustment (a depth known as the closure depth), and

h is the elevation between these two points.

There are a range of assumptions that underlie the application of the Bruun Rule. These assumptions are broadly applicable to eastern Coromandel beaches. This approach has therefore been adopted to estimate the potential impact of projected sea level rise on coastal erosion. The Bruun Rule is a simple approach and the estimated erosion is best regarded as an indication of the scale of erosion that might accompany projected sea level rise, rather than an accurate prediction. Nonetheless, this simple approach has been widely used in similar hazard calculations along east coast beaches of the North Island, including setbacks accepted by the Environment Court, and is in our opinion the best method presently available.

SEA LEVEL RISE PROJECTIONS

Sea-level has been rising around New Zealand at a time-averaged rate of about 0.16 m per century since the early-mid 1800s. In the future, projected climate change is expected to generate an increase in the rate of sea level rise, probably persisting for some centuries (IPCC, 2007; MfE, 2008; RSNZ, 2010).

Dahm and Munro (2002) adopted a sea level rise of 0.5 m based on sea level rise projections relevant at that time. More recently, national guidance has been updated by the Ministry for the Environment (MfE, 2008) based on the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC, 2007) and the science available to 2008. This national guidance document recommends a risk based approach but to guide this process provides the following sea level rise considerations for planning and decision timeframes out to the 2090s:

- *a base value sea-level rise of 0.5 m relative to the 1980–1999 average should be used,* ***along with,***
- *an assessment of the potential consequences from a range of possible higher sea-level rises (particularly where impacts are likely to have high consequence or where additional future adaptation options are limited). At the very least, all assessments should consider the consequences of a mean sea-level rise of at least 0.8 m relative to the 1980–1999 average.*

For longer planning and decision timeframes where, as a result of the particular decision, future adaptation options will be limited, an allowance for sea-level rise of 10 mm per year beyond 2100 is recommended (in addition to the above recommendation) (MfE, 2008, p20).

In essence, the guidance recommends consideration of sea level rise of at least 0.9 m over the next 100 years (i.e. to 2110).

It is important however to acknowledge that this figure is not an upper level or "worst case" projection for the next century. For instance, a more recent paper produced by the Royal Society of New Zealand to inform the public on sea level rise (RSNZ, 2010) notes that recent research suggests upper limit sea level rise estimates of 1.0-2.2 m by 2100, with lower limits ranging from 0.30-0.75 m (see Table 2 of RSNZ, 2010 and discussion of this table on their p3). They also noted:

> *"For the decades and centuries that are important for planning purposes, we cannot yet state the likelihood of a given rate of sea level rise. However, our uncertainty is mostly one-sided, with more possible effects that might hasten sea level rise than might slow it."*

Accordingly, we believe that the 0.9 m figure recommended for use by MfE (2008) is adequately but not excessively precautionary for the next century and meets the requirements of Policy 3 of the NZCPS 2010 to adopt a precautionary approach to such matters. We have therefore used this minimum national guidance in our calculations in preference to a higher sea level rise projection.

Nonetheless, it is important to appreciate that greater sea level rise may occur over the planning period. Moreover, it is important to note that sea level rise is presently projected to continue to rise well beyond the next century. For instance, RSNZ (2010) note that sea level rise is also projected to continue for several centuries and "*climate change may cause several metres of sea level rise over the next thousand years"* (p3). Accordingly, sea level rise is likely to continue to be a significant factor for eastern Coromandel beaches beyond the next century.

The projected sea level rise of 0.9 m over the next century is greater than the sea level rise projections used in the calculations by Dahm and Munro (2002) and therefore the FCPL needs to be updated to reflect this more recent projection.

EROSION CALCULATIONS

In line with Dahm and Munro (2002), eastern Coromandel beaches were broadly categorised as either barrier spit or pocket beaches. Barrier beaches typically have fine grained sediments and gentle offshore gradients. These beaches usually have wide Holocene dune systems backing the beach. Pocket beaches are composed of medium to coarse sediments and have much steeper offshore gradients. The dune deposits at these systems are generally less extensive. The difference in profile shape means that these two broad beach types are likely to respond differently to projected sea level rise.

The estimate of closure depth is critical to the Bruun rule calculations. For the purposes of the Bruun Rule, this factor should generally be adopted as the seaward limit of regular onshore-offshore sand exchange. In this study, the closure depth was estimated using existing offshore surveys from Waikato Regional Council's beach profile monitoring database. Calculations were conducted using several representative beaches of each type, where offshore profile data was available (see Table 1). Currently, only one or two offshore survey profiles exist for each beach profile site. More detailed investigations (including repeat offshore surveys) would be required to confirm the values adopted for closure depth and provide site specific assessments for each beach. Despite this, we believe the estimates are reasonable and in line with expectations for this environment.

The results are summarised in Table 1, based on a projected sea level rise of 0.9 m.

Table 1: Indicative estimates of the erosion likely to accompany projected sea level rise of 0.9 m at selected pocket and barrier beaches along the Coromandel east coast

Beach	Sea Level Rise (m)	h	l	Estimated erosion
Pocket Beaches				
Whangapoua	0.9 m	11.0 m	220 m	18 m
Wharekaho	0.9 m	15.0 m	300 m	18 m
Hahei	0.9 m	21.0 m	405 m	17 m
Tairua	0.9 m	15.0 m	350 m	21 m
Barrier Beaches				
Matarangi	0.9 m	8.5 m	250 m	26 m
Buffalo Beach	0.9 m	6.0 m	220 m	33 m
Pauanui	0.9 m	7.0 m	370 m	28 m
Whangamata	0.9 m	9.0 m	300 m	30 m

These results suggest that a projected sea level rise of 0.9 m over the next 100 years could result in 17-21 m net shoreline retreat at pocket beaches, and 25-33 m for the fine-grained barrier beaches. While it would be possible to apply individual figures to each beach, the limited data and the uncertainty and variability of the factors governing shoreline response to sea level rise are such that we feel this would be inappropriate and potentially unfair. In our judgment, a round figure of 20 m is appropriate to use for pocket beaches and 30 m for barrier beaches.

SUMMARY

In line with current national guidance (MfE, 2010), this review of the Future Erosion Setback has adopted a projected sea level rise of 0.9 m over the next 100 years . This is the minimum sea level rise value that should be adopted on the basis of current information. It is important to note that this is not an upper estimate, and that sea level rise is also projected to continue to rise for several centuries.

The beaches of the eastern Coromandel Peninsula were categorised as either pocket beaches or barrier spit beaches based on sediment and geomorphic properties. The erosion likely to be generated by sea level rise over the next 100 years was then estimated for each beach type using data from representative beaches.

On the basis of these calculations, we recommend that the Future Coastal Protection Line (FCPL) provides for:

- 20 m of erosion at pocket beaches
- 30 m at barrier spit beaches.

A list of beaches for which these estimate apply is provided in Table 2. This erosion is in addition to that defined by the Current Erosion Setback. The FCPL is therefore defined with respect to the CCEL.

Table 2: List of sites classified as either pocket or barrier beaches for the purposes of plotting the FCPL. It is important to note that these are very broad classifications. Ultimately site specific estimates might be developed as better information becomes available on closure depth and erosion response of the various eastern Coromandel beaches.

Pocket Beaches (20 m)	Barrier Spit Beaches (30 m)
Sandy Bay	Kennedy Bay
Port Charles	Matarangi
	Buffalo Beach (including Ohuka Beach)
Whangapoua	Cooks Beach
Rings Beach	Pauanui
Kuaotunu East and Kuaotunu West	Opoutere
Opito Bay	Whangamata
Wharekaho	
Matapaua Bay	
Maramaratotara	
Hahei	
Tairua	
Onemana	

It should be noted that the setback calculations assume that the beach system is composed of loose erodible sand over the full width of the assessed erosion. However, dunes are underlain by more erosion resistant materials at some pocket beaches along the eastern Coromandel. These harder materials will limit or slow erosion in the future. Where we are certain that such materials exist, we have reduced the FCPL value to 10 m in relation to the CCEL. Where the erosion resistant material is only known to occur in some areas of the beach, the plotted

setback will vary alongshore.

The 10 m figure allows for some erosion of the more erosion resistant geology should it become permanently exposed along the back of the beach. The figure is a judgment but we believe it is adequately precautionary based on existing knowledge of subsurface geology and the erosion rates evident in present cliffs and bluffs along the eastern Coromandel Coast.

It is possible that underlying erosion resistant materials are more widespread than we are currently aware of. There may therefore be justification to reduce the FCPL in other areas. We recommend that Council should provide opportunity for the setback to be reduced (to a minimum of 10 m) in areas where future investigations by an appropriately experienced coastal scientist confirm that such geology exists.

Dahm and Gibberd (2009) recommended that the FCPL apply only to eastern Coromandel beaches, as:

- The primary impact of sea level rise on coastal hazards at western Coromandel beaches relates to coastal flooding rather than erosion.
- It is very difficult to reasonably or reliably assess the impact of sea level rise on coastal erosion at these western Coromandel beaches.

Appropriate provisions to address future impacts of sea level rise on coastal inundation and, possibly, coastal erosion will need to be developed for west coast Coromandel beaches.

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