Submission on Draft Planning Circular: Advice on Coastal Hazards

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1 Background

I am a physical oceanographer with an expertise in sea-level rise. Until mid-2012 I was in paid employment at the Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC) and continue to be associated with them in an honorary capacity. The views expressed here are my own and should not necessarily be deemed to be those of the ACE CRC.

My recent research has been into the impacts of future sea-level rise on the coast. I was the author of the original *CANUTE* sea-level rise calculator[1] (Hunter, 2010), which combines information on the present frequency of ocean flooding events with the projections of sea-level rise and their uncertainties to yield future likelihoods of flooding; *CANUTE* currently has around 400 registered users. An extension of this technique then led to a simple, yet robust, derivation of a sea-level planning allowance (Hunter, 2012; Hunter et al., 2013). This method has been used for deriving the Tasmanian sea-level planning allowances[2], for advising the Victorian Government on future allowances[3] (Hunter, 2013), and as the basis for the development of the *Canadian Extreme Water Level Adaptation Tool (CAN-EWLAT)*[4] for the Canadian coastline.

In 2012, I provided advice to the NSW Office of the Chief Scientist and Engineer related to sea level rise benchmarks and their uses in planning.

2 Nomenclature

Different Australian States have used different nomenclature for the amount that infrastructure should be raised in order to allow for sea-level rise. In this document, the term *allowance* is used (or sometimes, for clarity, *planning allowance* or *sea-level planning allowance*). An asset raised by a certain *allowance* would experience the same risk of inundation under sea-level rise as it would without the allowance and without sea-level rise.

3 Introduction

The Planning Circular is to be commended for distinguishing between *current* and *future* coastal hazards. Indeed a well-used, pragmatic and supportable method of planning adaptation for sea-level rise is first to determine how to cope with the present hazard, and then to adjust this response according to how we think things will change in the future. The second part of this process is the basis of the sea-level rise allowances that have been declared by all Australian States.

However, coastal inundation and shoreline recession are quite different processes, and different considerations are required to cope with them. The Planning Circular does not adequately

[1] See: `www.sealevelrise.info`

[2] See: `www.dpac.tas.gov.au/divisions/climatechange/what_the_government_is_doing/new_tools_to_improve_planning_for_sea_level_rise_and_coastal_hazards`

[3] See: `www.vcc.vic.gov.au/page/resources/research-and-reports`

[4] See: `www.rpic-ibic.ca/en/events/marine-infrastructure-national-workshop/2014-marine-infrastructure-national-workshop/presentation-abstract`

distinguish between them.

The Planning Circular is also somewhat ambivalent about the type of information that should be included in a section 149(5) planning certificate. It needs to provide a better explanation of the meaning of the words ‘reliable’ and ‘accurate’. In particular, it seems to suggest that ‘inaccurate’ information should be discarded, without any appreciation of the fact that greater uncertainty often demands more stringent adaptation options and not less.

These concepts are expanded in the following sections.

4 Inundation and Recession

The draft Planning Circular does not adequately distinguish between *inundation* and *recession*. *Inundation* occurs by the simple flooding of a ‘hard’ shoreline (i.e. one that is not subject to erosion or deposition) by a rise in sea level; *recession* describes the process by which a ‘soft’ shoreline (i.e. one composed of erodible material such as mud or sand) moves towards the land due to erosion of sediment, while *progradation* describes motion in the seaward direction caused by deposition. On average (over many different beaches), sea-level rise leads to shoreline recession; however the processes involved in recession and progradation are complex and involve the effects of sediment supply, coastal currents, winds and waves as well as sea-level rise. Therefore, coastal inundation is far simpler than shoreline recession, and the two mechanisms should be approached in rather different ways when the effects of sea-level rise are considered. This is explained more fully in the following:

4.1 Coastal Inundation

Even in the absence of sea-level rise, the sea surface is never still. It is perturbed by processes such as tides, storm surges and waves. We therefore experience sea-level rise not as a simple progressive deepening of the water, but as an increase in the frequency of flooding events that occur at a given height. A rule-of-thumb is that a 0.1 metre rise in sea level increases the frequency of flooding events that occur at a given height by a factor of about three; a 0.2 metre rise increases the frequency by three times three (which equals nine) and so on (e.g. Hunter et al., 2012[5]).

Estimation of planning allowances to address potential future inundation has traditionally been accomplished using the global-average sea-level projections of the various Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC). These have predominantly come from the Fourth Assessment Report (AR4), although the South Australian allowance was based on the First Assessment Report of 1991. Also, the (now abandoned) NSW allowances, although based on global-averages from AR4, were partially adjusted for regional variations using the thermal-expansion component of the projected rise. The recently-released Fifth Assessment Report (AR5) was the first to provide *regional* sea-level projections which included the ongoing and future effects of changes of ice on land, and the resulting vertical land motions. These latest projections were used for the Tasmanian planning allowance[6].

It is important to note that, in Australia, allowances based on regional varying sea-level rise have been found to be little different from those based on global-average sea level rise. Therefore, the planning allowances previously derived by Australian States have been both robust and consistent;

[5]See: `www.acecrc.org.au/Publications/Position Analyses`

[6]See: `www.dpac.tas.gov.au/divisions/climatechange/what_the_government_is_doing/new_tools_to_improve_planning_for_sea_level_rise_and_coastal_hazards`

for the 21st century, all such allowances (including those based on regional projections) are in the range 0.8 to 1.0 metre.

As a consequence of the above, there is little to be gained from using 'local' information, such as the observations from a local tide gauge, for two reasons: (1) due to natural variability, observations of sea level at a single location give a poor estimate of the present long-term trend, and (2) extrapolation of the present sea-level trend is a poor predictor of future sea-level beyond about a decade. There is one exception to this: the case where there is evidence of significant local vertical land motion (e.g. due to subsidence related to groundwater withdrawal); the magnitude of such motion should be used to adjust any prescribed State-wide sea-level planning allowance.

4.2 Shoreline Recession

Shoreline recession (or the opposite effect, progradation) is caused by erosion or deposition of sediment, which is determined by a complex mixture of processes: sea-level rise, coastal currents, winds and waves. These may all be influenced by climate change, although sea-level rise on it own tends to lead to recession (motion of the shoreline *towards* the land). Process modelling of the long-term (annual to decadal) behaviour of 'soft' beaches is in its infancy, and does not yet provide a useful tool for the prediction of coastal impacts over typical planning periods. Coastal engineers therefore generally resort to rather simple semi-empirical methods to predict that part of the coastal behaviour that is driven by sea-level rise. One such method is called the *Bruun Rule* which states that the (horizontal) recession is simply proportional to the (vertical) amount of sea-level rise, where the constant of proportionality is typically in the range 50-100 (so 1 metre of sea-level rise would give rise to a recession of 50-100 metres). However, as noted above, a number of other factors affect beach recession; these may well be altered by climate change and, in any given location around Australia, are typically poorly known and understood. Local geomorphological and geotechnical observations may improve this understanding, but they cannot serve as a substitute for credible estimates of future sea-level rise.

We therefore have a complex system, the long-term response of which is only poorly understood. However, even the most primitive modelling requires some estimate of the expected future sea-level rise.

4.3 Inundation and Recession: Summary

Both coastal inundation and shoreline recession depend on sea-level rise (the former in a quite simple way, but the latter in a more complex way that we do not yet fully understand). In addition, shoreline recession depends on a number of other factors (e.g. coastal currents, winds and waves). Regional projections of sea-level rise, which include an estimate of local vertical land movement, are available from the IPCC AR5. It is difficult to see how any local observations (e.g. using a local tide gauge) would improve the situation. Sea-level planning allowances, as developed by most Australian States (predominantly to address inundation) relied on using some 'upper bound' of the sea-level projections for particular times in the future. More recent estimates (Hunter, 2012) as used in Tasmania and Victoria, which use additional information on the local tides and storm surges, yield roughly the same allowances.

The Planning Circular should therefore indicate that:

- existing Australian allowances appear to be robust and consistent, and
- projections of sea-level rise (as provided by the IPCC Assessment Reports) are a necessary input into estimation of future coastal inundation and shoreline recession.

5 Uncertainty

The Planning Circular states that:

- *Firstly, if the information is not sufficiently accurate, complete and reliable, as supported by a competent process of assessment, then the information should not be included in a section 149(5) planning certificate.*
- *Secondly, if the information is considered to be sufficiently reliable then information should be included that alerts the reader to the known information.*
- *Thirdly, if the information is sufficiently reliable, then the council should adopt a policy or planning instrument that manages development on the land. This would then require disclosure of the policy on the section 149(2) planning certificate.*

In the above, the meanings of the words *accurate* and *reliable* are not explained; they are often confused. The word *accurate* conveys some maximum allowable measure of uncertainty, while *reliable* implies trustworthiness and consistency. For example, a projection of future sea-level rise provided by the IPCC (an authoritative body relying on the expertise of many climate scientists) is accompanied by a quantified estimate of the *uncertainty*; so the information comes from a *reliable* source but is, to certain extent, *uncertain* or *lacking in accuracy.* On the other hand, someone driven more by ideology than expertise may make a projection which is apparently totally accurate but with minimal supporting evidence (e.g. 'the sea is not rising'); in this case, the information in *unreliable* but supposedly *accurate.* The Planning Circular needs to clearly define what is meant by *accurate* and *reliable*, and emphasise that planning should be *evidence-based* rather than relying on hearsay from unqualified parties.

The uncertainty of the IPCC projections[7] is relatively large (typically $\pm30\%$ of the best estimate) but this does not mean that the projections should be ignored. Indeed, there are a number of reasons, such as the *precautionary principle* and more objective assessments of the risk of sea-level rise (e.g. Hunter, 2012), why the uncertainty *must* be taken into account in planned adaptation, and why higher uncertainty generally requires more stringent adaptive measures (not less). Uncertainty is therefore not an excuse to ignore important climate drivers of coastal impacts. This point is summarised in the IPCC AR5 (Church et al., 2013; p. 1205):

For coastal planning, sea level rise needs to be considered in a risk management framework, requiring knowledge of the frequency of sea level variability (from climate variability and extreme events) in future climates, projected changes in mean sea level, and the uncertainty of the sea level projections ...

and should be emphasised in the Planning Circular.

[7]The uncertainty in projections of future sea-level rise is, in some ways, similar to the uncertainty associated with storm surges; we have little idea when the next major storm surge will arrive, or how large it will be, and so planning decisions must be based on statistical descriptions of storm surges (e.g. the '1 in 100-year event'), rather than exact information on each storm surge.

6 Summary

The Planning Circular should include the following:

- a better distinction between the effects of *coastal inundation* and *shoreline recession*,
- an acknowledgement that existing Australian allowances appear to be robust and consistent,
- an acknowledgement that projections of sea-level rise (as provided by the IPCC Assessment Reports) are a necessary input into estimation of future coastal inundation and shoreline recession,
- a better explanation of the words *accurate* and *reliable*, and
- an acknowledgement that important climate drivers of coastal impacts, such as projected sea-level rise, *must* be taken into account in planned adaptation, even if deemed to be *uncertain* or *inaccurate*, so long as they are considered *reliable*.

In conclusion, the sea-level rise allowances determined by Australian States have stood well the test of time. In NSW, far from being part of 'heavy handed coastal policy' (Minister Hazzard, Media Release, 30 January 2014[8]), they represent informed, professional and responsible risk management.

7 References

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[8]See: `www.planning.nsw.gov.au/DesktopModules/MediaCentre/getdocument.aspx?mid=1619`