CSL's Kāpiti Coast Coastal Hazard Assessment

Questions Raised by the Evidence

A Student Handout prepared by Bryce Wilkinson[1]

In August 2012, the Kāpiti Coast District Council (KCDC) wrote to approximately 1,800 coastal property owners and told them their properties had been identified as being at likely risk of significant erosion or inundation within 100 years. That warning was immediately placed on Land Information Memoranda (LIMs) — the official records that any buyer, bank or insurer consults before a property transaction.

Risk assessments require likelihoods to be addressed. This is documented in the appendix to this handout. On the face of it, this KCDC letter is inviting recipients to infer that such risk assessments have been made. But were they?

The underlying coastal hazard assessment had been prepared by Dr Roger Shand of Coastal Systems Ltd (CSL). This handout works through the evidence, asking what the assessment actually said, what KCDC claimed it said, and what independent scientists and statisticians concluded when they reviewed it.

The questions are organised under headings. Under each heading you will find the actual words used — from KCDC's letter, from CSL's report, from correspondence, and from the independent expert panel that reviewed the assessment in 2014. You are invited to judge whether those words mean what KCDC's letter implied they meant.

Background: What KCDC's Letter Claimed

The letter dated 25 August 2012, signed by KCDC's Group Manager Strategy and Partnerships, told coastal property owners that CSL's report:

> *"...**predicts** where the shoreline is likely to be within 50 and 100 years. It shows what **might happen** to the high tide line under two different management scenarios." — KCDC letter to coastal property owners, 25 August 2012 (emphasis added)*

The letter went on to state that around 1,800 properties had been identified as "at **likely** risk of significant erosion or inundation" and that the information must now appear on LIMs. It described coastal erosion as "becoming more the urgent" and referred to an "acceleration in coastal erosion" as a present fact. An attached hazard line map plotted CSL's **projected** future shorelines. [Emphasis added in each case.]

Five words in that letter warrant particular attention: predict, project, likely, might, and acceleration. Was KCDC confused about whether CSL's hazard lines were predictions or was CSL, or were both confused? Where is the future shoreline actually likely to be? And where is the evidence of an acceleration underway, when a NIWA report in 2012 for the Greater Wellinton Regional Council found no statistically significant evidence of an acceleration?

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[1] Bryce Wilkinson is solely responsible for the accuracy of the material in this document and the opinions expressed. He prepared it with the assistance of AI (Claude, Sonnet 4.6).

Question 1: Did the CSL Report Make Predictions — or Projections?

A prediction says something will happen, at least in the eyes of the person predicting the future. A projection is silent about what is likely to happen. It asserts what will follow if certain assumptions hold true.

These are two different things. A prediction carries an implicit claim that its assumptions are themselves probably correct. A projection is openly conditional: "if this, then that."

The CSL report stated on page 4 that:

> *"An erosion hazard assessment such as this is a detailed scientific study which predicts potential hazard (magnitude and probability) over different prediction periods."*

The CSL report produced three different coastal shoreline scenarios of which two were for 50 years ahead and one for 100 years ahead. Two of these three were for 'unmanaged scenarios that assumed no maintenance of sea walls. The report also assessed scenarios for inlets.

Many assumptions had to be made about parameter values for input variables (such as global sea-level rise, vertical land movements affecting Kapiti and net gains or losses of sedimentation.

So which values are likely, and what is the likelihood of retaining and enhancing seawalls in the next 50 to 100 years if the need to do so becomes increasingly obvious?

A word-count search of the CSL report reveals only two counts for the word "probability", one of which is in the sentence quoted above. The other (on page 64) is a recommendation that a probability analyse be undertaken. The word "probable" does not appear. The word "likely" appears 10 times, none of which refer to the coastal hazard assessments as distinct from the inlet assessments."

It is clear that what the report does is make highly assumption-dependent projections. Indeed, the map attached to the KCDCs letter correctly said the shorelines were projections.

Yet the word count in the report is 88 for "predictions" and 13 for "projections".

WHAT THE REPORT'S OWN TERMS OF REFERENCE REVEAL

CSL's report makes it clear that it was the KCDC that drove the decision to refer to its (conditional) hazard assessments as "predictions".

Point 10 in the Terms of Reference for CSL's report states:

> *"Change the terminology for the modelled 50 and 100 yr erosion lines from Coastal Erosion Hazard Distances (CEHDs) to Coastal Erosion Prediction Distances (CEPDs), and Coastal Erosion Hazard Lines (CEHLs) to Coastal Erosion Prediction Lines (CEPLs)."* —Terms of Reference 10, as quoted in CSL (2012), page 8

The original terminology was hazard lines. KCDC required CSL to call its erosion lines prediction lines. The word prediction — which later appeared in KCDC's letter to property owners as justification for the word "likely" — was inserted into the report at the client's instruction, not as a judgment by the report's author.

WHAT DR SHAND SAID

When the author of the report was asked directly whether his outputs were predictions or projections, he replied:

> *"My use of the terms prediction and projection is interchangeable I appreciate your analysis of the terms and apologise for the anxiety I may have caused.*

> *I don't know how "likely" was used in the "letter" you refer to, but in my report it is not used with reference to future erosion lines.*
>
> — Dr Roger Shand, in email correspondence with Bryce Wilkinson, 17 September 2012

In the same email Dr Shand attributed the hazard lines to KCDC's officers:

> *I draw your attention to the Terms of Reference provided me by the council officers. I fulfilled these instructions using best practice approaches. The officers then decided how to apply/implement that information to derive 50 and 100+yr hazard lines.*
>
> *Different methods of implementation result in different hazard line locations.*
>
> *… As I note above, there is no difference regarding my usage of prediction and projection. I am not involved in the implementation process*

One can easily imagine Dr Shand's discomfort about the KCDC's gross misinterpretation of the report's findings.

Question 2: What Justified the KCDC's "likely" assertion?

As already mentioned, KCDC's letter asserted that about 1,800 property owners their homes were at "likely risk" of significant erosion or inundation.

CSL report used the word "likely" 13 times. Not one of them refers to the risk facing any property or group of properties. One is a direct quote from the government's New Zealand Coastal Policy Statement 2010 (policy 25). Most relate to reassuring statements about inlet stability.

DR SHAND'S OWN DESCRIPTION OF HIS METHODOLOGY

When asked directly whether his report assessed the likelihood that properties would be eroded even within the context of a particular scenario, Dr Shand replied:

> *Hazard assessments are conservative in that they are based around justifiable possibility (my term). As such, when considering uncertainty, for example measurement uncertainty, we take the 95th or even 99th percentile of variation. — Dr Roger Shand, in correspondence with Bryce Wilkinson, 17 September 2012*

On this basis, a property that is on the border of a hazard line is highly unlikely to be affected, within the context of the modelled scenario. "Justifiable possibility" could also be a tsunami, major earthquake of a volcanic eruption around Lake Taupo.

> *"I said that the hazard line relates to "possible" erosion. …*
>
> *… it was well beyond the approach required by CSL to provide such detail* [about within scenario likelihoods] *Site specific assessments could provide such information and council may allow development/use as a result. — Dr Roger Shand, in correspondence with Bryce Wilkinson, 18 September 2012*

In short Dr Shand is clear. The CSL report did not assess future shoreline likelihoods. It did not even assess probabilities for each or any scenario.

KCDC'S RESPONSE WHEN CHALLENGED

When questioned as to the basis for using the word "likely" it its letter, a KCDC staff member replied that its letter was "based on" CSL's report. Dr Shand has made it clear that this could not be done, based on CSL's report.

In short, KCDC pointed to CSL, CSL pointed back to KCDC, and neither has identified any probability calculation that justified the use of the word "likely" to annotate the LIM's of around 1,800 LIMs.

Fourteen years have gone by and property owners are still waiting for meaningful evidence of concerning likelihoods.

Question 3: What Does a "Conservative" Probability Mean?

The peer review section of the CSL report — written not by Dr Shand but by Dr Mike Shepherd — contained the following statement:

> *"Dr Shand applied a rigorous scientific approach to quantify the erosion hazard so that prediction lines could be drawn. His results are necessarily conservative (precautionary) to comply with the recommendations of the 2008 MfE* [Ministry for the Environment] *Guidance Manual."* — Dr Mike Shepherd, peer review section of CSL (2012), p 105.

The word "precautionary" is placed in parentheses as if it is a synonym for conservative. What is a conservative position for a prediction line?

In engineering and design, a conservative design, meaning one that is on the side of safety, is entirely legitimate. If you are building a bridge, you might design it to withstand loads greater than the permitted maximum load.

But in statistics, a "conservative probability" has no meaning. A probability is what it is. You cannot make 40% more conservative by calling it 60% — that would be self-contradictory.

The CSL report embedded conservative (meaning exaggerated sea level rise) choices throughout its parameter selection — using high level projections for sea level rise, 95th-percentile values for short-term variability[2], zeroing out any accretion. These choices meant the resulting hazard lines were designed to produce a more alarming result than was likely, without the reader knowing the extent of that basis. There was no way for a reader — or a property owner — to ascertain from the CSL report what was likely.

The independent statistician on the 2014 expert panel, Dr Robert Davies, identified this problem directly. In Section 6 of the Carley Panel report he wrote:

> *"From a statistical perspective, it is recommended that 'best estimates' rather than precautionary values be adopted, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate. Alternatively, one could give several scenarios based on best, worst and midway cases."* — Dr Robert Davies, Section 6 of Carley Panel Report, June 2014

That recommendation describes exactly what the CSL report did not do. The precautionary choices were baked in throughout, whereas they should be added transparently after identifying what was likely. The result was a single set of hazard lines that looked like scientific findings but were in fact a compounded highly unlikely estimate — with no way for anyone to ascertain what was likely.

[2] CSL p 19.

Question 4: What Was the Basis for the 0.9 Metre Sea Level Rise Assumption?

The most consequential single number in the CSL report is the sea level rise figure used for the 100-year scenario: 0.9 metres. Every hazard line in that scenario is directly proportional to this figure — double the figure and the hazard lines move roughly twice as far inland.

WHERE THE 0.9M FIGURE CAME FROM

The figure was not measured. It was not a central estimate derived from observations. It was assembled through a chain of guidance documents:

- The IPCC's 2007 Assessment Report projected global mean sea level rise of between 0.18 and 0.59 metres by 2100 across a range of emissions scenarios. The upper bound of 0.59 metres applied to the most extreme scenario. The IPCC then added a further 0.10 to 0.20 metres to allow for ice-sheet dynamics it described as not well understood, producing an absolute upper bound of around 0.79 metres.[3]
- New Zealand's Ministry for the Environment (MfE) translated this into planning guidance in 2008, recommending a base planning value of 0.65 metres for 2100-2109, with the consequences of an additional 0.3 metres also to be considered.[4] The MfE manual described this as guidance "to aid assessment" — not as a prediction.
- KCDC instructed Dr Shand to use 0.9 metres for the 100-year scenario to 2110, describing it as a "worst case scenario in relation to storm activity" meeting precautionary requirements.[5]

WHAT THE 0.9M FIGURE REQUIRED

The observed rate of sea level rise at Wellington over the 20th century was approximately 1.7 mm per year — consistent with global measurements — implying about 17 centimetres of rise per century. The 0.9 metre figure requires that rate to increase to approximately 9 mm per year and sustain that acceleration for the entire century ahead.

This represents a vast acceleration in the global warming-affected rise or around 0.2 metre rise in the 20th century. According to NIWA's report for the Greater Wellington Regional Council in 2012, that acceleration could not be confidently detected in the sea level statistics to date.

No probability was ever attached to the 0.9 metre assumption at any point in the chain from IPCC to MfE to KCDC to CSL. The figure entered the model as a given — a planning input that KCDC chose — and was then used to produce hazard lines that KCDC described as showing properties were "likely" at risk.

The Carley Panel noted the compounding uncertainty this creates:

> *"There are large uncertainties in the projected 50- and 100-year sea levels, compounded by those in the analysis methodology applied to calculate the resulting shoreline recession and property erosion. ... Whatever projections of rising sea levels are accepted now for application in the analyses, they should be reappraised frequently in the future, based on measured sea levels showing accelerated rates of rise ... ..."* — Carley Panel, Section 4.2, June 2014, p 34.

[3] CSL, section 2.1.2, p 10.
[4] CSL section 3.13, p 18.
[5] KDCD letter to Bryce Wilkinson, 13 November 2012, p 2.

Question 5: Was Sea Level Rise Counted Twice?

The Gibb formula used by CSL to calculate erosion distances adds together several components, one of which is a "long-term trend" derived from historical aerial photographs, and another of which is the sea level rise component for the projection period.

The problem is this: the historical photographs already captured the shoreline's response to 20th-century sea level rise. That rise — roughly 17 cm over the century — was already embedded in the observed long-term trend. Adding a further projected sea level rise on top, without first removing the historical sea level effect from the trend measurement, counts sea level rise twice.

The Carley Panel (2014) identified this as a significant flaw and stated it directly:

> *"An important consequence of not having removed the contribution by the 20th century rise in sea level is that ultimately in calculating the future hazard lines they 'double counted' the effects of the rise in the relative sea level, in that separate analyses were also undertaken on the changes in sea levels projected for time frames of 50- and 100-years, entered as a separate factor in Gibb's equation."* — Carley Panel, Executive Summary, June 2014

The argument that double-counting might be justified as a precautionary approach did not impress the Panel.

> *"Purposely double counting is a decidedly unconventional approach, and should not be followed ... the question ... should instead be accounted for in the uncertainty of factor of safety."* — Carley Panel, Section 4.2, June 2014 — commenting on Dr Shand's defence, p 34.

The Panel recommended that the 20th-century sea level rise contribution be stripped from the historical trend before the projected future rise is added — the standard, non-duplicative approach. This had not been done.

Question 6: Was the Right Formula Used to Calculate Erosion from Sea Level Rise?

Translating a rise in sea level into a distance of shoreline retreat requires a formula. The standard formula, known as the Bruun Rule, was developed by Professor P. Bruun in the 1960s. It works by assuming that the beach will maintain its equilibrium profile shape as sea levels rise, so that a rise in water level pushes the shoreline inland by a distance that depends on the beach slope.

The CSL report explicitly stated that the Bruun Rule does not work when applied the Kāpiti Coast:[6]

- The Kāpiti Coast has been accreting — building seaward — over the long term, fed by sediment from rivers to the north. The Bruun Rule cannot produce a result showing accretion; it always predicts retreat for any positive sea level rise.
- Longshore sediment transport at Kāpiti is substantial and variable in both direction and magnitude — a factor the Bruun Rule does not account for.
- The estimates of the critical "closure depth" parameter (used in the denominator of the Bruun formula) vary threefold depending on the method chosen.

[6] CSL, p 18, last paragraph.

Having rejected the Bruun Rule, the CSL report used the same approach as the Komar et al. (1999) on the grounds that it "offers greater certainty"[7] when applied to the Kapiti Coast. The Komar model was developed for storm erosion events on the Oregon coast of the United States.

THE MODIFIED KOMAR RULE IS THE BRUUN RULE AGAIN

An article in 2012 that referred to shoreline expert, Willem de Lange, University of Waikato, explained that the Komar model was developed to assess likely inshore inundation during a storm. This was not a model of sea-level rise. But the article showed how "adapting it" it by replacing the term for the storm water effect by a sea-level rise estimate[8] made it mathematically identical to the Bruun rule.

> *"The [Komar] method does not include a sea level rise term at all. It is based on the extreme water level relative to the elevation of the dune toe, and the beach lowering during the storm. It is not intended to predict the effects of long-term sea level rise. Consequently the authors of the Kapiti Coast study modified the Komar et al equation by replacing the numerator term with the sea level rise (Equation 3 in the report). Therefore, instead of using the equation as defined, they used the ratio of the sea level rise to the slope of the beach. I have already discussed this ratio – it is known as the *Bruun Rule!"* — Guest author, "Are 1800 Kapiti homes really threatened by sea level rise?", 3 Sept 2012 https://www.climateconversation.org.nz/2012/09/are-1800-kapiti-homes-really-threatened-by-sea-level-rise/,

In plain terms: the report explicitly rejected the Bruun Rule as inappropriate for this coast, then adopted a version of it anyway. Every objection raised to the Bruun Rule — the absence of a sediment budget, the failure to account for accretion, the fixed slope assumption — applied with equal force to the formula that replaced it.

The Carley Panel acknowledged the Bruun Rule's limitations and found that CSL's calculation of the sea level rise component, while "reasonable", carried "moderately significant uncertainties based on the selection of the beach-profile slope used in the calculations." Dr Paul Komar, the second author of the Komar et al. (1999) paper whose model CSL had used, was the Deputy Chair of the Carley Panel.

Question 7: What Happened to Coastline That Was Growing, Not Eroding?

The CSL report derived its long-term trend rate from aerial photographs and old maps spanning roughly 135 years. At many sites, this historical record showed net accretion — the shoreline had been moving seaward, adding land, not retreating.

The methodology then repeated an asymmetric decision that it made in an earlier report for the KCDC in 2008. That report stated:

> *"Of particular note is that for all areas subject to a positive (seaward) shoreline trend, the rate was set to zero. This approach is common when assessing hazards for accreting coasts as it removes the assumption of continued accretion, provides an increasing safety margin."* — CSL (2008a), page 24, as quoted in the Carley Panel report, p 30.

Where historical data showed erosion, that rate was carried forward into the projection. Where historical data showed the shoreline was building seaward, the accretion was discarded and replaced with zero.

[7] CSL, p 18.
[8] CSL, equation 3, p 18.

The practical consequence of this rule can be illustrated with one example: several sites in the report's own data showed accretion at rates of 0.4 to 0.72 metres per year. At a rate of 0.55 metres per year, a 100-year projection would put the shoreline 55 metres further seaward than its current position. That figure was replaced with zero. The coast was not permitted to continue doing in the model what it had been doing in reality.

The Carley Panel acknowledged this is common practice but noted that in the Kāpiti case it represented a significant assumption:

> *"The Panel recognises that CSL is correct in this being a common practice in methodologies applied to erosion hazard projections, although in the case of the Kāpiti Coast it represents a rather extreme assumption that future rates of rising sea levels will overcome the positive balance provided by the sediment budget."* — Carley Panel, Section 4.1, June 2014 p 30

This asymmetric treatment is not statistically neutral. By using erosion rates where they existed but replacing accretion with zero, the model systematically biased every output toward the most adverse outcome, regardless of what the data at any individual site showed.

Question 8: Why Was the Sediment Budget Not Assessed?

The Kāpiti cuspate foreland — the distinctive seaward bulge of the coastline sheltered by Kāpiti Island — is an accretionary landform. Over 7,500 years it has been built by sediment deposited by currents and wind interacting with Kapiti Island to form the distinctive coastline bight.

Whether a coast erodes or accretes over time is primarily determined by its sediment budget — the balance between sand arriving at the beach from sources (rivers, cliff erosion, longshore transport) and sand leaving it (blown inland, transported offshore). If sources exceed losses, the coast accretes. If losses exceed sources, it retreats.

The CSL report acknowledged the importance of sediment supply. It noted the Ōtaki River's history and the interventions in the Waikanae River system. It recognised that the coast's accretionary character depended on sediment arriving from the north. But it did not assess the sediment budget. The formula used to calculate erosion from sea level rise contains no sediment budget term — the number of cubic metres of sand arriving from rivers plays no part in the calculation.

Professor de Lange identified this directly:

> *"Any assessment of coastal response to sea level change that does not include the sediment budget is probably unreliable. The Kāpiti Coast is a sediment-fed accretionary system. A methodology that ignores sediment supply cannot be considered a reliable predictor of outcomes on this coast."* — Professor Willem de Lange, report commissioned by Coastal Ratepayers United, 2024

The Carley Panel agreed and made the sediment budget its first and most prominent recommendation:

> *"The Panel recommends that KCDC undertake analyses of beach-sediment budgets, in order to determine the gains and losses of the beach sand that account for the shoreline changes found in the CSL time series... The quantification of the sediment budget should permit an assessment of whether the accretion of Kāpiti's central cuspate shore will revert to erosion in the near future."* — Carley Panel, Executive Summary, June 2014

Question 9: Was the Short-Term Storm Erosion Assessment Reliable?

Coastal erosion does not occur mainly through the gradual rise of the sea. The primary mechanism is storms: extreme waves, elevated tides, and storm surges that combine to push water levels far above normal, reaching and cutting into the dunes backing the beach.

The CSL report assessed the short-term (storm) erosion component by examining variations above and below the regression line fitted to historical shoreline positions — treating random scatter in the historical data as a proxy for storm impact.

The Carley Panel found this approach fundamentally unsound:

> *"It is clear that the recorded residuals and fluctuations are not responses to extreme, rare storm events that pose the greatest hazards. Accordingly, the conclusion of this Panel is that the CSL assessments of the short-term hazards cannot be viewed as being robust, and does not sufficiently represent the extreme conditions necessary to account for present-day and future erosion and flooding hazards."* — Carley Panel, Executive Summary and Section 4.3, June 2014

The Panel noted that a separate analysis by engineer John Lumsden (2003), which had directly modelled storm waves, tidal extremes and surge levels using actual oceanographic data, was far more appropriate for assessing storm hazards. That approach required collecting and analysing real data about waves, tides and surges — data that existed for the Kāpiti Coast and had not been used in the CSL methodology.

The Panel recommended that the Lumsden methodology be adopted for the storm component, and that the CSL fluctuation values be replaced. In other words, one of the two main components of the hazard line calculation was found to be insufficiently robust for planning purposes.

Question 10: Who Was Responsible for the Word "Likely"?

At a public information session held by KCDC in 2012, a council employee acknowledged that she had been responsible for the use of the word "likely" in the letter to property owners. When asked what probability calculation underpinned that word, and which sections of the CSL report supported it, she pointed to the word CEPL — Coastal Erosion Prediction Lines — as evidence that the report made predictions.

We now know from Term of Reference 10, quoted earlier in this handout, that the word "prediction" in CEPL was inserted at KCDC's own instruction, replacing the original term "Coastal Erosion Hazard Lines."

The accountability chain runs as follows:

- KCDC instructs CSL to rename hazard lines as prediction lines in Term of Reference 10.
- KCDC's letter to property owners uses the word "likely" and cites CSL's report as authority.
- When challenged, Dr Shand says likelihood assessment was beyond the scope of his work.
- When challenged, KCDC says its letter was "based on" CSL's report.
- No one identifies who performed the probability calculation that justified "likely."

The Carley Panel's overall verdict on the hazard lines was:

> *"It is the opinion of this Panel that the hazard lines recommended by CSL are not sufficiently robust to be incorporated into the Proposed District Plan."* — Carley Panel, Executive Summary, June 2014

Question 11: What Did the High Court Find — and What Does It Reveal?

In December 2013, Williams J of the High Court delivered an interim judgment in Weir v Kāpiti Coast District Council [2013] NZHC 3522, a judicial review brought by affected property owners with Coastal Ratepayers United as intervenor. The court was asked whether KCDC was even legally entitled to place the CSL information on LIMs at all.

The court ruled in KCDC's favour on the legal question. But the reasoning it used to reach that conclusion is itself important evidence about the nature of the CSL lines — and about whether KCDC's original letter accurately described them.

THE COURT RECORDS CSL'S OWN POSITION ON PROBABILITIES

Williams J summarised what Dr Shand had stated about his lines:

> *"As Dr Shand was at pains to point out in his report, these lines were not based on any probability assessment. Coastal science, he said, was not yet sufficiently sophisticated to attach probabilities to any particular lines. Rather, his lines were 'deterministic'. They identified a single worst case under each of the three scenarios... They were calculated on an intentionally precautionary basis."* — Williams J, Weir v KCDC [2013] NZHC 3522, paragraph [7]

This is independent judicial confirmation of what Dr Shand had said in private correspondence: that his lines carried no probability assessment and were explicitly deterministic. They did not represent likely outcomes. It is not a matter of disputed interpretation. It is CSL's own stated position, recorded by a High Court judge. The High Court judgement is clear that the coastal scientists who presented evidence saw then as worst-case possibilities, although no reason for rejecting even more alarming sea-level rise scenarios is evident.

In short, it is hard to avoid the conclusion that the use of the word ‘likely’ in the KCDC’s letter was solely its responsibility. It misunderstood the CSL report in this respect.

THE LEGAL DISTINCTION BETWEEN 'POTENTIAL' AND 'LIKELY'

The court upheld the LIM entries; it did so by distinguishing carefully between potential and likely erosion. Section 44A92)(a) [9] of the Local Government Official Information and Meetings (LIM) Act 1987 refers to potential erosion, not likely erosion. The judge explained:

> *"'Potential' is to be distinguished from 'likely' as the two terms are used in paragraph (2)... 'Likely' unquestionably refers to probability — specifically a state of facts that is more probable than not."* — Williams J, Weir v KCDC [2013] NZHC 3522, paragraphs [49 & 50]

The judge concluded that the LIM legislation required only that erosion be a 'reasonable possibility objectively determined' — not that it be probable, still less likely. Here is how the judge assessed a ‘reasonable possibility’:

[9] KCDC read this section as legally requiring it to put the coastal erosion information in the CSL report on homeowners’ LIMs. Since section44A92(a) did not require a likelihood assessment for coastal erosion, the issue was reduced to the question of whether the CSL report was information. Another low bar.

> *"He admits that his lines are a very worst case scenario... a worst case scenario objectively identified and evidentially based must, by definition, be a reasonable possibility — albeit the worst one. ... Indeed, the worst case is the boundary line between reasonable possibility and mere speculation."* — Williams J, Weir v KCDC [2013] NZHC 3522, paragraph [52]

He also made plain how low the evidentiary bar was for the LIM entries to survive:

> *"The Council needs to know about the report but it does not need to believe that the predictions in them are accurate or even probably accurate."* — Williams J, Weir v KCDC [2013] NZHC 3522, paragraph [64]

WHAT THIS REVEALS ABOUT KCDC'S ORIGINAL LETTER

The court ruled in KCDC's favour — but on the basis that the lines showed a reasonable possibility of erosion, not a likely one. The word 'likely' in paragraph (a) of the LIM legislation, the judge noted, is reserved for hazardous contaminants.'

The gap between what the court endorsed and what KCDC's letter claimed is therefore significant. KCDC's letter told property owners their homes were at 'likely risk.' The court upheld the LIM entries on the much weaker ground of 'reasonable possibility.' These are not the same thing.

The judge also found the LIM presentation itself deficient:

> *"... I am struck, as I noted earlier, by the stark simplicity of the prediction lines. None of the many and important conditions and assumptions contained in the CSL Reports are obvious in the graphic. To understand what they really mean one must go through the five pages of relatively densely written material. With respect to the Council, those five pages are hardly an exemplar of clear communication of the big points that a potential purchaser must know in order to properly understand the meaning of the lines."* — Williams J, Weir v KCDC [2013] NZHC 3522, paragraph [70]

He suggested at paragraph 71 that the lines should carry wording to the general effect of a 'very worst case scenario at 100 years and an equivalent on the 50 year line'. He also suggested that the written text on LIMs should acknowledge 'the scientific challenges to the CSL conclusions.'

Question 12: What Is the Precautionary Principle — and Was It Applied Correctly?

The precautionary principle is frequently invoked in environmental planning. It holds, broadly, that where there is the risk of serious harm, decision-makers should err on the side of caution rather than waiting for certainty before acting.

But the principle has two stages, not one. First, you must assess the probability of harm — forming the best estimate you can on the evidence available. Second, given that probability assessment, you decide how cautiously to respond.

The Carley Panel's statement is clear:

> *" From a statistical perspective, it is recommended that "best estimates" rather than precautionary values be adopted, with margins of error or factors of safety kept separate from the estimates and added at the end if appropriate. Alternatively, one could give several scenarios based on best worst and midway cases."* — Carley Panel, p 45, June 2014

In the Kāpiti case, the precautionary principle was invoked to justify selecting an outlier- sea level rise scenario (0.9 metres), zeroing out accretion, applying conservative parameter values at every step, and excluding tectonic uplift. Each of these choices individually was described as "precautionary." But together they produced a compound result — a single set of hazard lines — that was presented to homeowners as a likely outcome, rather than an outlier conditional projection whose likelihood was anyone's guess.

The Panel was explicit that this approach was not appropriate as a basis for automatic planning decisions:

> *"The assessment of coastal hazard zones should consider a range of plausible scenarios (e.g. low, mid, high, or best estimate and extremes). The range of scenarios (particularly for 100 years' time) should be considered in future planning, but automatic retreat of development behind the projections for the most extreme scenario should not be a default management plan."* — Carley Panel, Executive Summary ES.7, June 2014

The word "automatic" is significant. The Panel is not saying outlier scenarios should be ignored. It is saying they should not automatically drive planning decisions — which is precisely what happened when the worst-case hazard lines were placed on LIMs before any formal planning process had run its course.

Question 13: Was the Methodology Statistical or Deterministic?

The CSL report described itself as providing "statistically-based hazard impact magnitudes." This sounds as though the outputs carry a statistical confidence level — that they represent, say, the 90th percentile of likely outcomes.

In fact, the statistical work in the report was confined to deriving the input parameters — fitting regression lines to shoreline positions, computing standard errors of those regressions, and combining uncertainties using root-mean-square methods. These are legitimate statistical procedures.

But once those parameters were fixed, the model operated deterministically: given the inputs, the output followed necessarily. There was no distribution of outcomes around the hazard line — no statement that the shoreline had a 10% chance of being here, a 50% chance of being there. The likelihood of each scenario was not assessed. No one put a probability on the 0.9 metre sea level rise assumption.

When asked directly in correspondence, Dr Shand said his methodology was deterministic rather than probabilistic. Expressed differently, give values for the inputs and the assumed validity of the Bruun-type model, the output values were pre-determined. The Carley Panel's statistician found this unsatisfactory and made the recommendation quoted under Question 3: best estimates first, safety margins separately, or a range of scenarios.

The Panel also noted the path to improvement:

> *"The Panel also recommends that over the next decade, probabilistic estimates of long term change be developed. The greatest present impediment to this is assigning probabilities to future emissions scenarios and the consequent sea level rise."* — Carley Panel, Section 4.1, June 2014

This is an acknowledgement that assigning probabilities to the scenarios was the missing step — and that without it, no claim about "likely" outcomes could be scientifically supported.

Ten years have passed and no progress is evident.

Summary: The Chain of Concerns

Pulling these questions together, the following chain emerges:

- KCDC's letter to property owners used the words predict, likely, and acceleration — each carrying a factual claim about probability.
- The underlying CSL report used the word "prediction" not because Dr Shand intended it as an unconditional forecast, but because KCDC's own Terms of Reference required the terminology to be changed from "hazard lines" to "prediction lines."
- The word "likely" appeared nowhere in the CSL report in connection with property risk. Dr Shand himself described his methodology as based on "justifiable possibility," and said likelihood assessment was beyond his scope.
- The 0.9 metre sea level rise assumption driving the principal scenario was not a central estimate. It was an outlier planning input, derived from guidance documents, with no probability attached to it at any stage.
- The sea level rise contribution was counted twice in the formula — once embedded in the historical trend rate derived from aerial photographs, and again as a separate projected future rise.
- The formula used to translate sea level rise into shoreline retreat was, despite different labelling, mathematically identical to the Bruun Rule that the report itself said was inappropriate for this coast.
- Accreting shorelines — where the coast was building seaward — had their positive trend rates discarded and replaced with zero, systematically biasing all results toward erosion regardless of what the data showed.
- No sediment budget assessment was conducted, despite the coast's character being fundamentally determined by sediment supply from northern rivers.
- The short-term storm erosion component was based on statistical residuals from a regression line rather than on actual wave, tide and surge data, and was found by the Carley Panel to be insufficiently robust.
- The 2014 Carley Panel — appointed and paid for by KCDC — concluded that the hazard lines were "not sufficiently robust to be incorporated into the Proposed District Plan."
- The High Court (2013), while upholding KCDC's right to include the information on LIMs, did so on the basis that the lines showed a 'reasonable possibility' of erosion — not that erosion was 'likely.' The court recorded CSL's own statement that the lines were not based on any probability assessment and were 'deterministic.' The standard the court applied was explicitly weaker than the word 'likely' in KCDC's letter.

None of this proves the Kāpiti Coast faces no coastal hazard risk. Erosion and accretion are occurring at different places along this coastal strip.

But this is not the issue. The issue instead is whether either the CSL report, the Science Panel or KCDC provided any basis for asserting that 1,800 properties were likely to be at risk from sea level rise by around 2100. As its lead author made clear CSL's Systems report made no such case, such an assessment being beyond its scope.

Sources and Abbreviations

CSL (2012): Coastal Systems Ltd, Kāpiti Coast Erosion Hazard Assessment 2012 Update, prepared for KCDC by Dr Roger Shand.

KCDC Letter (2012): Letter from Group Manager Strategy and Partnerships, Kāpiti Coast District Council, to coastal property owners, 25 August 2012.

CSL Correspondence (2012): Written email exchange between Dr Roger Shand and Bryce Wilkinson, August–September 2012.

KCDC Correspondence (2012): Written correspondence from KCDC officials to Bryce Wilkinson, 2012.

De Lange (2024): Report by Professor Willem de Lange, University of Waikato, commissioned by Coastal Ratepayers United (CRU), 2024.

Carley Panel (2014): Carley, J.T., Komar, P.D., Kench, P.S. and Davies, R.B., Coastal Erosion Hazard Assessment for the Kāpiti Coast: Review of the Science and Assessments Undertaken for the Proposed Kāpiti Coast District Plan 2012, June 2014. Commissioned by KCDC.

CRU: Coastal Ratepayers United, an incorporated society formed by Kāpiti Coast property owners in 2012.

KCDC: Kāpiti Coast District Council.

LIM: Land Information Memorandum — an official document issued by local councils containing property-specific information, routinely consulted in property transactions.

NZCPS 2010: New Zealand Coastal Policy Statement 2010, prepared by the Department of Conservation.

Weir v KCDC (2013): Weir v Kāpiti Coast District Council [2013] NZHC 3522, interim judgment of Williams J, 19 December 2013. High Court of New Zealand, Wellington Registry.

SLR: Sea Level Rise.

Appendix: The NZCPS Requires Likelihood to be Assessed Prior to Decisions Embodying Caution

A recurring issue in the application of the New Zealand Coastal Policy Statement 2010 (NZCPS) to coastal hazard assessments is the conflation of the precautionary principle with the assessment of hazard risk. This is wrong.

Too often, precaution is invoked to focus attention unduly on alarming "worst case" scenarios, without estimating how (un)likely they are. In the process, what is likely might entirely escape consideration.

This appendix shows why this conflation and neglect of likelihoods violates the legal requirements embodied in National Coast Policy Statement (NZCPS) 2010.

Risk assessments must identify risks. The NZCPS's definition of risk is probability times consequence. To fail to assess probabilities is to fail to assess risks.

Caution has nothing to do with assessing probabilities. It comes later, when decisions about responses to the risks are being considered.

The following extracts from NZCPS document these two requirements.

1. Policy 24: Identification and Assessment are the Primary Obligation

Policy 24(1) establishes the foundational requirement in unambiguous terms:

> *"Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to…"*

The operative verb is "assessed." Section 24(1) policy does not say hazard risks can be hypothetical, imagined, assumed, postulated, or guarded against. Assessment is a knowledge-seeking activity: it requires forming a judgment about the actual state of affairs, including the probability of outcomes. The eight enumerated considerations at Policy 24(1)(a)–(h) are the required inputs to that assessment.

Two of those inputs are especially significant for the treatment of likelihood.

First, Policy 24(1)(b) requires consideration of:

> *"short-term and long-term natural dynamic fluctuations of erosion and accretion"*

This requires examination of the full distribution of coastal outcomes — not only extreme adverse outcomes. An assessment that focuses on the high end ("worst case") of possible sea level rise or erosion, while ignoring the central tendency and natural variability of coastal processes, does not satisfy this requirement.

Second, and most directly, Policy 24(1)(h) requires that the effects of climate change be assessed:

> *"…taking into account national guidance and the best available information on the likely effects of climate change on the region or district."*

The word "likely" is not incidental. Central government did not say "possible effects," "worst-case effects," or "effects that cannot be ruled out." It said likely effects. This is a probability concept embedded directly into the assessment requirement for climate change — the very domain in which precaution is most frequently invoked to bypass probabilistic reasoning.

2. The Glossary Definition of Risk Confirms the Likelihood Requirement

The NZCPS Glossary defines risk as follows:

> *"Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence (AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009)."*

Risk, within the meaning of the NZCPS, is therefore a two-dimensional concept: consequences and likelihood. An assessment that examines only consequences — or that treats all conceivable consequences as equally demanding of response regardless of their probability — is not a risk assessment within the meaning of the NZCPS. It is a consequences-only assessment. Policy 24 requires the former; an approach that focuses exclusively on extreme scenarios and dismisses their likelihood as irrelevant delivers only the latter.

3. Policies 25 & 27: Likelihood is Also Required at the Response Stage

The probability requirement does not end with the risk assessment. Policy 27, which applies where significant existing development is potentially affected by coastal hazards, contains its own explicit likelihood requirements at the stage of evaluating response options.

Policy 25, which applies to subdivisions, use and development explicitly refers back to the Policy 24(1) "areas potentially affected by coastal hazards" and with that the requirement to take account of "*the likely effects of climate change on the region or district*".

Policy 27(2)(b) requires that decision-makers:

> *"take into account the nature of the coastal hazard risk and how it might change over at least a 100-year timeframe, including the expected effects of climate change"*

The word "expected" carries its technical meaning: probability-weighted outcomes. It does not mean worst-case outcomes. This is not casual drafting; it directly invokes the concept of probabilistic expectation as the basis for evaluating how hazard risk will change over time.

Policy 27(2)(c) is yet more explicit. It requires decision-makers to:

> *"evaluate the likely costs and benefits of any proposed coastal hazard risk reduction options."*

This requirement is inseparable from the probability assessment at Policy 24. A decision-maker who has not assessed the likelihood of the hazard scenarios cannot know the expected cost of not responding to them and therefore cannot conduct the cost-benefit evaluation that Policy 27(2)(c) mandates. The two exercises are logically linked: probability assessment under Policy 24 is a necessary precondition for the cost-benefit evaluation under Policy 27.

4. The Role of Policy 3: Precaution as a Residual Tool

Policy 3(1) makes clear that precaution is to be applied to "proposed activities whose effects … are uncertain, unknown, or little understood, but potentially significantly adverse", i.e. it applies at the management stage (Policies 25-27) and depends upon the completion of Policy 24. Sea level rise and storms are not a "proposed activity". Seaside house construction would be a proposed activity, but hardly one whose effects are little understood. Developers, buyers, banks and insurers will assess the risks.

Perhaps more to the point, Policy 3(2) directs that a precautionary approach be adopted to the use and management of coastal resources potentially vulnerable to effects from climate change. This provision requires that an unbiased Policy 24 identification and assessment of "potential

vulnerability" has been done before considering the issue of "use and management". In no way does this policy support the use of precaution as a substitute for an unbiased assessment of potential vulnerability. Risk averse precaution comes into the picture when considering making decisions that might be wrong, given the assessed probabilities and the likely costs if a decision turns out to be wrong.

Policy 3(2) addresses how to manage uncertainty that remains after the best available probability assessment has been conducted. Where that assessment leaves material uncertainty about the extent of sea level rise or coastal change, decision makers need to balance the costs of being wrong from over-reacting against the costs of being wrong from under-reacting. If it were their money, they could well take a risk averse approach to such decisions, perhaps sacrificing some expected gain in order to have a lower downside risk. Where the losses from a decision that turns out to be wrong would fall on others, political and bureaucratic incentives are different. Such nuances aside, it is clear that Policy 3(2) cannot be adhered to unless the probabilistic assessment under Policy 24 has already been done to the best of available knowledge.

Critically, Policy 3(2) also requires that:

> *"avoidable social and economic loss and harm to communities does not occur"*

The word "avoidable" implies a judgment about what is in fact avoidable, which itself requires a probability assessment. You cannot determine what harm is avoidable if you have not first determined its likely nature. Policy 3(2) thus contains its own implicit probability requirement.

5. The Sequential Architecture of the NZCPS Hazard Provisions

Reading Policies 24, 25, 27, and 3 together, a clear sequential architecture emerges:

- First: conduct a genuine risk assessment under Policy 24, treating risk as the combination of consequences and likelihood (per the Glossary), and basing the climate change assessment on the "likely effects".
- Second: evaluate response options under Policies 25-27 when called upon to make management decisions by reference to their "expected" effects and "likely costs and benefits" — which can only be done if step one has been completed.
- Third: where material uncertainty remains after that assessment, apply the precautionary approach under Policy 3 to inform decisions at the margin — erring toward caution rather than optimism in the face of irreducible uncertainty.

Any approach that invokes precaution to bypass the likelihood assessment — rather than to supplement it at the margins of residual uncertainty — inverts this architecture. It treats step two as a replacement for step one, which the text of the NZCPS does not permit.

6. Conclusion

If the precautionary argument were correct — if decision-makers could simply identify an alarming "worst case" scenario and invoke precaution without assessing its likelihood — then the following provisions of the NZCPS would be rendered superfluous:

- Policy 24(1)(h)'s reference to "likely effects" of climate change;
- The Glossary's definition of risk as a combination of consequences and likelihood;
- Policy 27(2)(b)'s requirement to consider the "expected effects" of climate change; and
- Policy 27(2)(c)'s requirement to evaluate the "likely costs and benefits" of response options.

That cannot have been the legislative intent. The NZCPS provisions, read carefully and in sequence, require likelihood to be assessed as a component of risk before precautionary considerations are applied to management decisions.

A precautionary approach that treats the probability of extreme scenarios as irrelevant is not a precautionary approach within the meaning of the NZCPS. It is an approach that has substituted alarm for assessment — and that substitution is inconsistent with the text the NZCPS imposes.