Comments on Jacobs's Methodology Report (Volume 1)

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Kāpiti Coast
New Zealand

INTRODUCTION

Jacobs have published *Kāpiti Coast Coastal Hazard Susceptibility and Vulnerability Assessment Volume 1: Methodology* to "update previous coastal hazard assessments undertaken along the Kāpiti Coast District shoreline" to assist the KCDC's "Takutai Kāpiti: Our community-led coastal adaptation project".

The scope was set out in the contract between Jacobs and KCDC and is described in this report.

Coastal Ratepayers United Inc. (CRU)[1] represents the part of the Kāpiti community directly affected by the immediate coastal hazards and has over a decade's experience dealing with the technical issues that arise with assessing these. While Jacobs' Assessment is a significant step forward on previous assessments, in our view a number of professional judgments and technical assumptions made in it detract from the report and its usefulness for KCDC and the community in supporting its stated purpose (1.1), particularly its use for Hazard Assessment under the NZCPS for planning purposes.

Given the amount of time that CRU has had to review Volume 1, we have limited ourselves to identifying the material issues without quantifying their impact in detail or necessarily suggesting what should be done. However, we consider these issues are sufficiently significant that they require either amendment of Volume 1 or comment on the reasons for the choices made and any consequent limitations before proceeding to Volume 2.

We also make clear this in the nature of a review only and should be read in the context of the time and resources available to it. It is possible that these issues stem from misunderstandings or lack of information e.g., key data, raw data and code that has not yet been published.

KEY ISSUES

1. **Pervasiveness of "conservative" Approaches in the Report.**
2. **Relationship between Global MSL and Local SL.**
3. **Trigger Points**
4. **Use of RCP 8.5H+ and de facto Adoption of RCP 8.0 for Sea-Level Rise (SLR).**
5. **Treatment of Vertical Ground-Level Movement.**
6. **Treatment of Accretion when it Outpaces SLR**
7. **Use of Bruun Rule and Lack of Validation.**
8. **Linear Model in Time for Historic Trends.**
9. **Treatment of Options for Sea Walls.**
10. **Uncertainty Distributions and Materiality.**

[1] See Appendix for more information about CRU

1. Conservative Approaches

As a general comment, we have been struck by the pervasiveness of "conservative" approaches presented in the report. A partial list includes the Bruun Rule (section 6.4.3), coastal inlet migration (6.7.3), the bathtub model (7.2.2), extreme sea levels (7.3.1) and groundwater levels (7.3.3).

A strong conservative bias, like any other form of bias, is highly undesirable for planning purposes. By forcing the analyst's own risk preferences on to the decision-makers, it may lead the community to avoid selecting futures that would better accord with the community's own risk preferences.

We strongly encourage Jacobs to review its conservative choices and to balance them with non-conservative estimates wherever possible, even if that must reflect unsupported expert judgement. This is necessary so that the Community Panel can better understand the uncertainties inherent in the analysis. Making a single conservative choice simply hides those uncertainties.

2. Relationship between Global MSL and Local SL.

The Report directly incorporates GMSL projections (adjusted for local relative movements) in its model to project Kāpiti coast's RSL, and from that the shoreline. While MfE (2017)[2] uses this approach in its Guidance (Section 5.6), its use in any specific location should be tested empirically to ensure that the local historic observations (without local relative movements) are material, are significantly correlated with GMSL[3], and the parameters derived from this relationship are robust.

To achieve this the Report depends upon Bell et al. (2018) which is an update of Bell et al. (2012). The latter was subject to a review commissioned by CRU by de Lange[4] that addressed this specific issue[5] along with others that have largely been acknowledged in the Jacob's Report. While time has passed since de Lange was written the conclusions still should be addressed by any user of Bell et al. (2018) or MfE (2017).

Primarily de Lange suggests GMSL Projections may not be the dominant driver of Kāpiti coast's RSL and the historic relationship between them is weak.

Since 2012 the evidence has increased that other factors (e.g., tectonic processes) are even more significant and uncertain at Wellington. Consequently, if these factors are not being appropriately identified then analysis of the historic relationship of the residue (local absolute SLR) with GMSL will be unreliable, as is noted by the various references when discussing the statistical significance of this relationship. This then will impact on the parameters used in the projections of Kāpiti coast's RSL

A particular aspect of this problem is that the historic time series of estimated absolute local SLR can have models other than a simple linear relationship with a particular breakpoint fitted to it. The breakpoint analysis used in Bell et al. (2012) is not particularly sophisticated in the face of known regime changes whether natural (IPO, ENSO) or man-made (measurement techniques).

This issue is potentially material and should be discussed in the Report to justify the judgements made, and with that, the parameters and error estimates used in the assessment of the Kāpiti coast's RSL.

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[2] References are to the corresponding reference in the Jacobs' report Volume 1.

[3] The problems of downscaling Global MSL projections to regional projections are well understood e.g., IPCC (2013a).

[4]https://researchcommons.waikato.ac.nz/bitstream/handle/10289/9662/Comments%20on%20GWRC%20DCCS.pdf

[5] We note that Bell et al. (2018) does not reference the issues raised by de Lange or his report itself.

3. Trigger Points

When managing hazard risks from an evolving process there are two distinct ways of identifying when a vulnerability might occur.

One is the use trigger points of physical events such as a particular amount of sea-level rise. This is encouraged by MfE (2017) and focuses on triggering actions to manage a risk by the physical proximity to the hazardous event. We strongly endorse it for this use, particularly where triggering regulatory action is involved. Residents can typically assess what is happening over time and by using that can judge the consequences and how far off they might be. It also gives greater certainty because the regulations do not need to change depending on the actual pathways that evolve.

But equally, interested parties want to understand the likely future risks with only today's knowledge. Risk assessment, particularly the consequences, is tightly tied up with estimates of how long before they will occur. They are interested in where the envelope of likely pathways ends up over a particular period, and over time which pathways are being eliminated (or added). In this case the trigger points for adaptive management have become the pathway that is evolving. This approach allows people to test the sensitivity of investment decisions to the pathways, and even to delay investment to achieve a better understanding of the pathway that is occurring.

So, both needs should be accommodated in any assessment (as per the caption of Figure 3.2).

Focusing scenario runs around the fixed shoreline triggers alone, as appears to be happening in Sections 4.2 and 6.1, runs the risk of losing information about the dynamic that is unfolding — the likely pathways, and the uncertainties that will get resolved by time. It is easy enough to derive physical trigger points from scenario-based pathway analysis, but more difficult the other way around, so we recommend this be the former be the used in the risk assessment (see next section).

4. Use of RCP 8.5H+ and de facto Adoption of RCP 8.0 for Sea-Level Rise

The NZCPS Policy 24 requires hazard identification and assessment to be done "taking into account national guidance and the best available information on the likely effects of climate change" i.e., it is to be based on the likely effects, and the usefulness of any guidance/information is constrained by this requirement[6].

This requirement to be "likely" informs the remaining Policies including Policy 27 (1) and Policy 27 (2) (b) that references "the expected effects of climate change," back-referencing to the requirement to be "likely". Significantly, Policy 25's "In areas potentially affected by coastal hazards over at least the next 100 years …", is defined by Policy 24, that is in turn based on the "likely effects of climate change". Thus MfE (2017)'s view that Policy 25 requires the use of more extreme, i.e., "potential", effects is based on a misinterpretation of the law.

SLR is the primary effect of climate change considered by the Report.

RSLR projections from IPCC (2019) and MfE (2017) are given in Table 3.1. These are adjusted by the extremes of VLM to give Table 3.2, then rounded to give a series of RSLR projections in Table 3.3. These are then added to the estimated extreme sea levels based on a 1% AEP to give the input (Table 4.2) into calculations of impact on shoreline giving "SL" that is used in the probabilistic assessments.

This methodology uses an RSLR projection from RCP 8.5H+ as the upper scenario, RCP 2.6 median as the lower, and de facto uses figures similar to RCP 8.5 for the 2120 "Intermediate Projection".

[6] See, Allin "The Kapiti Fiasco" https://www.kapiticoast.govt.nz/media/29153/chapter-3-allin-appendix-1-allin-crozier-gwrc-pnrp-submission-received-14-july-2016-2.pdf

The assumed minimums and maximums applied to SL (or its components) in the probabilistic assessment are not given — they will not be published until Vol. 2[7].

These scenarios and the projections derived from them are unlikely[8], and all the probabilistic analysis will give is the likely range of unlikely futures. This will not be particularly useful in any application of the NZCPS.

MfE (2017) is explicit about the function of RCP 8.5H+ — it is only there for the "purposes of stress-testing adaptation plans where the risk tolerance is low and/or future adaptation options are limited, and for setting an SLR for green-fields development where the foreseeable risk is to be avoided" (p. 100).

Hence RCP 8.5H+ clearly is not "national guidance … on the likely effects of climate change". It is only going to be of use for cities like Wellington where a major port and much of the CBD might be at risk. Its application to Kāpiti is difficult to see.

In respect of the suggestion that it gives better coverage of ice sheet melt, IPCC (2019) postdates MfE (2017) and is a much broader-based review than it. Section 4.2.3.3.1 explicitly discusses the weaknesses in the alternative methods such as Kopp (2014) used by MfE (2017), and even MfE (2017) acknowledges this issue (Section 5.4.3)[9].

IPCC (2019) explicitly says its projections are designed to capture the "likely range of RSL" (Section 4.2.3.3.4) with the implication that Kopp (2014) and other more recent contributions based on similar methodologies do not.

RCP8.5 is de facto used as approximately the 2100 intermediate projection. For that to be useful under the NZCPS, RCP8.5 would need to be a "likely" scenario, able to inform the "likely effects" of climate change.

A series of papers in Climate Change 109 (2011) describe the RCP scenarios and their construction, including an overview[10] and RCP8.5[11]. RCP8.5 is the highest of what was designed as the reference scenarios i.e., no policy action. It gives an upper bound on these (i.e., "Compared to the scenario literature RCP8.5 depicts thus a relatively conservative business as usual case …"). For a fuller discussion see a recent article by Zeke Hausfather[12]

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[7]There is some curious language in Section 6.1 that says the probability distributions for PFSP arise from "pre-determined increments of SLR" possibly implying that Table 4.4 is applied deterministically i.e., its uncertainty is excluded from the probabilistic calculations. This seems highly unlikely since the timing of any hazard arising is central to its management. The community will need to have this uncertainty quantified as best as possible, and this is essential for setting any triggers/adaption thresholds in adaptive planning. Regardless the problems of using "unlikely" RCP scenarios still apply.

[8]MfE (2017) is incorrect to state likelihoods cannot be assigned to these scenarios (5.7.1). They are a product of the assumptions that go into them, and assessments can be made of their likelihood. The lie to MfE (2017)'s assertion occurs with it saying in the next breath: "It will be challenging, however, to achieve the lowest RCP2.6 M scenario as described earlier, because of the rapid and large reductions in emissions required globally".

[9]Ironically CRU had raised the same objections citing similar literature when commenting on a draft of MfE (2017) but these were put aside by the authors.

[10]https://link.springer.com/article/10.1007%2Fs10584-011-0148-z

[11]https://link.springer.com/article/10.1007/s10584-011-0149-y

[12] https://www.carbonbrief.org/explainer-the-high-emissions-rcp8-5-global-warming-scenario

RCP8.5 assumes no policy interventions and along with other assumptions each of which is in the nature of "possible" not "likely". Jointly they become highly unlikely.

In fact, if countries reduce their emissions in line with the Paris targets, then there is no possible future in which the climate changes in accordance with RCP 8.5.

It would be remiss of Jacobs not to draw the inconsistency to the attention of the Community Panel and to provide the Panel with sea-level estimates which are consistent with plausible expectations of the future path of global emissions. This is not to say that such scenarios are the only ones that should be presented, but they should be emphasised as the "likely" future and as such should legally be the ones that inform our District Plans.

RCP6.0[13] includes a reference scenario based on "no-climate-policy" (and further, assumes any existing policies are retired when they expire). This scenario only reaches 7 Wm^{-2} and would better represent the no-policy intervention scenario, although given the various international processes and agreements since AR5 (e.g., Paris) a reversion to "no policy" and 7 Wm^{-2} by 2100 would be regarded by most as unlikely. This is particularly so considering technological innovations over the last decade[14] — these will not be rolled back. Thus RCP6.0 is a reasonable representation of an upper limit for likely emissions.

Based on this IPCC (2019) then gives projected SLRs that take account of more recent information on ice sheet melt, and its published likely ranges gives a distribution based on multiple different climate model runs (and hence climate sensitivities to GHGs)[15]. There seems no good reason to move from this for the purposes of applying the NZCPS.

However, there is good reason to expect a more aggressive policy response, and this will be increasingly likely as pathways consistent with RCP6.0 unfold.

Faced with this situation and the use of an adaptive framework, further scenario runs that cover the "likely" outcomes are needed. CRU would expect at least two runs, one based on RCP6.0[16] and another RCP4.5 (broadly as recommended by MfE (2017). The probability distributions of the CED that result will show the likely (P66) and P90 extent of hazard vulnerability conditional upon the "likely" assumptions of SLR over the period.

This is the minimum required to allow the outputs to be used to give effect to the NZCPS in the District Planning processes.

This change will impact any of the other coastal hazards' assessment where SLR is treated as an input e.g., inundation.

5. Treatment of Vertical Ground-Level Movement.

The local VLM is independent of sea level rise. If the subsidence is 1-3mm/year, the expected effect is to raise the median RSLR by about 2mm/year. Since plate tectonics and climate change are uncorrelated, the effects on the upper and lower limits of RSLR will be less than the additional +/-

[13]https://link.springer.com/article/10.1007%2Fs10584-011-0150-5

[14]E.g., unanticipated PV and wind generation cost reductions, LEDs, better batteries/EVs.

[15]Note the IPCC gives a distribution for SLR and we would expect that to be used instead of the simple triangular assumption.

[16]The issue of the IPCC sea-level projections ending at 2100 can be addressed in a variety of ways using IPCC projections.

1mm/year, and should be estimated by simulation. The figures given in Table 3.2 are accordingly not correct.

6. Treatment of Accretion When it Outpaces SLR.

Section 6.8 makes the comment:

For this mapping product, only the 'hazard' has been mapped, so that where accretion was projected to occur over a specified time frame (i.e., if the long term accretion rate is higher than the effect of SLR) then only the 'present day' hazard (short term and dune stability) has been mapped.

It is unclear if this implies the reducing risk from the "present-day" hazard is not recognised as the shoreline progressively moves seaward over time. If so, any such projection will be incorrect.

7. Use of Bruun Rule and Lack of Validation.

Despite all the warnings about the Bruun rule not applying to accreting, eroding or protected shorelines (i.e., the Kāpiti coast) this is used as if it has the status of a physical model i.e. that with some adjustments it can independently (i.e., a priori) project the impact of sea-level rise on the coastline.

Given the nature of the Kāpiti coastline, this is most unlikely, particularly given the sediment movement on the coast. As the report correctly notes, referencing Morton (2003), sediment budgets are inherently hard to measure. However, the longshore movements are a critical example of the kind of thing that needs to be estimated to apply a physical model.

In light of this, the minimum CRU would expect is some empirical validation of the results from the Bruun analyses by way of hind-casting. This will raise the issue of separating the impacts of longshore sediment movements from sea level rise in the historic records. Doing this is an important issue that is concealed by the current methodology.

We make some suggestions for how to address this in the next section.

We would add that the Bruun rule and adjustments end up with a linear model with multiple parameters and assumptions. This model appears hard to justify based on the level and quality of information available. A simpler model should also be tested perhaps along the lines suggested below, or even simpler still where just the slope of the beach is fitted to the historic record for each transcript within each cell.

8. Linear Model in Time for Historic Trends.

The past long-term rates of shoreline movement are derived from analysis using DSAS to derive annual rates of movement at 50m spaced transcripts using the endpoints and the linear trend in time[17].

These are used to derive parameters for the long-term trends.

An alternative approach that could be used within each of the coastal cells (Fig. 6.6) is to test a simpler but still physical-based model of the change in shoreline position (known independently) being based on a linear combination of (1) longshore addition/subtraction over each time period (not known independently), (2) the accretion/erosion impact of SLR (known independently) at each transept, and a residue covering the processes that are independent of these.

[17]There is an inherent bias in using the vegetation line for measurement — it responds immediately for erosion, but with a lag for accretion. This should be tested and corrected for if significant.

On this approach, longshore changes for any period would be a function of the distance into the cell, and the sea level affects a function of the shape of the transept.

Such a linear model could be fitted to test if it is possible to partial out the two effects on these assumptions and to test the parameters derived from the Bruun Rule.

9. Treatment of Options for Sea Walls.

The assignment of likelihoods to the options for the future of sea walls is inappropriate. It is quite wrong to simply assume that existing structures will be abandoned at the end of their useful lives. That is a possible decision, but for many of the structures being considered, it is not at all a likely one. (Consider, for example, KCDC's current work to renew the Paekakariki seawall.)

These are decisions that will need to be taken and potentially planned for. The consequences of each for the hazard risks need to be understood, along with the options analysis envisaged by Policy 27 of the NZCPS. CRU would therefore expect all three to be modelled to allow the NZCPS to be given effect.

10. Uncertainty Distributions and Materiality.

The minimum, mean and maximum values used to determine the distribution of the parameters in the projections of the CED are yet to be published. An important issue for hazard management is the materiality of each of the uncertainties in the analysis i.e., their contribution. These need to be reported.

FINAL NOTE

The report suffers from poor proofreading. Inadvertently repeated passages of text, spelling errors and the like raise concerns in the reader's mind about whether some aspects of the analysis may also contain inadvertent errors. Generally, the errors do not impair the reader's ability to understand what is being said, except that on pp. 57-58 the authors twice say "perpendicular" when what they seem to mean is “parallel".

APPENDIX

Coastal Ratepayers United, Inc (CRU) is an incorporated society, most of whose members are ratepayers living on the Kāpiti Coast. CRU was incorporated in 2012, in response to coastal hazard provisions of Kāpiti Coast District Council's (KCDC's) Proposed District Plan (PDP) and the imposition of alarmist and unsupported risk statements which KCDC had decided to place on the LIMs of coastal properties. The Objects of CRU are set out in its Rules:

a) Take whatever steps are necessary to have reviewed the imposition of hazard lines on LIMs or any other documents;

b) Make representations to Councils concerning the coastline, including the rights and interests of property owners along or near the coastline;

c) Undertake scientific, engineering, legal and other research relating to the coastline and provisions to govern activities along or near the coastline;

d) Make representations, gather evidence and make submissions and appeals concerning any consultative or statutory document, including any Regional/District Plan or draft or proposed Regional/District Plan;

e) Take any appropriate legal or other action required to further the objectives of the Society;

f) Do anything necessary or helpful to the above purposes.

Legal action supported by CRU was successful in getting the LIM information fixed. Legal and political action succeeded in getting KCDC to appoint scientific and planning panels to review the PDP and its processes. The science panel found that the coastal hazard information used for the PDP and the LIMs was not fit for purpose, and the planning panel advised that the PDP was so flawed that it was nearly a toss-up whether to withdraw it and start again or try to fix it through the hearings process.

KCDC then withdrew all coastal hazard provisions from the PDP, with a promise to develop suitable new provisions by way of variation to the proposal by 2020 (a promise which was not honoured).

Regarding submissions on the PDP, a case was taken to the Environment Court about the way in which coastal hazard matters were being dealt with, and an appeal against the final approved version, all led to significant other improvements in the Plan.