Coastal Erosion and Accretion on the Christchurch Coastline

This document was written as a response to a specific community question to The Observatory.

Coastal erosion is the loss of sediment from the beach, and coastal accretion is the gain of sediment to the beach[1]. Both erosion and accretion can occur *via* the agency of the atmosphere (winds, rainfall) or the oceans. A useful relationship here is that at steady state, the *average* rate of erosion (*E*, from all routes) = the *average* rate of accretion (*A*, from all routes).

$$A + E = 0$$

Note that *average* here means over the averaging period, usually taken to be decades of time. So thinking of Southshore, it is a matter of record that on *average* the seaward side of the Spit is accreting (*i.e.* sediments are being added to the beaches) and this has been the case for decades, for example see Figure below[2].

However, during that time this does not mean that along the whole of the Spit open coastline there has not been any erosion, rather, on *average*, the open coastline is accreting. However, at some specific locations or for short periods of time, some erosion may occur. It is often the case that the time-bases of the erosion and accretion processes are different. In the Southshore situation, usually erosion is caused by short intense storms (increasing wave heights *etc*.) that take place over a few days, whereas the accretion process is largely continual, fed by sediments eroded by and emitted from the Waimakariri River, and then carried down the coast by

[1] "beach" in this document is used because geographically in the area under discussion the boundary between ocean and land is not a cliff but actually a beach.

[2] From Coastal Hazard Assessment Stage Two: Christchurch City Council (Tonkin and Taylor, 2015)

longshore drift. The relationship between *A* and *E* is governed by the sediment budget (which is the subject of NIWA reports, see *Shifting Sands* on this page). If *A* > *E*, then the system is said to be 'in surplus', and accretion will be occurring. The NIWA reports you mention[3], indicate that not only is the average situation accretion, but also that accretion will still be occurring even with predicted enhanced storm intensity and frequency, and 1.4m of sea-level rise. In this context the concept of erosion is probably restricted to the short term storm episode erosion.

It could be that the (CCC) staff were referring not to the average situation, but the result of individual or groups of storms. In that situation, it is likely that along some parts of the coast, erosion will occur for short periods of time, but in the context of continual replenishment from the longshore particle flux, that will be temporary, and not likely to change the overall picture. Think of it as short, sharp storms taking 'bites' out of specific but changing areas of the beach, but the longer-term accretion process continually adding sediment to the whole beach.

Looking at the most recent data that is being used by the Council to underpin their strategy of adapting to climate change, there are two very irritating problems that impact significantly on the results they are working with:

1. CCC (and all other LGAs in NZ) are bound to implement the New Zealand Coastal Policy Statement (NZCPS) in all of their planning. This statement although fixed (*i.e.* it is a written document)[4], is interpreted by guidance from Ministry for the Environment (MfE). Unfortunately, that guidance features the most extreme scenario from The International Panel on Climate Change, (IPCC) Fifth Assessment 2014, RPC8.5, as well as a NZ derivation of this called RPC8.5+[5], which is the 85th percentile of RPC8.5. In their 6th Assessment, (2022) IPCC now identify RPC8.5 as "extremely unlikely". However, it seems that this advice by IPCC has not yet been acted on by MfE or the Minister for Climate Change.
2. The practical outcome of this position is the results of current modelling which takes the sea-level rise which would result from RPC8.5 are labelled as 'likely' in NZ and hence in the CCC coastal hazard planning. This is likely to give large economic inefficiencies and unnecessary community wellbeing and financial damage.
    - Away from global and regional sea level rise modelling, the second issue relates to the underlying methodology of modelling the erosion data and definition of erosion zones. So modelling of local erosion/accretion on the Christchurch longshore and Southshore Spit under a number of sea-level scenarios (including RPC8.5 and RPC8.5+) was undertaken by Tonkin and Taylor (an environmental engineering consulting company). Later, another

[3] Hicks et.al (2018) Coastal sand budget for Southern Pegasus Bay Stage A (April 2018) #NIWA 2018062CH Project #CCC18501 and Hicks et.al (2018) Coastal sand budget for Southern Pegasus Bay Stage B: Future sand budget (June 2018) #2018172CH Project #NIWA CCC18501

[4] https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/new-zealand-coastal-policy-statement-2010/

[5] Note this 85th Percentile was first used by the UK Ministry DEFRA not as a realistic scenario, but a pressure-test of their proposed policy.

engineering consulting company (Jacobs) were contracted to identify the locations and extents of the coastal hazard and erosion zones from the Tonkin and Taylor results. Unfortunately, the scenarios given for the second piece of work only partially overlap with those given for the first set of work. Separately, there is also a double counting of the erosion terms because of the methodologies used[6].

- All things being equal, the double counting results in a switch from accretion to erosion on the Longshore and Spit coast in about 60 years. Removing the double counting implies this switch from accretion will not happen in the foreseeable future, of course assuming all things are equal and no heretofore unidentified situation changes this.

The other matter you have requested on the detail of how the 'Community Adaptation' process will work in terms of communities supported by CCC to develop their own trigger-points is one we are not in a strong position to comment on. As you are aware the process in Lyttleton has begun, and we understand there is a committee of appropriate experts and CCC staff in place to advise both community and Council on the various impacts and their detailed implications for (in this case) Lyttleton. My understanding is that Communities will not be able to use this group to develop their own local trigger points but instead Council will make those decisions. You are correct that numerous overseas examples identify that successful community adaptation requires community consent, and the best examples are those in which the communities themselves make the key decisions. I understand that the process with Iwi may not follow the same system as for others, given that many Marae and settlements are in places which are both sacred to Māori and at the same time indefensible from sea-level rise.

Finally your comment on Christchurch flooding is interesting. The focus on sea-level rise in Christchurch while being valid, in our view is also an example of cognitive bias…because one has familiarity with sea level rising and falling (*e.g*. the tides), it is thought by many as therefore more likely and more important than other less imaginable effects.

My view is that it is almost certain that the major impacts of sea-level rise on Christchurch (from the East) will be after (much later than) those from pluvial and fluvial flooding of Christchurch from the West. I note that in the most recent three years only one of the pluvial flooding events which has affected central and western Christchurch has also affected Southshore.

[6] Murray Hicks (lead author of the 'Sand Reports' and Principal Scientist at NIWA), *Personal Communication*.