PREDICTIONS IN AN UNCERTAIN WORLD – ASSESSING EFFECTS UNDER THE RESOURCE MANAGEMENT ACT 1991

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1. Introduction

1.1 The aims of this paper

[1] The RMA is about the future. This paper is about how we go about attempting to predict the future[3] with as much accuracy as possible. It has these aims:

- To explain why lawyers (and judges) have difficulty with assessing the likelihood of the effects of causes as opposed to the traditional court role of "finding" the causes of effects (Parts 1 and 2 of this paper);
- To outline (tentatively) how science can assist us with assessing probabilities and likelihoods[4] (Part 3);
- To analyse how the Environment Court has attempted to assess risk in some of the many types of cases that came before it (Parts 4 to 9);
- To remind readers of the potential importance of section 7(b) of the RMA especially when making the overall judgment necessary to most RMA proceedings other than under Part 12 of the RMA (Part 10 of this paper); and
- To set the scene for a paper from Dr Andy Reisinger and Dr Judy Lawrence on the effects of anthropogenic climate change and the implications for decision-making under conditions of uncertainty.

[2] Recently Justice Glazebrook in a paper called *Miscarriage by Expert*[5] enjoined judges and counsel to improve their knowledge of probabilities and statistics. That call is particularly applicable to practitioners under the Resource Management Act 1991 ("RMA" or "the Act") and I have included tentative suggestions as to how we can make a start down that road.

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2 The views in this paper are mine, not necessarily or even more likely than not those of the Environment Court. I am grateful to Dr Andy Reisinger and Dr Judy Lawrence for helpful comments on a draft of this paper, and also to the Environment Court's Research Counsel Mrs Sarah Schulte and Ms Bernadette Cuttance and to my Case Manager Ms Christine McKee, for help to prepare this paper. All mistakes are of course mine.

3 Whenever the verb "predict" is used in this paper it should be read probabilistically as meaning "attempt to predict".

4 Note that scientists attribute different meanings to these words.

5 The Hon Justice Glazebrook, *"Miscarriage by Expert"* (speech to Commonwealth Magistrates' and Judges' Association Triennial Conference, Wellington, 21 September 2015). (www.courtsofnz.govt.nz/speechpapers/HJG2.pdf).

[3] Illustrating how our assessments of risk need to be updated regularly in the light of further and better information, the timing of this paper is unfortunate. Not only is it likely to be superseded and improved on by the paper from Dr Reisinger and Dr Lawrence that follows it, but also we now have the first of an ongoing series of papers from Professor Sir Peter Gluckman of the Office of the Prime Minister's Chief Advisor, with the very similar title *Making decisions in the face of uncertainty*. Part 1 was issued[6] in May this year and I have included some relevant passages in this paper. Parts 2 and 3 are still to be issued. Part 2 is proposed to give further detail about the concepts of risk perception and risk management, and

> Part 3 will tackle the longer-term trends that may affect New Zealand … it will introduce risks, including global risks, that have system wide effects – for example climate change, demographic change and disruptive technologies.[7]

1.2 Why is prediction relevant to the RMA?

[4] Avoiding, remedying and mitigating the adverse effects of activities on the environment[8] is an essential part of what is meant by 'sustainable management' in s 5 of the RMA. The importance of managing effects is emphasised by the Act's description of the functions of local authorities. The functions of territorial authorities (district councils) under s 31 RMA include:[9]

> (a) … achiev[ing] integrated management of the **effects** of the use, development, or protection of land and associated natural and physical resources of the district:
>
> (b) the control of any actual or potential **effects** of the use, development, or protection of land, including for the purpose of —
>
> (i) the avoidance or mitigation of natural hazards; and
>
> (ii) the prevention or mitigation of any adverse **effects** of the storage, use, disposal, or transportation of hazardous substances; and
>
> (iia) the prevention or mitigation of any adverse **effects** of the development, subdivision, or use of contaminated land:
>
> (iii) the maintenance of indigenous biological diversity:
>
> (c) *[Repealed]*
>
> (d) the control of the emission of noise and the mitigation of the effects of noise:
>
> (e) the control of any actual or potential **effects** of activities in relation to the surface of water in rivers and lakes:
>
> … [Emphasis added]

[5] The functions of regional councils under se 30 RMA include preparation of objectives and policies in relation to actual and potential effects of the use, development and protection of land which are of regional significance[10] and the same purpose for the control of the use of land as territorial authorities.

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6 P Gluckman *Making decisions in the face of uncertainty* (2016) (Office of the Prime Minister's Chief Advisor). (www.pmsca.org.nz)

7 P Gluckman *Making decisions in the face of uncertainty* (2016) (Office of the Prime Minister's Chief Advisor) p 5. (www.pmsca.org.nz)

8 Section 5(2)(c) RMA.

9 Section 31(1).

10 There is a difference in the wording of the functions about natural hazards of territorial authorities and regional councils. However the Court of Appeal said early on that the difference is immaterial: *Canterbury Regional Council v Banks Peninsula District Council* [1995] 3 NZLR 189 at 195.

[6] Section 32 of the RMA makes evaluation reports assessing effects a key procedural step when preparing a plan or plan change under the Act. The assessment of policies and methods (including rules) for achieving an objective must:[11]

> (2) An assessment under subsection (1)(b)(ii) must—
>
> (a) **identify and assess the benefits and costs of the environmental, economic, social, and cultural effects** that are anticipated from the implementation of the provisions, including the opportunities for—
>
> (i) economic growth that are anticipated to be provided or reduced; and
>
> (ii) employment that are anticipated to be provided or reduced; and
>
> (b) if practicable, quantify the benefits and costs referred to in paragraph (a); and
>
> (c) assess the risk of acting or not acting if there is uncertain or insufficient information about the subject matter of the provisions.
>
> [Emphasis added]

A number of important concepts are introduced by s 32 – the idea that most activities have beneficial effects as well as costs so that it is the net benefit of the activity which is important, the utility of quantifying the benefits and costs, and the comparison of the risk of acting with not acting when information is insufficient or uncertain (does this require a precautionary approach?)[12]

[7] Finally, when considering applications for resource consents,[13] consent authorities are required[14] to have regard to any actual and potential effects on the environment of allowing the activity.

[8] This emphasis on effects means that the traditional tripartite model for legal decisions is no longer adequate under the RMA. No longer can councils (acting judicially) or the Environment Court simply find the facts, identify the relevant law, and give an evaluation. In most[15] proceedings under the Act a third step is interposed: to make predictions as to potential effects by assessing the probabilities of adverse effects and the cost of their consequences: see *Long Bay-Okura Great Park Society v North Shore City Council*[16] *("Long Bay").* That has important implications for the traditional legal concepts of burden and "standard" of proof but, more widely, for traditional legal concepts of how we go about making predictions that are not simply guess work using the heuristics[17] we use on a daily basis when making intuitive judgements (or, in the case of the courts, judgments).

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11 Section 32(2) RMA.
12 cf *The Rio Declaration on Environment and Development* UNESCO, 1992.
13 Section 104 RMA 1991.
14 Section 104(1)(a) RMA 1991.
15 Prosecution, enforcement and declaratory proceedings under Part 12 of the RMA usually raise fewer sets of issues.
16 *Long Bay-Okura Great Park Society Inc v North Shore City Council* (NZEnvC) A078/2008 at [20].
17 It is obligatory to refer to D Kahnemann *Thinking, Fast and Slow* (Farrar, Strauss and Giroux, NY, USA, 2011).

1.3 The description of the "environment"

[9] The first step is always to identify the relevant resources and their environment. As O'Regan J wrote for the Court of Appeal in *Royal Forest and Bird Protection Society Inc v Buller District Council:*[18]

> The definition of 'environment' is a prior question to consideration of the effects of the proposed activity on that environment.

[10] Perhaps "description of the environment" would have been more accurate since "environment" is already defined,[19] but otherwise his point is well made. Describing the environment is largely a traditional exercise in fact finding, and the standard of proof (of facts) is on the balance of probabilities: *Royal Forest and Bird Protection Society Inc v Buller District Council*,[20] per Panckhurst J.

[11] Section 2 RMA widely defines 'Environment' as including (unless the context requires otherwise):

> **environment** includes—
>
> (a) ecosystems and their constituent parts, including people and communities; and
>
> (b) all natural and physical resources; and
>
> (c) amenity values; and
>
> (d) the social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) or which are affected by those matters.

[12] Consequently, the environment is almost always a small subset of New Zealand's environment as a whole. Ascertaining the relevant "environment" is a matter of context. When considering a new district or regional plan the environment is at least the territory covered by the district or the area of the region as the case may be. The Act also contemplates[21] that there may be spillover effects (or externalities) which affect adjacent districts so the environment may cover more than one district.

[13] The relevant environment is determined (usually) by the extent of the relevant effects. What may be relevant activities, causing positive or negative effects, is determined by reference initially (when first preparing a plan) to Part 2 of the RMA and subsequently by district or regional plans in the light of intermediate documents in the statutory hierarchy[22] (such as National Policy Statements, Regional Policy Statements, Regional Plans).

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18 *Royal Forest and Bird Protection Society Inc v Buller District Council* [2013] NZCA 496; (2013) 17 ECRNZ 616 at [23].

19 In s 2 RMA 1991.

20 *Royal Forest and Bird Protection Society Inc v Buller District Council* [2006] NZRMA 193 (HC) at [73].

21 Section 74(2)(c) RMA: at least that is one inference from the obligation that a district plan needs to be consistent with neighbouring plans.

22 "The hierarchy of plans" was described in *Christchurch City Council v Banks Peninsula District Council* [1995] 3 NZLR 189 at 194 and is now routinely referred to.

[14] Complications occur when considering the future environment for a particular application for resource consent. It is only the reasonably foreseeable – as forecast by an operative[23] district plan – environment that needs to be considered. Unexercised resource consents off-site – see *Queenstown Lakes District Council v Hawthorn Estate Ltd*[24] – or permitted activities on-site (the "permitted baseline") may[25] be taken into account. The point of the latter is that if the district plan permits effects of a similar quality, scale and intensity there may be no point in refusing consent.

[15] Issues about what is the relevant "environment" arise in all sorts of contexts. Notoriously the environment in "supermarket wars" may include a shopping centre some distance away – see the North Shore cases.[26] A similar scenario arose in Hamilton where it was alleged that commercial development at Te Rapa (known rather tactlessly as 'The Base') would shade the central business district about seven kilometres away: *Kiwi Property Management Ltd v Hamilton City Council*[27] *("Kiwi Property")*.

[16] Usually on preparation of a plan, the relevant parts of the environment are defined only implicitly as part of the statement of issues – the questions which are to be answered by stating objectives and implementing policies. If matters under ss 6 to 8 are raised, then the relevant resources need to be described, eg

- the inland edge – usually the nearest skyline ridge – of the coastal environment needs to be described under s 6(a) (*Christchurch City Council v Minister of Conservation*);[28]
- outstanding natural landscapes need to be identified *(Environmental Defence Society Inc v Kaipara District Council)*[29] which contained a comment by the court that the council had "downed tools" when it came to the landscape chapter in its proposed plan and it could not do that;
- significant habitats under s 6(c) need to be identified *(Friends of Shearer Swamp v West Coast Regional Council)*;[30] and
- each of the other relevant values/resources under ss 6 to 8 RMA needs to be recognised and provided for/had particular regard to/taken into account.

[17] For a resource consent application, the relevant environment has to be identified first by the applicant in its AEE, then by the council and other parties, and ultimately (if there is an appeal) by the Environment Court. For example, in *Gallagher v Tasman District Council*[31] the council had promoted a plan change ("PC22") to manage the low lying coastal plain near Mapua at the foot of Tasman Bay. Amongst other things PC22 prohibited subdivision within a "coastal risk area". That included a 2.22 hectare property owned by the appellants. The first issue identified by the parties was:[32]

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23 *Queenstown Central Ltd v Queenstown Lakes District Council* [2013] NZRMA 239 (HC) is, with respect, wrong on this point. It has never been followed.

24 *Queenstown Lakes District Council v Hawthorn Estate Ltd* [2006] NZRMA 424 (CA).

25 Section 104(2) RMA 1991.

26 *Westfield (New Zealand) Ltd v North Shore City Council* [2005] NZSC17 (SC); *Discount Brands Ltd v Northcote Mainstreet Inc* [2005] NZRMA 57 (CA).

27 *Kiwi Property Management Ltd v Hamilton City Council* (2003) 9 ELRNZ 259 (Environment Court).

28 *Christchurch City Council v Minister of Conservation* (1992) 1 ELRNZ 211; affirmed on appeal: *Minister of Conservation v Christchurch City Council* (1993) 2 NZRMA 593.

29 *Federated Famers Inc v Northland Regional Council* [2015] NZEnvC 89.

30 *West Coast Regional Council* v *Friends of Shearer Swamp* [2012] NZRMA 45 (HC).

31 *Gallagher v Tasman District Council* [2014] NZEnvC 245.

32 *Gallagher v Tasman District Council*, above n 31, at [11].

> …
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> 2.1 The planning context for hazard risk identification and management that the Court needs to consider in order to determine the issues in the appeal:
>
> (a) Whether it is the mid Ruby Bay coastal plain area (respondent's position); or
>
> (b) The Gallaghers' property at 32 Broadsea Avenue. …

The court simply found that[33]

> … consideration of both the wider and immediate context is necessary in order to determine this appeal.

We will look later at how the court resolved the question of hazards (effects) on that environment.

[18] The description of the environment when ecosystems are relevant can be very complex. Where it is possible there may be adverse effects on native fauna it may be necessary to give evidence with respect to the *IUCN Red List Categories and Criteria* ("the *Red List*")[34] or similar criteria set by the Department of Conservation. The *Red List* categorises taxa of fauna by assessing them under five sets of criteria relating to:

> A: Evidence of reduction in population;
>
> B: Geographic range (EOO or AOO — see next two paragraphs);
>
> C: Evidence of small population size (fewer than 250 mature individuals) and declining population;
>
> D: Evidence of very small (fewer than 50 mature individuals) or restricted population size;
>
> E: Any quantitative analysis showing the probability of extinction in the wild meets a threshold.[35]

[19] The Extent of Occurrence (or "EOO") of a species (or more accurately of a taxon)[36] is defined in the same document as:

> … the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy ... This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (eg large areas of obviously unsuitable habitat) … Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).

[20] The area of occupancy ("AOO") is defined as:[37]

> … the area within its 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases (eg irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a

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33 *Gallagher v Tasman District Council*, above n 31, at [32].

34 IUCN (2012) *IUCN Red List Categories and Criteria*: [*Version 3.1, Second Edition*] Gland, Switzerland and Cambridge, UK: IUCN. IV + 34.

35 50% probability means taxon is critically endangered, 20% endangered, 10% vulnerable.

36 A taxon is "a group of one or more populations of an organism … seen by taxonomists to form a unit" according to Wikipedia (www.en.wikipedia.org/wiki/taxon searched 6/10/16).

37 The *Red List*, above n 34, at p 12.

> scale appropriate to relevant biological aspects of the taxon, the nature of threats and the available data …

1.4 Causes: activities, natural hazard and climate change

[21] It is important to realise that there are three classes of causes (of effects) in the RMA:

1. activities (or its synonym[38] "uses");
2. natural hazards; and
3. climate change.

The first class is familiar to lawyers. It is simply a subset of the array of activities undertaken by humans.

[22] As for the other two classes, s 2 RMA states:

> **natural hazard** means any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.

[23] The definition of climate change shows that it is anthropogenic (human-caused) change which is primarily relevant here. The effects of **climate change** are singled out by s 7(i) as a matter to which particular regard must be had. Section 7(i) – which was inserted[39] in 2004 – has been largely ignored in cases to date except in relation to potential sea level rise.

[24] Note that neither natural hazards nor climate change are activities for which responsibility can be normally attributed (except in a moral sense in the case of climate change) to the activity of an individual. This suggests that when we talk about the effects of natural hazards or of climate change we are discussing something slightly different from the effects of an activity. But clearly such non-attributable effects are not to be ignored.

[25] Further, it is notoriously difficult to distinguish between causes and effects. The only thing philosophers are (usually) prepared to concede is that causes precede effects. The difficulty with that definition is that it makes it impossible to distinguish a cause/effect relationship from a mere association. As John Stuart Mill wrote[40] in the 19th Century:

> Nothing can better show the absence of any scientific ground for the distinction between the cause of a phenomenon and its conditions, than the capricious manner in which we select from among the conditions that which we choose to denominate the cause.

[26] Challenging that, in *Causation in the Law*,[41] Hart and Honoré wrote:

> In most cases where a fire has broken out the lawyer, the historian, and the plain man would refuse to say that the cause of the fire was the presence of oxygen, though no fire would have occurred without it: they would reserve the title of cause for something of the order of a short-circuit, the dropping of a lighted cigarette, or lightning … In making

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38 *Donkin v Board of Trustees of Sunnybrae Normal School* [1997] NZRMA 342 (NZEnvC); *Hill Park Residents Association Inc v Auckland Regional Council* (NZEnvC) A30/2003.

39 By s 5(2) RMA Act 2004 (2004 No. 2).

40 J S Mill *A System of Logic, Ratiocinative and Inductive, Being a Connected View of the Principles of Evidence, and the Methods of Scientific Investigation*, Book 2 Chapter 5 (John W Parker, West Strand, London, 1843), p 401.

41 HLA Hart and A M Honoré *Causation in the Law* (1985) p 11.

> this distinction it is plain that our choice, though responsive to the varying context of the particular occasions, is not arbitrary or haphazard.

[27] They claim that the causes and mere antecedent conditions can be separated:[42]

> In distinguishing between causes and conditions two contrasts are of prime importance. These are the contrasts between what is abnormal and what is normal in relation to any given thing or subject matter, and between a free deliberate human action and all other conditions.

[28] That distinction may explain why the (abnormal) short-circuit in their example is regarded as a cause, whereas the presence of oxygen is a mere background condition. The distinction between normal and abnormal simply introduces new problems; is abnormal the same as "infrequent" or does it mean "infrequent and irregular"? The other distinction suggested by Hart and Honoré also raises problems about "free deliberate action". What is "free" in this context? How can deliberation be necessary in s 9(3) of the RMA when the Act contemplates liability[43] for unintentional adverse effects? The Hart and Honoré discussion is less relevant to the RMA because they are discussing causation in the common law. Their interest is in how the courts establish causes (for which people are responsible) from the effects, whereas under the RMA we are usually considering all causes. We will return to this in more detail later because the idea of causes for which someone is responsible seems to be at the heart of the leading authority on 'cumulative' effects.

1.5 The definition of effect

[29] "Effect" has its own definition in s 3 RMA. It states:

> **3. Meaning of effect**
>
> In this Act, unless the context otherwise requires, the term **effect** includes—
>
> (a) any positive or adverse effect; and
>
> (b) any temporary or permanent effect; and
>
> (c) any past, present, or future effect; and
>
> (d) any cumulative effect which arises over time or in combination with other effects—
>
> regardless of the scale, intensity, duration, or frequency of the effect, and also includes—
>
> (e) any potential effect of high probability; and
>
> (f) any potential effect of low probability which has a high potential impact.

Categories (f) and (d) present particular difficulties – effects of low probability/high impact and cumulative effects – and we will consider these later (in parts 4 and 5 of this paper).

[30] In *Westfield (New Zealand) Ltd v North Shore City Council*[44] a decision of the Supreme Court, Richardson J considered the phrase "… any actual and potential effects on the environment" in s 104(1)(a) RMA. He wrote:[45]

> Potential is often used in the sense of possible, something which may or may not happen, as opposed to actual. Depending on context, that can range in the level of

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42 HLA Hart and A M Honoré *Causation in the Law* (1985) p 11.
43 Section 341 RMA.
44 *Westfield (New Zealand) Ltd v North Shore City Council* [2005] NZSC 17.
45 *Westfield (New Zealand) Ltd v North Shore City Council* [2005] NZSC 17 at [182].

> certainty from highly probable, more probable than not, reasonably probable, significant or substantial possibility, distinct possibility, something that might well happen – down to the slim or faint possibility and on to barely conceivable.

Clearly he recognised that predictions can have different probabilities. However, the Supreme Court did not need to decide this and he left the issue for future cases.

1.6 The concept of risk

[31] We saw earlier that the concept of risk is expressly introduced in s 32 RMA: councils must examine the risk of acting or not acting to address an issue. The idea of risk is also introduced indirectly but clearly in the s 3 definition of "effect". The word "effect" is defined as including:

> …
>
> (f) any potential effect of low probability which has a high potential impact.

The conjunction of 'low probability' and 'high potential impact' in s 3(f) RMA suggests the concept of risk because the relationship between the probabilities of an effect and its consequences or costs is incorporated in the definition of 'risk'.

[32] In *Franks v Canterbury Regional Council*[46] the High Court was considering the risk posed by a natural hazard (coastal erosion). Justice Panckhurst "accept[ed] the validity" of Dr R Somerville QC's submission that the decision-maker was:

> … required to assess both the likelihood (probability) of the occurrence, and the likely consequences (impact) of that hazard.

In fact the relationship can be expressed as a simple product:

> Risk = Probability of an effect x Cost of consequences.

[33] The Environment Court confirmed in *Long Bay*[47] that:

> … the RMA requires local authorities to examine both the probability of an effect and its consequences or costs (ie the risk). … Rather than describing the evaluation of probabilities as "fact finding", it is preferable in our view to describe it as risk assessment. That follows quite neatly from the definition of 'effect' in section 3. It is also, as we have seen, appropriate under section 32 of the RMA with its reference to risk.
>
> [Underlining added]

[34] The potential utility of this is discussed later but in brief it provides for a potential increase in the rationality and transparency of our decision making – see Cass Sunstein's *Risk and Reason*.[48] On the other hand there is another qualitative way of characterising risk that Dr Reisinger will elaborate on. This is to characterise risk as the combination of exposure, hazard and sensitivity to the hazard taking into account changes over time.

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46 *Franks v Canterbury Regional Council* HC Christchurch CIV-2003-485-0011131 Panckhurst J 10 June 2004 at [16].
47 *Long Bay*, above n 16, at [45].
48 C Sunstein *Risk and Reason* (2002) Cambridge UP.

2. Potential problems from the common law approach to causation, effects and risk

2.1 Causes in the common law

[35] Because lawyers often have difficulties with the idea of assessing different probabilities for the same potential effect it is worth considering this issue a little more. Contrast the following two questions:[49]

- **Effects of Causes** Ann has a headache. She is wondering whether to take aspirin. Would that cause her headache to disappear (within, say, 30 minutes)?
- **Causes of Effects** Ann had a headache and took aspirin. Her headache went away after 30 minutes. Was that caused by the aspirin?

Note that in the second example the question is about the past – as are most legal proceedings. In general courts are concerned with the causes of (and responsibilities for) effects, whereas science – and much of the RMA – is concerned with the effects of causes. This distinction was drawn by John Stuart Mill (again) when he observed that[50]

> … as a general rule, the effects of causes are far more accessible to our study than the causes of effects …

[36] It is difficult to move from a base rate statistic (eg aspirins cure headaches in 30% of cases) to a finding that an aspirin cured Ann's headache in the example above. So it is illuminating to note the circumstances in which courts will allow use of base rate data – there is a useful paper[51] by J J Koehler on this. Typical examples are in predictions of harm in bail applications or in family law. Both those situations are about the future and thus are atypical of the issues in most common law proceedings in that they raise questions about the effects of causes (will the defendant offend again if bailed? Is a step-father more likely to be violent?). That is why the normal judicial task is so difficult: base rates can often not be used to look backwards, and so science can only help Judges so far in normal civil or criminal proceedings.

[37] Happily for resource management practitioners wanting to use scientific methods, most resource management proceedings are about the future. On the other hand, many lawyers and judges have difficulties with assessing the future primarily because the cause/effect questions are the other way around. For a case where the Supreme Court of the USA avoided discussing base rates of sea level rise caused by global warming, see *Massachusetts v Environmental Protection Agency*[52] and the commentary on that case in "Statistical base and background rates: the silent issue not addressed in *Massachusetts v EPA"*.[53]

[38] Second, there are problems about the "standard of proof" for the predictions which are necessary under the RMA. All lawyers know that the civil standard of proof of facts is on the balance of probabilities. Does the same standard apply for 'proof' of predictions? There is an immediate difficulty under the RMA in respect of an alleged effect of low probability but high potential impact. That is obviously relevant under s 3. What does it

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49 See A P Dawid, M Musio and S E Fienberg *From Statistical Evidence to Evidence of Causality* 28 October 2014.
50 Above n 40, Book 3, Chapter 10 at 8, p 528.
51 J J Koehler, "When do Courts think base rate statistics are relevant?" (2002) 42 Jurimetrics 373.
52 *Massachusetts v Environmental Protection Agency* 127 S CT 1438 (2007).
53 A Taggart and W Blackman "Statistical base and background rates: the silent issue not addressed in *Massachusetts v EPA"* (2008) Law, Probability and Risk 7 (4): 275–304.

mean to say an effect of low probability is proved on the balance of probabilities, eg you are told you have one chance in one million of being killed in a road accident?

2.2 The common law on predicting the future

[39] The standard solution when faced with difficulties about the future is to grasp at a statement by Sir Robin P Cooke in *Commissioner of Police v The Ombudsman*[54] and to distinguish "fact-finding" from judgment. That approach is neither valid nor useful. First, "judgment" or evaluation is needed at all stages of the judicial exercise, especially when for the reason given earlier, finding the cause of an effect does involve a considerable degree of subjective judgment. Further, when considering contested facts, in addition to assessing the relevance, logic, coherence and credibility of each piece of evidence in the light of the competing hypotheses, the court must always consider its preconceptions, the dangers of intuition and of the use of heuristics, before it can make any finding of fact. There is no essential distinction between the evaluations required in fact-finding and in making predictions. Judgment is required in both even if they do look in different directions in time.

[40] Second, an overall evaluation involving a judgment is usually required under the relevant objectives and policies of plans under the RMA so there is scope for confusion as to which "evaluation" is being carried out.

[41] Third, it is a basic tenet of the common law that once facts are found on the balance of probabilities by the court they are treated as reality. As Lord Hoffmann wrote in *Re B:*[55]

> If a legal rule requires a fact to be proved (a 'fact in issue'), a judge or jury must decide whether or not it happened. There is no room for a finding that it might have happened. The law operates a binary system in which the only values are 0 and 1. The fact either happened or it did not. If the tribunal is left in doubt, the doubt is resolved by a rule that one party or the other carries the burden of proof. If the party who bears the burden of proof fails to discharge it, a value of 0 is returned and the fact is treated as not having happened. If he does discharge it, a value of 1 is returned and the fact is treated as having happened.

On the other hand it would simply be foolish to treat predictions as to the future in the same way.

[42] The common law approach runs into difficulties with predictions of effects of less than 50% probability. Lord Diplock said in giving the advice of the Privy Council in *Fernandez v Government of Singapore*[56] "the balance of probabilities" is:[57]

> … a convenient and trite phrase to indicate the degree of certitude which the evidence must have induced in the mind of the court as to the existence of facts, so as to entitle the court to treat them as data capable of giving rise to legal consequences.
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> …
>
> But the phrase ["the balance of probabilities"] is inappropriate when applied not to ascertaining what has already happened but to prophesying what, if it happens at all, can only happen in the future. There is no general rule of English law that when a court is required, either by statute or at common law, to take account of what may happen in the future and to base legal consequences on the likelihood of its happening, it must

54 *Commissioner of Police v The Ombudsman* [1988] 1 NZCR 385 (CA) at 392.
55 *Re B* [2008] 4 All ER 1 at [2] (HL).
56 *Fernandez v Government of Singapore* [1971] 2 All ER 691 (PC).
57 *Fernandez v Government of Singapore* above n 56, at 696.

> ignore any possibility of something happening merely because the odds on its happening are fractionally less than evens.

[43] Similar approaches to predictions have been followed in Canada and Australia – see *Janiak v Ippolito*,[58] a decision of the Supreme Court of Canada, and *Malec v C Hutton Proprietary Limited*,[59] a decision of the High Court of Australia. In *Athey v Leonati*[60] the Supreme Court of Canada referred to these cases and confirmed that:

> [F]uture events need not be proven on a balance of probabilities and are simply given weight according to their relative likelihood.

That is the logical and scientifically consistent approach.

[44] Fourth, the bundling of predictions being made with evaluation overlooks that separate falsifiable predictions can be made about individual cause/effect (stressor/response) relationships. This is so important it is considered further in the next section.

2.3 Predictions can be falsified

[45] We have already referred to *Kiwi Property*.[61] There the Environment Court considered (inter alia) the refusal by the Council to rezone 10.58 hectares at Te Rapa about seven kilometers north of the City Centre. Appeals were brought by the landowner Wengate Holdings and trade competitors including Kiwi Property Management Ltd. As can be expected of a supermarket case there were many issues, but the interesting aspect of the decision for this paper are two simple predictions. First the Environment Court accepted[62] that an intensive shopping mall in the commercial services zone was "… more beneficial than real". Second, after many pages of description of the evidence the court found:[63]

> … that the retail premises of the plan as now supported by Council may have some impact on trade at the existing centres but that the impact will not be sufficient to generate flow-on consequential effects.

Those "findings" are interesting because they are predictions about the future and thus typical of RMA cases. The case went to the High Court. In *Westfield (NZ) Ltd v Hamilton City Council*[64] the High Court said:

> Of course the Appellants are entitled to argue that provision ought to be made for potential effects, particularly those which have a high potential impact. But the Court was entitled to approach the matter in robust terms by effectively concluding that adverse consequences were so unlikely that further controls were not necessary. In my view that is what it did.

[46] Of course since those predictions were about the future they were also testable. What makes this case illuminating is that there is now some evidence about what has actually happened. First there is now a shopping centre at Te Rapa – "The Base" which calls itself the largest in New Zealand. Second, there is an interesting powerpoint[65] by Mr

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58 *Janiak v Ippolito* [1985] 1 SCR 146.
59 *Malec v C Hutton Proprietary Limited* (1990) 169 CLR 638.
60 *Athey v Leonati* [1996] 3 SCR 458.
61 *Kiwi Property Management Ltd*, above n 27.
62 *Kiwi Property Management Ltd*, above n 27, at [148].
63 *Kiwi Property Management Ltd*, above n 27, at [148].
64 *Westfield (NZ) Ltd v Hamilton City Council* [2004] NZRMA 556 (HC).
65 N Roberts and C E Kirman *Retail Redistribution* (www.rmla.org.nz>uploads>2016/09, 6/10/16 accessed at 1553).

Nick Roberts and Dr Claire Kirman which gives detailed figures showing a decline in foot traffic and increased vacancies in the Hamilton "Farmers' Golden Mile" (the CBD).

[47] Of course to scientists, these examples are trivial (as indeed supermarket cases often are). They could fairly point out that the differences between this sort of case and some climate change impacts are manifold. Sea level rise is irreversible. By the time we can prove the full effect there will be much change in the system because of inertia in the oceans and the buildup of GHGs in the atmosphere. In short, humans are conducting an experiment on the stability of the atmosphere and biosphere that is not conducive to testing as you can with a supermarket.

3. Scientific approaches to risk management

3.1 To quantify risks or not?

[48] As stated earlier, the risk of an effect[66] has been defined as the product of a probability and its consequences:

Risk (**R**) = Probability (**P**) x Consequences (**C)**

We will consider the probability and consequences in turn. However, there are a number of things to be aware of. First is that different professions use different vocabulary for (more or less) the same things – see below. Second the formula has a convenient tidiness about it, but we need to be careful of the complexities of the real world. We look at dynamic (time factors) in 3.7 below. There are other complexities about changes over time which Dr Reisinger will elaborate on. Third with regard to climate change, Drs Reisinger and Lawrence have commented that both probability and consequences change over time (the latter because the value of assets, our societal reliance on those assets and ability to replace those assets with alternatives will change as society continues to develop).

[49] It is increasingly clear that there are other ways of looking at risks beyond simply the likelihood and the cost of the consequences. These are:

- the shape of the stressor/response curve (is it a normal sigmoidal curve or something else?).
- the vulnerability of the resource in question – this looks at the relationship between probabilities and consequences; and
- the dynamic time factors relating to speed of onset and questions of reversibility.

We consider these in 3.5 et ff below:

Confusing jargon

[50] Because prediction and risk assessment are so important in the real world a huge amount of research has gone into the subjects. Investors, bankers, and insurers have each developed their own techniques, as have scientists. In addition to the problem (for lawyers) of bearing in mind we are talking about future effects from causes (and not past causes of the actual effects), difficulties arise from the fact that different types of experts use different terminology.

[66] See the Glossary to the NZCPS 2010.

[51] One confusion to be aware of is that many people (including professionals) often use "risk" as a synonym for "probability".

[52] Within most specialist fields there are rigorous and logical methodologies, for example:

- *Guidelines for Ecological Risk Assessment*;[67]
- *WHO Human Health Risk Assessment Toolkit: Chemical Hazards*;[68]
- *The NZTA's Integrated transport assessment guidelines*;[69]
- Noise – the New Zealand Standards (eg NZS 6808:2010 *Acoustics – Wind farm noise*); and
- Odours – *The Good Practice Guide*.

[53] Each expertise comes with its own jargon, for example:

- ecologists talk about "stressors" and "response";
- epidemiologists talk about "exposure", "dose" and "response";
- traffic engineers talk about "generation" and "impacts" (rather a sinister term in that context); and
- noise experts write about "SACs" – special audible characteristics.

3.2 Assessing probabilities in the light of evidence: Bayes Rule

[54] We now look at a logical rule which is likely to lead to development of the law of evidence over the next 50 years. That is Bayes Rule. In its simplest form Bayes Rule tells us how to update an initial probability in the light of evidence. Bayes Rule states the posterior probability of any hypothesis H (eg that average global sea levels are rising) given the evidence E_i as represented by this rule:

$$\Pr(H|E_i) = \frac{\mathbf{\Pr(E_i|H)}}{\mathbf{\Pr(E_i|\ not\ H)}} \times \Pr(H)$$

where $\Pr(H)$ = the initial probability of the hypothesis

$\Pr(E_i|H)$ = the probability of the evidence E_i given the hypothesis H

$\Pr(E_i|\ not\ H)$ = the probability of E_i given that H is not true.

(The formula in **bold** is called the likelihood ratio).

Application of the rule can be repeated for further evidence and there are some sophisticated computer programmes for calculating "Bayesian Networks" when each piece of evidence is not independent.

[67] USEPA 1998.
[68] WHO 2010.
[69] S Abley, P Durdin, M Douglass NZTA research report 422 (November 2010).

[55] Bayes Rule is routinely used by scientists, and is a powerful weapon for assessing the probability of future effects. Having said that we should note that there is literature that has raised real issues with the use of the Bayes Rule in the climate change impacts setting. This is in particular where probabilities cannot be quantified in a simple way, and hence updating probabilities relies much more on expert judgement and interpretation/weighing of new evidence than on simple observational facts that corroborate or contradict a clearly described proposition.

[56] I also mention that Bayes Rule is also (potentially) useful in the common law. The potential use of Bayes Rule in a "civil" type of proceeding (actually under Part 12 of the RMA) was explained by the Environment Court in *Dunedin City Council v Saddle Views Estate Limited*[70] as follows:

> [57] When we turn to consider the alternative hypotheses we will give our provisional views based on a more explicit model of the fact finding process. At the very start of the fact-finding process in a civil proceeding[71] the initial probability Pr(H) of the plaintiff's hypothesis H is usually assumed to be 0.5 (the balance of probabilities) but it changes as each piece of evidence is considered. Thus if there are n pieces of independent evidence so that $E_i = E_1, E_2, E_3 \ldots E_n$ in turn, then the notional calculation of Pr(H) given E_i (usually written as $Pr(H|E_i)$) needs to be carried out n times. Of course courts usually carry out the whole exercise in a global, intuitive way, not sequentially as scientists would. But understanding that the posterior probability of a hypothesis, given the evidence is a function of a likelihood ratio comparing the probability of each piece of independent evidence being true (given the hypothesis) with the probability of the evidence being true (given the hypothesis is false), has several benefits:
>
> (1) each piece of evidence can be evaluated separately and belief in the probability of the hypothesis amended accordingly;
>
> (2) there is less risk of committing the "prosecutor's fallacy" (or the defendant's fallacy) by considering only the probability of the evidence in the light of one party's position i.e. it assists even-handedness between parties;
>
> (3) it makes judicial fact-finding consistent in theory with the scientific interpretation of facts which is: "… based on questions of the kind 'What is the probability of the evidence given the proposition?' "[72]
>
> (4) it is more difficult (and less transparent) to assess $Pr(H|E_i)$ than it is to assess $Pr(E_i|H)$ given that the former needs to take into account all the other evidence in the case, whereas the latter assessment can be carried out separately, thus allowing the decision-maker "… to confront his various opinions [about the different pieces of evidence] with one another to see if they are coherent".[73]
>
> [58] Where lawyers struggle with the use of the likelihood ratio is with the idea that the posterior probability of a hypothesis (given evidence) can depend on the probability of a piece of evidence given the hypothesis, divided by the probability of the evidence[74] given the falsity of the hypothesis. That seems to reverse (and complicate) the assessment. But the step is perfectly logical and is in fact critical to ensuring that each

[70] *Dunedin City Council v Saddle Views Estates Limited* [2016] NZEnvC 107 at [57] and [58].

[71] But not in the real world.

[72] J Curran "The Use of Bayes' Theorem in Jeopardy in the United Kingdom?" (20 October 2011) Stats Chat http://www.statschat.org.nz/2011/10/20/the-use-of-bayes-theorem-in-jeopardy-in-the-United-Kingdom (searched 26 May 2016).

[73] De Finetti, B. [1972], Chapter 8, "How to Choose the Initial Probabilities", at p. 144-145; "English Summary" by L. J. Savage for the joint paper with de Finetti [1962] published in Italian (cited in A. Biedermann. F. Taroni and C. Champod *Reply to Hamer: the RvT Controversy* (2012) 11 P and R 361-362).

[74] Q: 'The probability of evidence? — is not the evidence, the evidence?': A: 'Yes, but is the evidence true (or accurate)? That needs to be — can only be — assessed against the hypothesis and the alternative hypotheses.'

> piece of evidence is considered separately and not [merely] in some global intuitive roundup.

[57] The Environment Court added:[75]

> [60] There is now an extensive literature on likelihood ratios and their role in the proof of facts in judicial proceedings, see for example Professor E K Cheng's *Reconceptualising the Burden of Proof*[76] and Professor L Kaplow's *Likelihood Ratio Tests and Legal Decision Rules*.[77] The issues have barely been raised in civil proceedings in New Zealand, and in England the Court of Appeal (arguably) confused the issues in *RvT*.[78] For a balanced commentary on *RvT* by one of the leaders in the field of forensic probabilities see Professor D H Kaye's *Likelihoodism, Bayesianism and a Pair of Shoes*.[79]

[58] Unfortunately neither counsel in the case took up the court's invitation so when the court came to consider the evidence, it did do so in the normal "global intuitive" way.[80]

[59] Establishing the initial or prior probability is often the most contentious part of applying Bayes Rule. It is not a problem in civil proceedings (in common law jurisdictions) where the initial probability of a *fact in issue* is 50%, ie $P_o(H) = 0.5$. If the fact in issue is "the moon is made of blue cheese", the court must start with the probability of that hypothesis being 0.5.

[60] Returning to the consideration of alleged effects under the RMA: when predictive questions are asked under the Act we should not assume (as a civil proceeding does) that $P_o(H) = 0.5$. Fortunately, in relation to the effects of causes, we can look at base rates: obviously the probability that the sun will rise tomorrow is quite high if we look at the base rate. The sun has risen for about the last 4.543 billion years. So Bayes Rule is even more helpful, potentially, under the RMA than it is in civil proceedings.

[61] To enable readers to experiment with the use of base rates to calculate their mortalities attached is a recent table for the base rates for death from different causes in the USA.[81] In 2013 the odds of death for a selected group of injuries were:[82]

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75 *Dunedin City Council v Saddle Views Estates Limited*, above n 70, at [60].
76 E K Cheng "Reconceptualising the Burden of Proof" (2013) 122 Yale LJ 1254.
77 L Kaplow "Likelihood Ratio Tests and Legal Decision Rules" (7 October 2013) www.law.harvard.edu/programs/olincentre.
78 *RvT* [2010] EWCA (Crim) 2439; [2011] 1 CrAppR 9.
79 D H Kaye "Likelihoodism, Bayesianism and a Pair of Shoes" (2012) 53 Jurimetrics 1.
80 Final Decision: *Dunedin City Council v Saddle Views Estate Limited* [2016] NZEnvC 199.
81 I could not find a convenient table for the New Zealand statistics.
82 National Centre for Health Statistics (USA) National Safety Council 2013.

Odds of Death in the United States by Selected Cause of Injury 2013[83]

Cause of Death	Number of Deaths, 2013	One-year odds	Lifetime odds
All motor vehicle accidents	35,369	8,938	113
Car occupants	6,625	47,718	606
Motorcycle riders	4,230	74,735	948
Assault by firearm	11,207	28,208	358
Exposure to smoke, fire and flames	2,760	114,539	1,454
Fall on and from stairs and steps	2,233	141,571	1,797
Drowning and submersion while in or falling into swimming pool	651	485,605	6,162
Firearms discharge (accidental)	505	625,998	7,944
Fall on and from ladder or scaffolding	420	752,688	9,552
Air and space transport accidents	412	767,303	9,737
Cataclysmic storm[84]	63	5,017,918	63,679
Flood	42	7,526,877	95,519
Bitten or struck by dog	35	9,032,253	114,622
Earthquake and other earth movements	34	9,297,907	117,994
Lightning	23	13,744,732	174,426

[62] Of course the odds that an older person will die of a heart attack or cancer are significantly higher than dying from an accident (or being murdered).

3.3 A generic approach to risk management

[63] Another useful general model for assessing and managing risks is the Australian Standard/New Zealand Standard ISO 31000:2009 *Risk Management – Principles and Guidelines* (ISO 31000). This sets out "generic guidelines on risk management"[85] whose essential elements are:

(1) to establish the context of the assessment and the objectives in issue;[86]

(2) to identify the risk, in terms of the probability of an effect in relations to the objectives;

(3) to analyse the cost of the consequences of the effect;

(4) to evaluate the risk, which involves "making decisions, based on the outcomes of risk analysis, about which risks need treatment and the priority for treatment implementation";[87] and

[83] Based on fatalities and life expectancy in 2013. Ranked by deaths in 2013 (Source: National Centre for Health Statistics, National Safety Council http://www.iii.org/fact-statistic/mortality-risk accessed 2/09/2016.
[84] Includes hurricanes, tornadoes, blizzards, dust storms and other cataclysmic storms.
[85] ISO 31000 para 1.
[86] ISO 31000 para 5.3.1.
[87] ISO 31000 para 5.4.4.

(5) to treat the risk which "involves the selection of one or more options for modifying risks, and modifying those options".[88]

[64] In *ZJV (NZ) Ltd v Queenstown Lakes District Council*[89] – from which that summary is drawn – the court suggested that:

> ISO 31000 is a systematic elaboration of the approach which is, or should be, used by a consent authority when considering the potential effects of an application for a resource consent. The context is the "environment" as defined in section 2 of the RMA. Defining the context is a fact-finding and predictive exercise in describing the existing setting of the proposal and the reasonably foreseeable changes to it. The relevant objectives are usually those set out in the controlling district plan and those in any higher order instrument (e.g. national policy statement or regional plan) unless the latter have already been sufficiently "particularised"[90] in the district plan. Some fundamental objective such as minimising injuries or death to humans are often not expressed directly because they are so obvious. Only when the environment has been identified and the objectives ascertained can the predictions of risk be made.

3.4 Assessing the likelihood of an effect

[65] We have looked briefly at the methods used for assessing probabilities of alleged effects. Usually in practice, the probability is not expressed in numerical terms. Until recently there has been little consistency about the language used to express probabilities. Fortunately that is now being remedied by the climate change debate.

[66] The International Panel on Climate Change ("IPCC") has issued *Guidance Notes* (2010) for assessing the likelihood of effects. The general scheme in earlier guidance was to assess:

- Confidence in facts; and
- Likelihood for predictions.

That scheme became confused in the (2010) guidance for the Fifth Assessment. In particular there was criticism of using probabilistic language for qualitative assessments. For further discussion of the issues around the IPCC Guidance Notes, see *The IPCC and treatment of uncertainties: topics and sources of dissensus*.[91] The co-presenters in this session think this is over-simplified (which is extremely likely to be true) or even plain wrong (likely). They have explained that "Both likelihood and confidence are intended to express the distance between what we can say based on the scientific literature and the presumed 'truth' in the real world. Likelihood does so by quantifying certainty, whereas confidence focuses more on the evidence base qualitatively (ie are there conflicting theories, are there multiple lines of evidence, are there alternative explanations that run counter to the mainstream)? Both can equally apply to facts or predictions."[92]

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88 ISO 31000 para 5.5.1.

89 *ZJV (NZ) Ltd v Queenstown Lakes District Council* [2015] NZEnvC 205 at [102]-[104].

90 Referring to *Environmental Defence Society Inc v New Zealand King Salmon Company Ltd* [2014] NZSC 38; [2014] 1 NZLR 593; [2014] NZRMA 195; (2014) 17 ELRNZ 442.

91 C E Adler and G H Hadorn *The IPCC and treatment of uncertainties: topics and sources of dissensus* Wiley Interdisciplinary Reviews: Climate Change (2014), Volume 5, issue 5.

92 A Reisinger email communication 12 October 2016.

[67] In case it is useful in other contexts than climate change, note that the IPCC measures certainty using a likelihood scale:

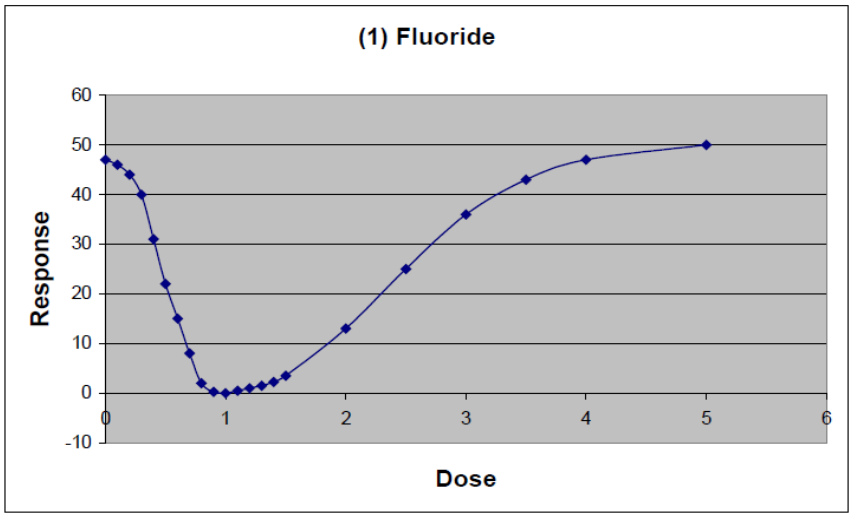
Likelihood Terminology	Likelihood of the occurrence / outcome
Virtually certain	> 99% probability
Extremely likely	> 95% probability
Very likely	> 90% probability
Likely	> 60% probability
More likely than not	> 50% probability
About as likely as not	33 to 66% probability
Unlikely	< 33% probability
Very unlikely	< 10% probability
Extremely unlikely	< 5% probability
Exceptionally unlikely	< 1% probability

It seems to me this scale can be useful for stating qualitative or subjective probabilities or likelihoods in the RMA setting. Note that on the balance of probabilities is not to be found – it is simply in the middle of "about as likely or not".

3.5 What the shape of a curve tells us about future observations

[68] Attached is Figure 1 showing the dose-response relationship for fluoride in humans.

Figure 1 – Dose-Response Relationship of Fluoride



Gordon A. Fox, EVR 2001: Risk and Toxicity 9-10, fig.2 (2000), available at chuma.cas.usf.edu/~gfox/EVR2001/risk_and_toxicity.pdf.

This confirms Paracelsus' insight that it is the dose which makes a poison. But it also shows that no dose is more harmful than some.

[69] Many dose-response relationships show a simpler sigmoidal function, the general version of which is shown in Figure 2.[93]

Figure 2

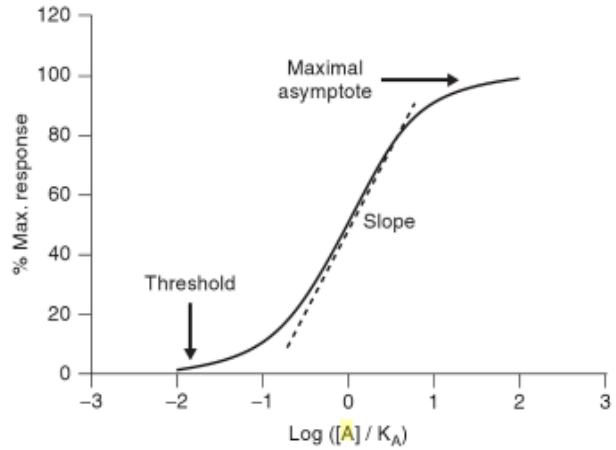


Figure 2: Dose-response curves. Any dose-response curve can be defined by the threshold (where response begins along the concentration axis), the slope (the rise in response with changes in concentration), and the maximal asymptote (the maximal response).

[70] Notice we tend to think sigmoidally but act at perceived thresholds. But where are the "thresholds" (if any) on Figure 2? The answer is that the threshold is where the response begins along the x (concentration) axis. The scientific threshold is much lower than we tend to think of it as being when we use "threshold" or "tipping point" as metaphors.

[71] We always need to bear in mind with neat curves, like the two above, that they are 'fitted' curves. They are the best fits for (often) a mass of confusing data, established using models that assume a normal bell-shaped ("Gaussian") distribution. In reality there are many other distributions which may fit the data better:

For example unlikely events occur much more often than expected. The Global Financial Crisis ("GFC") of 2008 was a 'one in a million' event. Increasingly in the climate change context there is much discussion of 'fat-tail' events. Possible examples include the release of frozen methane from the bottom of the oceans, or accelerated melting of ice in Greenland, or of the Antarctic ice sheets.

93 T P Kenakin *A Pharmacology Primer* (3rd ed) (Elsevier, San Diego, California 2009) p 16.

3.6 Vulnerability

[72] Recognition of the vulnerability to incur costs is shown in an interesting illustrative vulnerability scale[94] developed by accountants (shown in Figure 3). This is potentially useful in enforcement cases in assessing the degree of culpability of landowners and managers in pollution cases.

Figure 3[95]
Illustrative Vulnerability Scale

Rating	Descriptor	Components
5	Very High	• Risks not identified qualitatively • No scenario planning performed • Lack of consent holder or owner enterprise level / process level capabilities to address risks. • Responses not implemented • No contingency or crisis management plans in place
4	High	• Consent holder or owner has scenario planning for identified risks performed. • Low enterprise level / process level capabilities to address risks • Responses partially implemented or not achieving control objectives • Some contingency or crisis management plans in place
3	Medium	• Stress testing and sensitivity analysis of scenarios performed • Consent holder has medium enterprise level / process level capabilities to address risks • Responses implemented and achieving objectives most of the time • Most contingency and crisis management plans in place, limited rehearsals
2	Low	• Strategic options defined in application / consent / or plan • Medium to high enterprise level / process level capabilities to address risks • Responses implemented and achieving objectives except under extreme conditions • Contingency and crisis management plans in place. Some rehearsals
1	Very Low	• Real options deployed to maximise strategic flexibility • High enterprise level / process level capabilities to address risks • Redundant response mechanisms in place and regularly tested for critical risks • Contingency and crisis management plans in place and rehearsed regularly

[73] Adaptive management – discussed later – is in part a response to vulnerability issues.

[94] I am indebted to P Curtis and M Carey's paper "Risk Assessment in Practice" (2016) Committee of Sponsoring Organisations of the Treadway Commission for this description and for the basis of the table.
[95] P Curtis and M Carey "Risk Assessment in Practice", above n 94.

3.7 The (dynamic) time factors

[74] Time introduces many complications to assessment of risk: the speed of onslaught of an improbable risk, reversibility (or not) and inertia effects, and acceleration.

Speed of onset / observation

[75] This relates to the time that elapses between the occurrence of an event and the point at which the effects are observed. Knowing the speed of onset is useful when developing risk response plans.

[76] Some effects may take years to observe. There will be problems if Regional Councils have got their figures wrong in relation to non point source discharges from stock. For example, it is common on the Canterbury Plains for contaminants such as forms of nitrogen (N) and phosphorus (P) – products of dairy excreta – to take 9 to 12 or more years to move through aquifers to rivers. So if a problem is discovered at the end of that period, it may continue for a further decade.

Reversibility and inertia

[77] The important example is climate change reversibility. "A large fraction of climate change is largely irreversible on human time scales …".[96]

[78] Related to reversibility is that many effects have inertia. Causes once started have effects which are difficult or impossible to stop. This can occur in social and ecological contexts, and of course has economic implications too. For example, at least part of the sea level rise predicted from climate change is built in – it cannot be stopped.

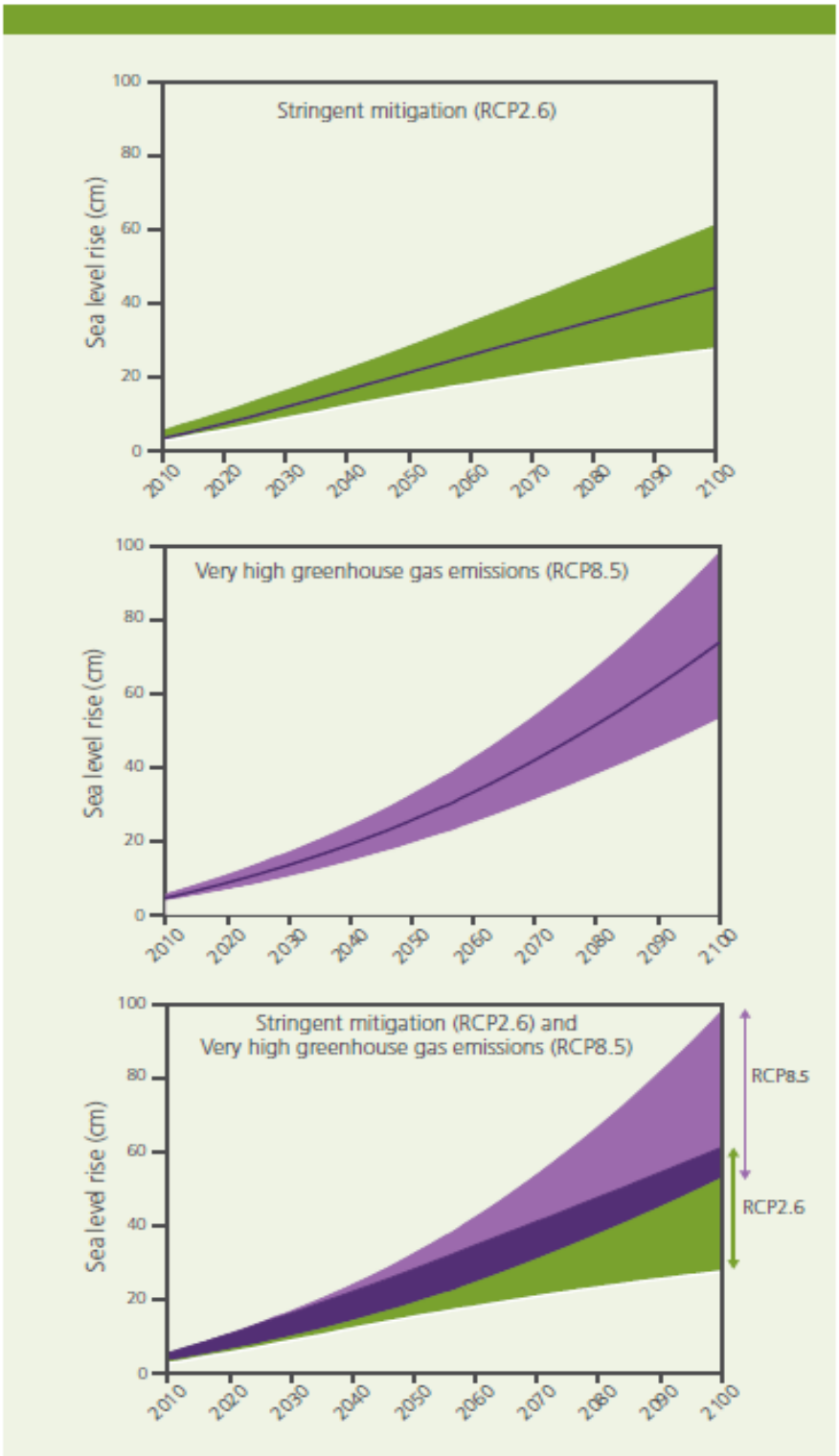
3.8 Acceleration issues

[79] Acceleration issues can be illustrated by reference to climate change. It is virtually certain that sea levels will continue to rise generally during the 21st Century.[97] Look at the shape of the curves on Figure 4 below. They show that the rate of change is not increasing in a linear fashion but accelerating. So in 2100 not only is the sea level likely to be (on average if the conservative IPCC scenarios are correct) 89 centimetres higher than now also but (at the highest end of the IPCC scenarios) increasing at a rate of 16 centimetres each ten years.

[96] M Collins et al Chapter 12 *Long-Term Climate Change: Projections, Commitments and Irreversibility* Climate Change 2013: the Physical Science Basis IPCC Working Group 1 Contribution to AR5 (CUP, Cambridge, 2013) p 1033.

[97] IPCC AR5 Chapter 13.

Figure 4



Data: IPCC, 2013

Figure 4: The most recent projections of global mean sea level rise by the IPCC relative to 1986-2005. The green band represents the range for the RCP2.6 scenario, and the purple band represents the range for the RCP8.5 scenario. In the top two graphs, the lines represent the median of the range.

3.9 Quantifying the costs of effects

[80] Assessing the costs of an effect can be a very complex exercise in itself. For brevity, and to establish a benchmark, consider the costs of loss of a single human life.

[81] Where we are talking about the consequences of an accident being death, the question of the value of a statistical life ("VOSL") is raised. The VOSL used by the Ministry of Transport was $4.06 million in June 2014 (and it is updated to account for inflation).[98]

[82] In fact people's willingness to pay to save a life varies[99] on the potential cause of death and on whether the risk of death is imposed or assumed voluntarily. A study in New Zealand on house fire safety "… suggests a value lower than the New Zealand transport VOSL"[100] whereas:[101]

> The Health and Safety Executive in the UK recommends a higher VOSL for prevention of cancer death than the transport VOSL, to take into account 'the protracted period of pain and suffering' associated with the disease[102]

As we shall see the Environment Court has considered this variation.

[83] Of course there is potentially a huge range of other costs to be assessed – one for each class of effects with which the RMA is concerned. Economists have techniques for valuing – albeit not yet very accurately – most of the potential effects under the RMA. A useful description of some of those methods is given in the Treasury's *Guide to Social Cost Benefit Analysis.*[103] The cases on, and methods of valuation of natural assets under the RMA have been subject of a paper[104] by Mark Christensen although the discussion of the cases is largely a description of the evaluative methods used.

[84] We will consider how to wrap up all the costs and benefits, and to assess the net benefits of an activity later (in part 10).

4. Cumulative effects

4.1 The dictionary sense of cumulative effects

[85] Section 3(d) RMA is misleading because it suggests that a "cumulative effect" is a separate class of effects whereas the whole world is subject to multiple causes and multiple effects at the same time. When considering any cancer risk remember we are (on average) getting 80,000 $\mu W/cm^2$ of electromagnetic radiation from the sun during all daylight hours,[105] compared with, for example 1,000 to 5,000 $\mu W/cm^2$ from the cellphone by your ear.

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98 Ministry of Transport *The social cost of road crashes and injuries 2015 update* (March 2016).

99 J Guria, *Fix Flawed values of statistical life and life years to get better policy outcomes* NZIER Insight 2010 p 3.

100 J Guria, above n 99 p 3.

101 J Guria, above n 99 p 2.

102 Citing Mason, H., Jones-Lee, M. and Donaldson, C. (2009). *Modelling the monetary value of a QALY: a new approach based on UK data*. Health Economics, 18(8), 933-950. Baker, R., Chilton, S. M., Jones-Lee, M. W. and Metcalf, H. R. T. (2009). *Valuing lives equally in a benefit-cost analysis of safety projects: A method to reconcile theory and practice*. Safety Science 47, 813–816.

103 New Zealand Treasury *The Treasury Guide to Social Cost Benefit Analysis* (July 2015).

104 M Christensen, "Valuation of Natural assets under the RMA" (2013) 17 NZJEL 291.

105 *Shirley Primary School v Christchurch City Council* [1999] NZRMA 66 (Environment Court) at (231).

[86] All effects in the real world are cumulative. Humans often have a choice to put up with them or avoid, remedy or mitigate them. However, valued components of the natural world such as most native fauna and flora have no option but to suffer whatever changes humans throw at them. Choosing ornithological examples: some generalist species such as sparrows or magpies may be able to deal with anthropogenic stressors quite well. In contrast specialist birds with special ecological niches like Kiwi or New Zealand King Shags may be much more vulnerable. While we can isolate types of adverse effects when dealing with neighbours in subdivisions we need to be more careful when dealing with the natural world.

[87] Laypeople and scientists have a similar concept of cumulative effects. The definition of cumulative effects given by the US Department of Commerce is:[106]

> This term refers to the impact on the environment which results from the incremental effects of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency … or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.

[88] Another example is a document produced by a group of scientists reviewing the effects of aquaculture in the Marlborough district which describes "cumulative" effects in relation to marine aquaculture as:[107]

> … Ecological effects in the marine environment that result from the incremental, accumulating and interacting effects of an aquaculture development when added to other stressors from anthropogenic activities affecting the marine environment (past, present and future activities) and foreseeable changes in ocean conditions (i.e. in response to climate change).

That description appears to fit within s 3(d) RMA.

4.2 The multiple stressor/cumulative effects problem

[89] The "multiple stressors problem" has been described as the combination of these issues:[108]

> [First] populations exist in real landscapes that, more often than not, are being altered simultaneously by various combinations of human land use practices, changes in climate, and the introduction of nutrients, xenobiotic chemicals, nonnative and genetically-modified organisms, and other human-related stressors. Natural stressors, eg, weather, competitors, and predators, also contribute to the mix of threats that populations must withstand to remain viable.
>
> [Second] The solution likely is not as straightforward as simple addition of effects; rather, some stressors may interact synergistically or antagonistically, such that their combined effect is greater or lesser than the sum of their individual effects.
>
> [Third] The timing of effect also is important, and has particularly acute implications for model-based assessments. For example, should a chemical-induced effect precede or follow a weather-induced effect?
>
> [Fourth] Only somewhat less significant are methodological gaps in the ability to account for compensatory processes that influence population dynamics, and to

[106] *Guidance on cumulative effects analysis in Environmental Assessments and Environmental Impact Statements* NOAA (USA 2012) p 2.

[107] *Literature Review of Ecological Effects of Aquaculture* (2013) Ministry of Primary Industries at s 2.2.2. It should be noted that this publication does not contain a consensus view but is a series of individual chapters by different experts on the subjects of their expertise at p 12-13.

[108] Munns, Jr., W. R. 2006. "Assessing risks to wildlife populations from multiple stressors; Overview of the problem and research needs", *Ecology and Society* 11(1): 23. [online] URL: (www.ecologyandsociety.org/vol11/iss1/art23/).

> accommodate issues of spatial context and scale. Including homeostasis of organism health, density dependence in the demographic rates of populations, and genetic change in populations that can occur randomly or directionally, compensatory processes result from dynamic mechanisms that are ignored or are reflected only rudimentarily in the population models typically used in ecological risk assessment.
>
> [fifth] Similarly, the spatial context of stressor exposure can also influence population outcomes. In addition to the obvious requirement of suitable habitat for a population to remain viable, the placement of habitats in relationship to the distributions of anthropogenic and natural stressors can significantly influence the exposure of populations to those stressors.
>
> [sixth] And then, there is the issue of data…

[90] For examples of how the court has struggled with these issues look at its attempts to understand a methodology called the Instream Flow Incremental Methodology ("IFIM") which attempts to model and predict the hydraulic and ecological effects of changing flows in rivers; see *Ngati Rangi Trust v Manawatu-Wanganui Regional Council*;[109] *Re Rangitata South Irrigation*;[110] *Re Talley*;[111] *Director General of Conservation v Marlborough District Council*[112] and *Groome v West Coast Regional Council*.[113]

4.3 The *Dye* understanding of cumulative effects

[91] A 2001 decision of the Court of Appeal – *Dye v Auckland Regional Council*[114] ("*Dye*") – has caused ongoing problems when it is applied more widely than its facts justify. In the context of a resource consent application the Court of Appeal held that a "cumulative effect" is not a wide concept. Tipping J, giving the decision of the Court, wrote:[115]

> The definition of effect includes "any cumulative effect which arises over time or in combination with other "effects". The first thing which should be noted is that a cumulative effect is not the same as a potential effect. This is self evident from the inclusion of potential effects separately within the definition. A cumulative effect is concerned with things that will occur rather than with something which may occur, that being the connotation of a potential effect. This meaning is reinforced by the use of the qualifying words "which arises over time or in combination with other effects". The concept of cumulative effect arising over time is one of a gradual build up of consequences. The concept of combination with other effects is one of effect A combining with effects B and C to create an overall composite effect D. All of these are effects which are going to happen as a result of the activity which is under consideration.
>
> [Underlining added]

[92] The converse appears to be that effects of other stressors (which are not the activity under consideration) are not cumulative effects as a matter of law. That is problematic in relation to the (extensive) parts of the environment which are "ecosystems and their constituent parts"[116] because they are all affected accumulatively by all effects from all stressors. Further, *Dye* does not recognise that 'cumulative' effects of multiple stressors are the main consideration in preparations of district plans and other statutory instruments.

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109 *Ngati Rangi Trust v Manawatu-Wanganui Regional Council* (NZEnvC) A67/2004 (18 May 2004).
110 *Re Rangitata South Irrigation Ltd* (NZEnvC) C109/2004 (6 August 2004) at [113] et ff.
111 *Re Talley* (NZEnvC) C102/2007 (3 August 2007) at [184]
112 *Director-General of Conservation v Marlborough District Council* [2010] NZEnvC 403.
113 *Groome v West Coast Regional Council* [2010] NZEnvC 399.
114 *Dye v Auckland Regional Council* [2002] 1 NZLR 337; [2001] NZRMA 513 (CA).
115 *Dye* at para [38].
116 Section 2 RMA.

[93] Another oddity of *Dye* is Tipping J's confidence that future effects will happen. There is a common lawyer's typical tendency to see things in binary (0-1) rather than in probabilistic terms in this statement.

[94] *Dye* was explained by Justice Cooper, one of the High Court Judges with extensive experience in the RMA, in *Rodney District Council v Gould*[117] as follows:

> … I consider that all that was said in *Dye* was that an effect that may never happen, and which, if it does, will be the result of some activity other than the activity for which consent is sought, cannot be regarded as a "cumulative effect".

That is helpful. But it still leaves a sense of unease. Would not the effects of building a house just above the high water mark likely be cumulative on the (non-responsible in an individual sense) effects of storm surges and climate change induced sea level rise?

[95] Other decisions under the RMA show some disquiet over the restrictive application of the term "cumulative effects". First, *Dye* does not use the ordinary meaning of "cumulative" as pointed out by the Environment Court in *The Outstanding Landscape Protection Society Inc v Hastings District Council*.[118] Second, the learned Chief Justice, in her minority judgment in *West Coast ENT Inc v Buller Coal Ltd*,[119] wrote that she:

> … would have thought that contribution to the greenhouse effect is precisely the sort of cumulative effect that the definition in s 3 permits to be taken into account under s 104(1)(a) in requiring the consent authority to 'have regard to any actual and potential effects on the environment of allowing the activity'.

[96] More recently, *Harris v Central Otago District Council*[120] pointed out that strictly *Dye* is only authority for the proposition that a potential effect on the environment which might be caused by some other activity which requires a resource consent under the relevant plan, is not a cumulative effect of allowing the activity for which consent is sought. It seems that the restrictions of *Dye* are not necessary: the potential effects of another independent application for resource consent would not usually be part of either the existing or the reasonably foreseeable future environment and so are irrelevant anyway.

[97] The court expanded on this in R J Davidson Family Trust v Marlborough District Council[121] ("Davidson") observing:

> … that the complexity of *Dye*'s discussion of 'actual and potential effects' in s 104(1)(a) RMA are also unnecessary. There is a simple reason why Parliament used that phrase rather than the defined word "effects". Obviously if a resource consent is applied for in the proper order – in advance of carrying out an activity – all its effects are potential, i.e. they have not occurred yet. However, the legislature anticipated the reality that in a small but significant percentage of cases, particularly after an abatement notice has been issued by a local authority, a resource consent is applied for retrospectively. In such a case most of the effects are "actual".
>
> [179] To those points we can add:
>
> (1) *Dye* does not take into account — because it did not need to — the reality that all stressors, regardless of who or what causes them, cause "cumulative" effects on ecosystems; and

[117] *Rodney District Council v Gould* [2006] NZRMA 217 (HC) at [122].
[118] *The Outstanding Landscape Protection Society Inc v Hastings District Council* [2008] NZRMA 8 (NZEnvC) at [50].
[119] *West Coast ENT Inc v Buller Coal Ltd* [2013] NZSC 87; [2014] 1 NZLR 32; (2013) 17 ELRNZ 688 (SC) at [91].
[120] *Harris v Central Otago District Council* [2016] NZEnvC 52; [2016] NZRMA 250 at [48].
[121] *R J Davidson Family Trust v Marlborough District Council* [2016] NZEnvC 81 at [178]-[179]. This decision has been appealed to the High Court.

> (2) the *Dye* view of the world is rather static — in reality this second's effects are the next second's environment. The past effects of stressors — the accumulated[122] effects — have become and are continually becoming, part of the environment which is the setting of any proposal.

This makes the point we have already noted, that change is constant in the world of effects.

[98] Finally, in *Davidson* the court pointed out that:[123]

> … *Dye* does not mean that "cumulative" effects in a wider sense are irrelevant. If the potential effects of stressors, other than the activity for which consent is sought, are relevant then they may be taken into account under section 104(1)(c) RMA. Accordingly we will analyse such potential effects — which we will call "accumulative effects" — separately so as not to confuse the analysis imposed by *Dye*. The different treatment of such effects under *Dye* may have been intended to have this consequence: whereas cumulative (in the *Dye* sense) effects must be had regard to under section 104(1)(a), the consent authority has a discretion under section 104(1)(c) as to whether it takes accumulative effects into account at all. However that is probably an over legalistic approach, because the potential (future) effects of other stressors are also part of the reasonably foreseeable future environment (under section 104(1)(a)) and that must be established in any event. In other words, there is no bright line distinguishing accumulative effects of other stressors from the future dimensions of the 'environment': to the contrary, they are the same thing.

There are potentially important issues buried in that paragraph as to how cumulative effects in the wider sense of the word 'environment' are to be considered in any case about the future.

5. Effects of low probability but high potential impact

5.1 An example

[99] Recall that s 3(f) includes in the term 'effect', any effect of low probability but high potential impact. An example of how the court has considered this type of effect is *Orica Mining Services New Zealand Limited v Franklin District Council* ("Orica"). Orica sought resource consents to establish and operate a facility on a site at Ridge Road, Pokeno, for the storage of conventional explosives, the storage of Ammonium Nitrate, and the manufacture and storage of Ammonium Nitrate Emulsion ("ANE"). ANE is classed under HSNO as a Dangerous Good Class 5, an *oxidiser.*

[100] The issues for the court were:[124]

> … what is the likelihood of an explosion of the ANE tank, what would the consequences or adverse effects if it did explode, and whether that risk, (i.e. the probability and the adverse effects) should be accepted or, if it cannot be reduced, be avoided altogether.

[101] Under the heading "Attempting to quantify probability" the court wrote:[125]

> [29] Based on world-wide industry experience, Mr Dennison estimated the likelihood of an ANE tank exploding as …*one in 10 million per year* and that of a false-alarm evacuation of the site …*one every 7500 years*. There was an attempt to compare

[122] The court wrote that it would use "accumulated" for the past effects of any stressors; "accumulative" for future effects of all stressors (other than the application).
[123] *Davidson*, above n 121, at [180].
[124] *Orica Mining Services New Zealand Limited v Franklin District Council* W032/2009.
[125] *Orica*, above n 124, at [29].

> those sorts of figures with the probability of being killed by lightning, of winning a lottery, and so on.

The court was reluctant to place a figure or range on the probability. It concluded that the chances of an undesired event are foreseeable, even if at the low end of the spectrum of probability.

[102] It is a little difficult to understand why the court dismissed the comparisons. Leaving aside the possibility of winning Lotto, if the probability of this accident is smaller than of being killed on the road is that not of some significance? As Sir Peter Gluckman points out:[126]

> Care must be taken in how risks are framed and probabilities presented. For example, stating that a certain level of exposure to a substance results in a doubling of the risk of developing a disease sounds on its surface like a cause for serious concern. But if the absolute risk of the disease is extremely small, the increase resulting from the exposure will be insignificant. The media often ignores this basic fact. If the baseline risk of developing a rare cancer is 1 in a million, and a chemical exposure increases that risk to 1 in 500,000, it is less informative to talk about a doubling of risk than to point out that the risk remains minimal. On the other hand if the baseline risk was 1 in a 100 and chemical exposure increased the risk to 1 in 10, clearly there are grounds for banning the chemical. The point is it is always important to use absolute numbers and to focus on degrees of safety rather than to characterise exposures as safe or dangerous – risk is not black and white. We recognise that most activities and decisions involve some risk, however small it may be, and that individuals and societies must decide how much risk they are willing to tolerate.

[103] One other useful insight was stated in *Orica*:[127]

> One significant factor in that assessment of reasonableness would be the distinction to be drawn between neighbouring activities coming to and accepting an existing and known risk and, as here, neighbouring activities having a new risk come to them.

[104] The court concluded:[128]

- The probability of an explosion of the ANE store is very low, but foreseeable.

…

- Blast overpressure can cause effects at levels of 2kpa and higher (i.e. within a radius of 1450m) and significant building damage, with severe injury to those inside, occurring at 5kpa and greater (i.e. within a radius of 725m).
- There are of the order of 26 existing dwellings and possibly more than 16 permitted additional dwellings within 1450m of the site, and 6 existing dwellings within 725m of the site.
- The effects of an ANE explosion are undoubtedly significant beyond the boundaries of the site and within a 725m radius they would undoubtedly be unacceptable. Out to 1450m the effects are still significant, but obviously on a rapidly decreasing scale as the distance increases.

[126] P Gluckman, above n 6, at pp 26-27.
[127] *Orica*, above n 124, at [54]. Also see P Gluckman, above n 6, at p 27 et ff.
[128] *Orica*, above n 124, at [46].

[105] The court considered that if there was an explosion its severe effects must qualify as an effect under the RMA.[129] As it happens the application did not meet the Industry's own code of practice[130] so the court had little difficulty in finding that the level of risk was unacceptable.[131]

5.2 Extinction of species

[106] Can we compare the extinction of another species with the death of one human? The cases do not give a coherent answer. In *Meridian Energy Ltd v Central Otago District Council*,[132] the High Court said:

> … it is simply not possible to express some benefits or costs in dollar or economic terms. For example, the loss of an ecosystem such as a wetland hosting a large bird population which is going to be overwhelmed by land reclamation may not be capable of expression in dollar terms.
>
> Likewise it would be difficult, if not impossible, to express some of the criteria within Part 2 of the Act (ss 5-8) in terms of quantitative values.

But is that correct? After all we put a value on human life (the VOSL) as discussed earlier.

[107] The (remote) possibility of the extinction of a species arose in *Davidson*.[133] There the court was considering an appeal about a mussel farm in the Marlborough Sounds. The site was at the head of Beatrix Bay in the middle reaches of Pelorus Sound. Beatrix Bay is already largely lined with mussel farms. One of the issues was whether there would be adverse effects on New Zealand King Shag, a blue-eyed shag which is endemic to the Sounds. The global population of King Shag is less than 1,000. Consequently, the taxon is identified as *vulnerable* by the International Union for the Conservation of Nature and Natural Resources ("IUCN") in the *Red List*.[134] It is so categorised because:[135]

> … this **species is facing a high risk of extinction in the wild in the medium-term future** based on the criterion (D1) **population less than 1000 individuals**, and is restricted to four core breeding colonies (criterion D2: **five or less locations**), rendering the species susceptible to stochastic effects (e.g. infrequent, significant events) and human impacts.

The criteria referred to are contained in the *Red List*. Either of the two criteria referred to (D1 and D2) is sufficient[136] to place King Shag in the *vulnerable* category.

[108] Of relevance is Policy 11 (indigenous biological diversity) of the NZCPS 2010. This policy is:

> **Policy 11: Indigenous biological diversity (biodiversity)**
>
> To protect indigenous biological diversity in the coastal environment:
>
> (a) avoid adverse effects of activities on:
>
> (i) indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists;

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129 *Orica*, above n 124, at [49].
130 *Orica*, above n 124, at [56].
131 *Orica*, above n 124, at [56].
132 *Meridian Energy Ltd v Central Otago District Council* [2010] NZRMA477 (HC) at [107] and [108].
133 *Davidson*, above n 121.
134 *Vulnerable* is one of the three 'threatened' categories in the *Red List*.
135 *Davidson*, above n 121.
136 The *Red List*, above n 34, at p 15.

> (ii) taxa that are listed by the International Union for Conservation of Nature and Natural Resources as threatened;
>
> (iii) …
>
> (iv) habitats of indigenous species where the species are at the limit of their natural range, or are naturally rare;[137]

[109] The court said about this:[138]

> the first important aspect of policy 11 is that certain adverse effects are simply to be avoided: the effects on certain threatened categories of animals and birds and on certain classes of habitat of indigenous fauna.

[110] The IUCN criteria referred to in policy 11 of the NZCPS do use the concept of thresholds. For example there are thresholds for population decreases[139] or changes in extent of occurrence or area of occupancy[140] but they are tightly defined and are given as alternatives. For the King Shag the IUCN small population criterion D[141] applied. There are no applicable thresholds for criterion D in the IUCN Red List.

[111] The Environment Court found that it had adequate information to find/predict that:[142]

> (1) King Shag habitat will be changed by shell drop and sedimentation;
>
> (2) the effects of the farm accumulate and are likely to be adverse;
>
> (3) it is as likely as not there will be adverse effects on the populations of New Zealand King Shags and their prey; and
>
> (4) there is a low probability (it is very unlikely but possible) that the King Shag will become extinct as a result of this application.

However, it found it had[143] insufficient information to assess the effects in the previous paragraph (the combined effects of the Davidson Family Trust mussel farm together with the other mussel farms in the bay) against the effects of other major environmental stressors, both anthropogenic and stochastic. Pastoral farming, exotic forestry, deforestation, dredging and trawling fall into the first category, while flooding and stochastic fall into both.

[112] On the relationship between stressors the court recognized:[144]

> … there are considerable uncertainties about the inter-relationships between stressors. The accumulative effect of marine farms on King Shag habitat may be less of an immediate threat than sediment run-off from land-based activities and bottom dredging. That does not mean it is not a threat. Further, potential effects of climate change (such as increase in water temperature) loom in the next few decades.

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[137] "Naturally rare" is defined in the Glossary as meaning "Originally rare: rare before the arrival of humans in New Zealand" [NZCPS 2010 p 27].
[138] *Davidson*, above n 121, at [162].
[139] See the *Red List* Vulnerable Criteria A, above n 34.
[140] See the *Red List* Vulnerable Criteria B, above n 34.
[141] The *Red List* Vulnerable Criteria D, above n 34, at p 22.
[142] *Davidson*, above n 121, at [206].
[143] *Davidson*, above n 121, at [207].
[144] *Davidson*, above n 121, at [276].

[113] The Environment Court explained that:[145]

> The point of policy 11(1) NZCPS is that if a species is at the limit of its range then it is automatically susceptible to stressors and any adverse effects on its habitat should be avoided.

[114] The essential question was if the population is stable despite all existing mussel farms, how can one more farm have a more than a minor adverse effect on the taxon? The answers given were:

> [284] … first … is that our finding that the current population of King Shag is apparently stable needs to be qualified by the lack of information about almost all other aspects of its population dynamics. The information given to us was completely inadequate to allow us to detect any trend in the population. At present data on the number of breeding pairs, breeding success rates, or even of the age and sex ratio of birds is almost completely lacking. In particular there is no data on the survival rates and population trends of mature female King Shags. These last are particularly important because it is the likely preferred foraging grounds of females which mussel farms have been extended into over the last 10 to 15 years.
>
> [285] A second additive answer is that it is generally recognised that the precise effects of combinations of stressors on bird populations are not known. Thus the *Red List* works usually on the basis that if there is a percentage reduction in population of a taxon over time then that puts the species at risk. There are elaborate criteria depending on initial population; size of population reduction, declines in EOO or AOO or habitat quality, and so on[146]. However, when a taxon is reduced to less than 1,000 individuals on the planet, because of the risk of stochastic events, <u>waiting for a reduction in population is no longer regarded as an appropriate trigger for protecting the taxon</u>.

6. Assessing the consequences of an effect

6.1 Qualitative assessment

[115] Sir Peter Gluckman wrote:[147]

> The other part of the risk equation is the assessment of the impact or consequences resulting from a shock. Consequences can be expressed in terms of economic, environmental, or social criteria, and are assessed on an impact scale from insignificant through to extreme. In some cases the impact can be estimated quantitatively by event modeling or using past data, measured in, for example, numbers of fatalities/injuries, monetary cost, or extent of area affected. Other situations require qualitative descriptors corresponding to levels of impact on the deemed value of other types of assets (e.g. emotional costs, cultural costs, reputational damage etc).

[116] On quantitative approaches he added:

> Where there is sufficient experience with a particular hazard to estimate probabilities, a quantitative approach to risk assessment is the commonly accepted way to deal with the situation. Such quantitative assessments are very useful, but they can also suggest a level of accuracy that can be misleading. The problem is that providing numerical estimates conveys a level of precision, while the concept of risk itself necessarily implies inherent uncertainty.

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145 *Davidson*, above n 121, at [277].
146 "V The Criteria for Critically Endangered, Endangered and Vulnerable" The *Red List*, above n 34, at p 16 et ff.
147 P Gluckman, above n 6, at p 20.

[117] Under the RMA the consequences of effects are normally assessed qualitatively. For example in *Gallagher v Tasman District Council*[148] the range of potential consequences from overtopping of the sea wall included:

- flooding;
- water flowing into neighbour's properties;
- water being unable to drain quickly;
- danger to people from deep water.

[118] To safeguard potential houses on the site the appellants proposed floor levels about 1.5 metres to 2.1 metres above existing ground level.[149] The court recognised that[150] "… at the present day the extent of flooding on the Gallagher property probably falls into the inconvenient rather than hazardous category". It predicted that[151] dwellings built on the elevated building platforms proposed by the appellants would almost certainly be well elevated above present day inundation levels". The court concluded:

> However, it seems apparent that even at present day levels such inundation must have effects on practicality and safety of access, plantings, cartilages, outbuildings and other facilities and on the amenity of those people whose properties would be subject to inundation from time to time.

[119] The court found that there was[152]

> … insufficient knowledge about present day groundwater levels … to identify with any certainty the extent to which development of the sort proposed on the Gallagher property by the Structure Plan might impact on neighbouring properties and exacerbate inundation on them

It concluded:[153]

> In our view, the present hazard risk exposure of the Gallagher property is such that the feasibility or wisdom of any more intensive residential development is highly questionable...

It declined consent.

6.2 Attempts at quantification of the risk

[120] An attempt to provide a quantitative analysis was made in *ZJV (NZ) Ltd v Queenstown Lakes District Council*.[154] There the court was concerned with a number of alleged adverse effects of operating a helicopter on to a pad at the top of the very busy Skyline 'Gondola' in Queenstown. One of a number of potential adverse effects on safety was canopy collapse of the paragliders which use the same hill to fly off.

[121] The court summarised the evidence of the key witness as follows:[155]

> … It is Mr Shelley's estimate that fewer than 1 in 500 [incidents of turbulence from helicopters] will result in unrecoverable canopy collapse and of those perhaps 1 in 20

[148] *Gallagher v Tasman District Council*, above n 31, at [104].
[149] *Gallagher v Tasman District Council*, above n 31, at [245].
[150] *Gallagher v Tasman District Council v Tasman District Council*, above n 31, at [136].
[151] *Gallagher v Tasman District Council*, above n 31, at [136].
[152] *Gallagher v Tasman District Council*, above n 31, at [137].
[153] *Gallagher v Tasman District Council*, above n 31, at [138].
[154] *ZJV (NZ) Ltd v Queenstown Lakes District Council*, above n 89.
[155] *ZJV (NZ) Ltd v Queenstown Lakes District Council*, above n 89at [141].

> will be fatal for the paraglider pilot. Using these estimates, the expected number of fatal incidents becomes 0.000044 per year which for 15,500 paraglider flights per year a chance of less than 1 in $3.25x10^8$ for each flight. This is within the acceptable range of risk within the Woodruff matrix (1 in 10^6) even if Mr Shelley's estimates with respect to fatal accidents are increased by a factor of 100.

[122] The court then considered quantification of all the risks[156]

> [142] Mr Shelley provided an economic analysis to show a net reduction in social cost arising from the introduction of his proposed controls when quantified in dollar terms the social costs of the proposal with no controls and with the proposed controls can be estimated. The difference can be regarded as the social benefit of the controls. Excluding the benefit accruing to Ziptrek this is some $\$4.717x10^6$ annually. This has a net present value of $\$64x10^6$ over 20 years assuming a 4% post-tax real discount rate.
>
> [143] Mr Shelley compared the annual social cost of the proposal with controls to that of each visitor travelling 100km as a car passenger to the helipad. The latter at $\$4.5x10^6$ per year being 10 times the $450,000 annual social cost of the proposal with controls. He concluded 'Consistent with the Woodruffe analysis, the social cost analysis indicates that the helipad presents an acceptable level of risk.'

[123] This kind of analysis can be improved and made more transparent, but the important point is that the court is no longer relying on a broad intuition (see the *Orica* case) but comparing the social cost of the proposal with that of traffic risks for example which the public accepts every day. This seems to be a very important analytical technique to ensure that the outcome is not over cautious. Of course an adjustment needs to be made for voluntary versus imposed risks and that adds another level of complexity (and subjectivity).

7. The effects of activities on people and communities

7.1 Positive social/cultural and financial ("economic") effects

[124] In this section we look at some of the many types of effects on people and communities as a result of activities by others. It always needs to be borne in mind that people rarely set out to damage the environment intentionally. In fact almost all activities are undertaken to achieve hoped for financial ("economic") benefits and the negative effects are unintended or ignored externalities. The positive effects – including increasing jobs – are taken into account after deducting the producer's (likely) costs:[157] see *McVicar v Christchurch City Council (No. 2).* See also the wider analysis by Dr Pickford in "Economic Efficiency and the Resource Management Act".[158]

7.2 Negative social effects

[125] The Hamilton case *Kiwi Property Management Ltd*[159] introduced at the start of the paper is an example of how these can arise even in supermarket wars.

[126] Some general ideas are all we have space or time for:

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156 *ZJV (NZ) Ltd v Queenstown Lakes District Council,* above n 89 at [142] et ff.

157 In a plan context – s 32; in a resource consent context – see *McVicar v Christchurch City Council (No. 2)* (NZEnvC) C144/05.

158 M Pickford "Economic Efficiency and the RMA" (2014) 18 NZJEL 149.

159 *Kiwi Property Management Ltd*, above n 27.

1. the RMA is expressly designed (s 5(2)) to enable people and communities to provide for their own wellbeing (rather than to have other people's opinions of "what's best for their wellbeing" imposed on them);
2. the "effects of trade competition" are excluded[160] from consideration of proposed resource consents effects. This is poor drafting in the statute. It is the effects on trade competitors which should be excluded for consideration. On the whole the effects of trade competition are social goods;
3. however, the Supreme Court has ruled that the more remote social and cultural effects of new shopping centre proposals on existing ones can be taken into account. Blanchard J wrote for the majority in *Westfield (New Zealand) Ltd v North Shore City Council:*[161]

> [120] The Court of Appeal considered that only "major" effects needed to be considered, since only then would the effect on environment be more than minor, in terms of s 94(2)(a). But in equating major effects with those which were "ruinous", the Court went too far. A better balance would seem to be achieved in the statement of the Environment Court, which Randerson J adopted, that social or economic effects must be "significant" before they can properly be regarded as beyond the effects ordinarily associated with trade competition on trade competitors. It is of course necessary for a consent authority first to consider how trading patterns may be affected by a proposed activity in order that it can make an informed prediction about whether amenity values may consequentially be affected.

7.3 Effects on safety

- explosives – see *Orica* discussed above;
- jet boats: *Kawerau Jet Services Holdings Ltd v Queenstown Lakes District Council*;
- helicopters: *ZJV (NZ) Ltd v Queenstown Lakes District Council*.[162]

7.4 Noise effects

- wind farms: *Palmerston North City Connect v New Zealand Windfarms Ltd* [2014] NZCA 601; (2014) 18 ELRNZ 149;
- frost fans: *Avatar Glen Ltd v New Plymouth District Council* [2016] NZEnvC 78; [2016] NZRMA 292.

7.5 Odours

[127] A full and careful decision of odour questions from commercial mushroom growing is found in *Waikato Environmental Protection Society Inc v Waikato Regional Council*[163] (the New Zealand Mushroom case). The court found on the evidence:

> - … that the effect caused by chronic odour is a slowly accumulated stress which can make people subjected to the recurring odour more sensitive to it and that it is the repeated nature and accumulated effect of the odour impacts that is of primary concern;
> - The provisions of … the regional plan, … which record that an adverse odour effect may occur "from frequent incidents of lesser intensity or offensiveness";

[160] Section 104(3) RMA.
[161] *Westfield (New Zealand) Ltd v North Shore City Council* [2005] NZSC 17; (2005) 11 ELRNZ 393 at [120].
[162] *ZJV (NZ) Ltd v Queenstown Lakes District Council*, above n 89.
[163] *Waikato Environmental Protection Society Inc v Waikato Regional Council* [2008] NZRMA 431 (NZEnvC).

- The *Good Practice Guide* which notes that low-level odour may have an adverse effect even though no single odour event considered in isolation could reasonably be assessed as objectionable or offensive.

[128] The applicant submitted that individual "odour events" were not cumulative.[164] The court referred to the dictionary definition of "cumulative" as meaning:[165]

> The term "cumulative" means "increasing or increased by successive additions".[166]

[129] It then held:

> Whether or not a series of individual odour discharges can have a cumulative effect so that each new odour event increases the overall effect of the discharges is, in our view, to be determined by the Court as a matter of fact. It is undisputed that the odour discharges have continued over a period of time and will continue to do so. We are of the view that the impact of each effect may be assessed in combination with other similar effects (i.e. other preceding odour discharges). The rationale for NZ Mushrooms' submission would apply to any ongoing intermittent event. If the effects of such events must be measured in isolation from each other, with no regard to their frequency and ongoing component, as the applicant contends, the concept of cumulative effect would become largely meaningless.

That is a straightforward example of cumulative effects in the *Dye* sense.

[130] The *NZ Mushrooms* case is also an example of the application of industry guidelines. The court referred to *The Good Practice Guide for Assessing and Managing Odour in New Zealand*[167] as usefully identifying a number of factors to be considered. They are:[168]

- Frequency – how often an individual is exposed to odour;
- Intensity – the strength of the odour;
- Duration – the length of a particular odour event;
- Offensiveness/Character – the character relates to the "hedonic tone" of the odour, which may be pleasant, neutral or unpleasant;
- Location – the type of land use and nature of human activities in the vicinity of an odour source.

These are another example of how to assess a dose/stressor relationship.

7.6 Effects on tangata whenua

[131] This is a vast and specialist subject area. Recent cases include, for example: *Te Runanga O Ngai Te Rangi Iwi Trust v Bay of Plenty Regional Council*[169] (spiritual effects should be taken into account) confirmed on appeal in *Ngati Ruahine v Bay of Plenty Regional Council*,[170] and *Wakatu Inc v Tasman District Council*.[171] Also worth attention

[164] *Waikato Environmental Protection Society Inc v Waikato Regional Council* [2008] NZRMA 431 at [166].
[165] *Waikato Environmental Protection Society Inc v Waikato Regional Council* [2008] NZRMA 431 at [166].
[166] *Compact Oxford English Dictionary.*
[167] *The Good Practice Guide for Assessing and Managing Odours in New Zealand* (2003) Ministry for the Environment.
[168] Table 2.1, *Good Practice Guide.*
[169] *Te Runanga O Ngai Te Rangi Iwi Trust v Bay of Plenty Regional Council* [2011] NZEnv C 402.
[170] *Ngati Ruahine v Bay of Plenty Regional Council* [2012] NZHC 2407; [2012] NZRMA 523.
[171] *Wakatu Inc v Tasman District Council* [2012] NZRMA 363.

may be the slightly older decision of *Ngati Hokopu ki Hokowhitu v Whakatane District Council.*[172]

[132] There is also a very interesting and thought-provoking section on the Environment[173] in the aptly titled "Lex Aotearoa: An Heroic Attempt to Map the Māori Dimension in Modern New Zealand Law" by Justice Joseph Williams.

7.7 Heritage

[133] *Lambton Quay Properties Nominee Ltd v Wellington City Council*[174] ("Lambton Quay") concerned an application to demolish the Harcourts building (built 1928) in Lambton Quay. The building had a "B" classification under the Historic Places Act 1980. The court summarised[175] the position as follows:

> [99] The principal positive effect of demolition would be the resulting opportunity to build on the site a larger, more functional and more profitable building, but attempting to bring that within the matters reserved for discretion would be dubious at best.
>
> [100] If it is not to be demolished, then until such time as it is strengthened to an acceptable seismic standard, there will be an adverse financial effect on the owner, because the building is unable to pay its way, let alone produce a return on the funds invested in it. For so long as it remains unstrengthened, the absence of, or at least the very significant lessening of, a reasonable financial return will continue, together with the further adverse effect of the risk it poses to life, limb and other property in the event of a major earthquake.
>
> [101] The principal adverse effect of demolition would be the loss, forever, of the heritage values the existing building has, and its contribution to amenity and the streetscape, of which it is said to be a significant part.

[134] The court held that the current market value was nil, but the current redevelopment value if the building was demolished was $3.1 million. Despite that the court declined demolition. It held that the financial issue was not sufficient reason, on its own, to justify that course. The building had high heritage values; its exterior was original and in good shape. The district plan and s 6 RMA required the alternatives to be exhaustively excluded.

7.8 Direct "nuisances"

[135] There is no space here to deal with other direct "nuisances" such as interference with views or sunlight moving into a neighbour's "space" increasing the intensity of development and reverse sensitivity effects.

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172 *Ngati Hokopu ki Hokowhitu v Whakatane District Council* (2002) 9 ELRNZ 111 (NZEnvC).

173 J Williams "Lex Aotearoa: An Heroic Attempt to Map the Māori Dimension in Modern New Zealand Law", (Harkness Henry Lecture 2013) (2013) 21 Waikato Law Review (Taumauri) 1 at 17-23.

174 *Lambton Quay Properties Nominee Ltd v Wellington City Council* [2013] NZEnvC 238; [2013] NZRMA 39.

175 *Lambton Quay Properties Nominee Ltd v Wellington City Council* [2013] NZEnvC 238; [2013] NZRMA 39 at [99]-[101].

8. Natural hazards and the effects of climate change

8.1 Natural hazards

[136] The local authorities have a function of controlling the use of land so as to avoid or mitigate natural hazards.

[137] One specific control which is often overlooked is a specific power relating to subdivision. Section 106 of the RMA states (relevantly):

> **106 Consent authority may refuse subdivision consent in certain circumstances**
>
> (1) A consent authority may refuse to grant a subdivision consent, or may grant a subdivision consent subject to conditions, if it considers that—
>
> (a) the land in respect of which a consent is sought, or any structure on the land, is or is likely to be subject to material damage by erosion, falling debris, subsidence, slippage, or inundation from any source; or
>
> (b) any subsequent use that is likely to be made of the land is likely to accelerate, worsen, or result in material damage to the land, other land, or structure by erosion, falling debris, subsidence, slippage, or inundation from any source; or
>
> (c) sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision.
>
> …

[138] There are no cases yet on what "likely" means in s 106. In a decision about s 6(c) Official Information Act 1982 Cooke P wrote for the Court of Appeal that the word "likely" does not mean an event must be more likely than not to occur. Instead, it must be enough if there is "a serious or real and substantial risk".[176] It is interesting that in that specific (different) statutory context the Court of Appeal was prepared to give a slightly forced (and low threshold) meaning rather than the ordinary meaning represented in the IPCC scale (60% to 75%).

8.2 The effects of climate change

[139] Climate change is defined as:[177]

> ***climate change*** means a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

"The effects of climate change" are a matter to which particular regard is to be had: s 7(i) RMA. What those effects are is not defined. Note that it is the effects 'of' climate change, not the effects 'on' climate change.

[140] For the specific s 104E RMA on <u>not</u> having regard to the effects of discharges <u>on</u> climate change, see *West Coast ENT Inc v Buller Coal Ltd.*[178] The Supreme Court majority confirmed that those effects were removed from the scope of the RMA in general by the 2004 Amendments.

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176 *Commissioner of Police v Ombudsman* [1988] 1 NZLR 385 (CA).
177 Section 2 RMA.
178 *West Coast ENT Inc v Buller Coal Ltd* [2013] NZSC 87; [2014] 1 NZLR 385; [2014] NZRMA 133.

[141] The scientific consensus is that (human-caused) climate change has caused sea levels to rise around New Zealand by approximately 20 centimetres over the last century. If that was asserted before a local authority (and disputed) it would need to be proved on the balance of probabilities because it is a matter of (past) fact.

[142] But of course in most situations under the RMA we are concerned not so much with the past as with predictions (often using projections) as to the future. Depending on the alleged consequences it is open to a local authority to 'find' or predict that (anthropogenic) climate change is an effect of low probability but high potential impact. In this case the "balance of probabilities" is as we saw earlier, irrelevant.

[143] Further, if we look at Figure 4 (the IPCC predictions from the Fourth Report) we see that they believe there is a very high probability that the sea level will be above the minimum rise of about 50 centimetres (in the "very high greenhouse gas emissions scenario") by 2100; and even more relevant is that thereafter the curve is rising steeply.

Weather Patterns

[144] In her PCE 2015 report Dr Wright identified three changes:[179]

> *Rainfall*
>
> As the atmosphere warms, it can hold more moisture – about 7% for every 1ºC increase in temperature.[180] As the climate changes, both the distribution of rainfall across New Zealand and its intensity are projected to change.
>
> Rainfall is projected to increase in the west of both islands and in the south of the South Island. Northland and eastern regions of both islands are projected to become drier.[181] It is also projected that heavy downpours will become more extreme.[182]
>
> Increases in the amount and intensity of rainfall in some catchments raise the risk of river flooding. Areas close to river mouths can experience the 'double whammy' of river flooding coinciding with the sea pushing its way upriver at high tide. As high tides become higher because of sea level rise, such floods will become more likely.[183]
>
> *Winds*
>
> The duration and intensity of winds drives the power of waves. As circulation patterns in the atmosphere change, westerly winds are projected to become more prolonged and more intense in New Zealand, especially in Winter.[184]
>
> Increased winds would lead to larger waves breaking on the shores of the west coasts of both islands.[185]
>
> *Storms*

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179 *Preparing NZ for rising seas: Certainty and Uncertainty*, (2015) Parliamentary Commissioner for the Environment at p 22.

180 For more information, see IPCC, 2013, Working Group 1, Chapter 3, p 269.

181 IPCC, 2014, Working Group 2, Chapter 25, p 1380. The IPCC states with a 'medium' level of confidence. Changes in rainfall are expected to be more pronounced in winter.

182 IPCC, 2014, Working Group 2, Chapter 25, p 1380. The IPCC states with a 'medium' level of confidence that most regions of Australasia are likely to experience an increase in: *"the intensity of rare daily rainfall extremes …. And in short duration (sub-daily) extremes".*

183 Changes in rainfall will also affect the amount of sediment washed down rivers. This will change the amount of sediment carried by longshore currents and, in turn, affect erosion and accretion along coastlines (see Chapter 4). In some coastal areas, the water table will be pushed upward by the rising sea, increasing the risk of flooding from heavy rainfall (see Chapter 5).

184 IPCC, 2014, Working Group 2, Chapter 25, p 1381. The IPCC has made this projection with a 'medium' level of confidence.

185 McGlone *et al.*, 2010, p 89.

> As the atmosphere becomes warmer, storm patterns are likely to change. Storm surges ride on top of the sea and can be driven on to land by wind – their impact will be increased by sea level rise.
>
> It is projected that cyclones that form south of New Zealand in winter will become more intense, leading to stronger winds and larger waves on shore exposed to the south. It is also projected that the intensity of cyclones elsewhere in the country will decrease.[186]

The Cases

[145] There have been a number of cases in the Environment Court since 2004. We will look at three. First, *Kotuku Parks Ltd v Kapiti Coast District Council*[187] shows how different natural hazards cause effects that may accumulate. The decision describes how an engineer had assessed safe building levels for the proposed subdivision based on achieving the minimum level required for protection from flooding from the Waikanae River and the sea, in two scenarios:

> The first was a 1% annual probability flood-event in the river coinciding with a 5% annual probability storm sea-surge event (including a 200-millimetre allowance for future sea level rise).
>
> The second was a 1% annual probability storm sea-surge event, with a similar allowance for future sea-level rise.
>
> It was on consideration of those cases that [the engineer] had adopted the minimum building platform level of 3.4 metres RL on which the subdivision development had been designed. That allowed a freeboard for contingencies of 0.75 metres. The District Council had recommended 3.6 metres RL for roads, and 3.8 metres RL for houses, and Kotuku Parks Ltd had accepted those greater safety factors as the design levels.

[146] Second, in *Gallagher v Tasman District Council*[188] a proposed plan change to the Tasman District Plan ("PC22") sought to impose controls on subdivision and development of land at risk from hazards of coastal erosion, stormwater inundation and seawater inundation, to give effect,[189] to Objective 5 and Policy 25 of the New Zealand Coastal Policy Statement 2010. The court was satisfied that the risk scenario identified by expert evidence was a "sufficiently realistic possibility" to justify the imposition of the PC22 controls.

[147] The appellants owned land inside a 4.5 metre high revetment along the Ruby Bay coast. The court recorded[190] a National Institute of Water and Atmospheric Research ("NIWA") report which showed a 1% Annual Exceedance Probability Event ("AEP") would:[191]

> … vary from an event with a maximum wave height of about 3.9 metres and no storm tide elevation (relative to NVD-55) to one with no wave height and a storm tide elevation of 2.75 metres, as well a range of combinations of these heights … in between.

[148] The parties agreed that[192] (relevantly):

- the planning horizon should be to the year 2115;

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186 IPCC, 2014, Working Group 2, Chapter 25, p 1381. The IPCC has made this projection with a 'medium' level of confidence.
187 *Kotuku Parks Limited v Kapiti Coast District Council* (NZEnvC) Decision A73/2000, 13 June 2000.
188 *Gallagher v Tasman District Council*, above n 31.
189 Under s 75(3)(b) RMA.
190 *Gallagher v Tasman District Council*, above n 31.
191 *Gallagher v Tasman District Council*, above n 31, at [54].
192 *Gallagher v Tasman District Council*, above n 31, at [57].

- the estimates of SLR from climate change should be 0.45 metre in 2065 and 1.0 metre in 2115.

[149] The Environment Court recorded[193] that the witnesses

> … all agreed that a conservative approach should be adopted in assessing the hazard risk from coastal inundation induced flooding on the Gallagher property

and then stated:

> For a 2115 1% AEP event with 1m of SLR, we have decided that Mr Reinen-Hamill's 242 l/s/m overtopping rate should be adopted as the *best fit* from all of the evidence which we heard. We consider that it is a realistic possibility.

[150] Third, the Auckland Unitary Plan Independent Hearings Panel ("the Hearings Panel") in its *Report to Auckland Council Hearing topics 022 Natural hazards and flooding and 026 General – others July 2016* expressed the issue in relation to coastal inundation and sea level rise as:

> What degree of risk relating to coastal inundation and sea level rise should the Unitary Plan address?

[151] Its recommendations were in full:[194]

> The Panel recommends that the Plan provisions should deal with coastal inundation and associated sea level rise on the basis of a projected 1 metre sea level rise within 100 years (i.e. to 2115). This is consistent with Policy 25 of the New Zealand Coastal Policy Statement.
>
> The Panel recommends that the Unitary Plan provisions should deal with the 1 per cent annual exceedance probability (AEP) coastal storm tide event plus the 1m projected sea level rise. The Panel accepts that this issue is not affected by the issues relating to the Building Act 2004 and the Building Code referred to above and discussed in section 5.3 of the Overview because the scope of the building regime does not extend to managing land use in terms of the anticipated effects of climate change.
>
> The Panel does not recommend including maps showing a 2m sea level rise or as any basis for rules in the Unitary Plan. That potential rise in sea level is presently considered unlikely to occur within 100 years and is therefore beyond the planning horizon identified in the New Zealand Coastal Policy Statement.

[152] First, without being unkind to the Hearings Panel which was working under immense pressure, the NZCPS says "… at least 100 years".[195] That may be important because if we look at the IPCC figure[196] and extrapolate for 2100 to 2130 in each decade we find the curve is steepening sharply even if we only start with the median figure of 89 cm rise by 2100.

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193 *Gallagher v Tasman District Council*, above n 31, at [95].

194 Auckland Unitary Plan Independent Hearings Panel, *Report to Auckland Council Hearing Topics 022 Natural Hazards and flooding and 026 General-others.*at para 7.2.

195 New Zealand Coastal Policy Statement 2010 Policy 24.

196 Above n 97, Figure 4.

9. Risk management

9.1 Permits for managing effects *versus* taxes

[153] It is worth considering the general policies for controlling effects where the effects are pollutants. In his book *The Carbon Crunch* Professor Dieter Helm gives an instructive example:[197]

> … Suppose, for example, that the price of mercury pollution in a river is fixed on the basis of an estimate of how much pollution factories along its banks might discharge at the fixed price. Now suppose that the estimates turn out to be wrong, and they discharge more into the water than expected. Mercury is very poisonous, so a bit more pollution would have very serious consequences. It therefore matters more in this case that we can be certain about how much mercury they will emit than worrying too much about the price. The damage function is a very steep curve. This would be a case for strict permits. And we should go for tradable permits, or even an outright ban. Taxes would at best be inappropriate, and at worst might lead to dangerous mistakes.

[154] Dr Helm continued with a different, more important, pollutant – carbon:[198]

> … Now consider climate change. Suppose we estimate that a certain amount of carbon will be emitted from our cars, heating systems, power stations and factories. But then suppose again we get our estimates wrong, and a bit more or a bit less is in fact emitted. It will not make much difference to climate change – a few more or less tones of carbon are neither here nor there. Now suppose we nevertheless went for permits and fixed the quantities, and it turned out that we had underestimated the costs of reducing emissions. The extra costs might be large, especially in the short run – for example, if new nuclear power stations have cost overruns, or wind turbine costs do not fall as much as some predict. In this case, we should therefore care more about getting the costs wrong than the quantity, at the margin. Hence, to be certain about the costs, we should fix the price, and worry less about the precise level of emissions that will result.

[155] *The Carbon Crunch* concluded[199] on this point:

> … These cases illustrate a general policy recommendation: fix the quantity when the slope of the damage function is steep relative to that of the cost function; fix the price when the cost function is steep relative to the damage function.[200] Which one is carbon? The answer is that it is likely to be the latter, and hence a carbon tax is better than a permits scheme.

[156] Professor Helm's analysis – which is much richer and more detailed than there is space for here – suggests that New Zealand may be getting it badly wrong in relation to two important sources of pollution:

- carbon – where we use a (nearly defunct) Emissions Trading Scheme;
- water pollution – where it appears all regional councils use a permit scheme[201] rather than taxes.

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197 D Helm *The Carbon Crunch* (2012) Yale UP First edition p 181.

198 D Helm, above n 197.

199 D Helm, above n 197.

200 Dr Helm's footnote states: For an excellent summary of the arguments see Hepburn, C. Regulating by Prices, Quantities or Both; An Update and Overview. *Oxford Review of Economic Policy,* 22(2), 2006, pp 226-247. For the classic treatment of the choice between prices and quantities see Weitzman, M L. Prices vs Quantities. *Review of Economic Studies,* 41, 1974, pp 477-491.

201 Under s 14 RMA.

9.2 Reversibility

[157] In *Ravensdown Fertiliser Co-operative Ltd v Otago Regional Council*[202] the court consented to the ongoing operation of a long-standing fertiliser works even though it would continue to emit hydrogen sulphide odours. In that case the court considered that the extent of the rotten egg smell would not be so noticeable and unpleasant that a significant adverse effect could reasonably be said to exist as regards Ravendown residents. The court also signalled that if its expectations about there being no significant adverse effects were shown to be wrong then the matter would have to be revisited in so far as the installation of expensive scrubber equipment was concerned.

9.3 Adaptive management

[158] The *Ravensdown* approach has developed into a more sophisticated technique for managing adverse effects called "adaptive management". The International Union for Conservation of Nature and Natural Resources ("IUCN") has issued guidelines on the application of the precautionary principle[203] which includes a guideline on using an adaptive management approach. Adaptive management includes the following core elements:[204]

(a) monitoring of impacts of management or decisions based on agreed indicators;

(b) promoting research, to reduce key uncertainties;

(c) ensuring periodic evaluation of the outcomes of implementation, drawing of lessons and review and adjustment as necessary, of the measures or decisions adopted; and

(d) establishing an efficient and effective compliance system.

[159] In *Clifford Bay Marine Farms Ltd v Marlborough District Council*,[205] the Environment Court granted a resource consent for a marine farm in Clifford Bay. It summarised the position as being:

> The two options open to us are to decline consent, or to grant it in such a way that if any adverse effects on the use Hector's dolphin make of the habitat arise, they are limited, and measures to reverse them speedily can be implemented. The probability of undetected adverse effects of significance occurring unrelated to, and unaccompanied by, other existing adverse effects are of sufficiently low probability that they should not lead us to decline the application altogether.

It imposed conditions about preliminary baseline monitoring and for adaptive management. The decision was overturned by the High Court, but it now appears that the Supreme Court understands and endorses – what the Environment Court was trying to do to manage risk – see *Sustain Our Sounds Inc v New Zealand King Salmon Co Ltd*[206] (*"SOSI"*).

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202 *Ravensdown Fertiliser Co-operative Ltd v Otago Regional Council* (NZEnvC) Auckland A86/99, 20 August 1999.

203 International Union for Conservation of Nature "Guidelines for applying the precautionary principle to biodiversity conservation and natural resource management" (as approved by the 67th meeting of the IUCN Council 14-16 May 2007) [IUCN Report].

204 IUCN Guideline 12.

205 *Clifford Bay Marine Farms Ltd v Marlborough District Council* (NZEnvC) C131/2003 (22 September 2003) at [157].

206 *Sustain Our Sounds Inc v New Zealand King Salmon Co Ltd* [2014] NZSC 40; [2014] NZLR 673; [2014] NZRMA 421; (2014) 17 ELRNZ 520.

[160] In Crest Energy Kaipara Ltd v Northland Regional Council, the Environment Court said, as summarised in Sustain Our Sounds Inc v New Zealand King Salmon Co Ltd:[207]

> … that it is important in such plans for baseline knowledge to be collected on which management plans can build in "an on-going and cycling process". Plans should set reasonably certain and enforceable objectives, plan and design a process for meeting those objectives, establish a monitoring regime and a process for the evaluation of monitoring results leading to the review and refinement of hypotheses. After that point the process will often start again at the design and planning level.
>
> [Footnotes omitted]

[161] An often quoted case from New South Wales is *Newcastle & Hunter Valley Speleological Society Inc v Upper Hunter Shire Council,*[208] a case involving consent for a limestone quarry, where Preston C J said that:

> Adaptive management is not a "suck it and see", trial and error approach to management, but it is an iterative approach involving explicit testing of the achievement of defined goals.

[162] In *SOSI* the Supreme Court quoted and discussed[209] the references above and then stated that there are two questions[210] to be answered:

> … [First] what must be present before an adaptive management approach can even be considered and [second] what an adaptive management regime must contain in any particular case before it is legitimate to use such an approach rather than prohibiting the development until further information becomes available.

[163] Giving the judgment of the Supreme Court, Glazebrook J elaborated:[211]

> As to the threshold question of whether an adaptive management regime can even be considered, there must be an adequate evidential foundation to have reasonable assurance that the adaptive management approach will achieve its goals of sufficiently reducing uncertainty and adequately managing any remaining risk. The threshold question is an important step and must always be considered. As Preston CJ said in *Newcastle*, adaptive management is not a "suck it and see" approach.[212] The Board did not explicitly consider this question but rather seemed to assume that an adaptive management approach was appropriate. This may be, however, because there was clearly an adequate foundation in this case.

[164] Basically, as Dr Reisinger will discuss, there are advantages in managing uncertainty through adaptive pathways because these reduce the pressure to make binary (0-1) decisions.

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207 *SOSI*, above n 206 at [115].

208 *Newcastle & Hunter Valley Speleological Society Inc v Upper Hunter Shire Council* [2010] NSWLEC 48 at [184].

209 *SOSI*, above n 206 at [113].

210 *SOSI*, above n 206 at [124].

211 *SOSI*, above n 206 at [125].

212 Referring to *SOSI* at [121] and adding: "See also the comments of Tremblay-Lamer J quoted at [123] above; the explicit consideration of the two options in *Clifford Bay Marine Farms Ltd v Marlborough District Council*, above n 199, at [113]; and the threshold question discussed in *Crest Energy Kaipara Ltd v Northland Regional Council*, ..., at [229]".

9.4 Environmental compensation (offsetting effects)

[165] A topic we do not have time or space to consider is that of environmental compensation:

> *J F Investments Ltd v Queenstown Lakes District Council*[213]
>
> *Mount Field Ltd v Queenstown Lakes District Council*[214]

This is another issue which needs to go to a higher court for resolution.

[166] Doubt was thrown on the concept of environmental setoffs and/or compensation in Royal Forest and Bird Protection Society of New Zealand Inc v Buller District Council (No 2).[215]

10. Weighing the effects

[167] In all prospective decisions under the RMA there is a 'weighing' exercise in which positive effects of activities/hazards/climate change have to be put into the scales and weighed against the negative effects, together with other matters prescribed by the RMA or by plans and other instruments under it. Ultimately that weighing exercise is usually a subjective exercise, but it can have an objective component if all the consequences can be monetised (which may be possible in simpler cases). That can even be decisive where s 6 and s 8 are not involved.

[168] The analysis for preparation of district plans is described in s 32 and is too complex to go into here, so the concluding remarks will be confined to the resource consent situation.

[169] That objective component to the weighing of the risk of effects is given in s 7(b) RMA which requires particular regard to be had to:

> (b) The efficient use and development of resources.

[170] Efficiency is a relative concept. It is therefore important that the benefits and costs of a proposed activity are compared with:

- the benefits and costs of the status quo and/or
- the benefits and costs of other uses of the relevant resource(s) as sought by the relevant (operative) district or plan.

Note that if there are two comparisons for the proposal so that there are three altogether we need to speak of the best of the options. That is purely a grammatical use of better/best terminology as a simple alternative for more efficient.

[171] In *Marchant v Marlborough District Council*[216] the court wrote:

> [200] It is, in theory, straightforward to calculate the net benefit of the two possible options open for the use (or protection) of the water space where each mussel farm is proposed to be located. The net benefit of the marine farm should be compared with the net benefit of the water space if empty of the farm. The latter benefit is more than zero

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213 *J F Investments Ltd v Queenstown Lakes District Council* (NZEnvC) C48/2006.
214 *Mount Field Ltd v Queenstown Lakes District Council* [2012] NZEnvC 262.
215 *Royal Forest and Bird Protection Society of New Zealand Inc v Buller District Council (No 2)* [2013] NZHC 1346; [2013] NZRMA 293.
216 *Marchant v Marlborough District Council* [2012] NZEnvC 72 at [200].

> because the water space has financial value for fishermen, social value for recreationalists, and is part of the district's environmental capital. There are three sets of persons affected by the use or protection for the water space : producers (i.e. the mussel farmer), consumers (mussel eaters or exporters), and third parties affected by externalities. The latter can be positive (improved fishing around the mussel farm) or negative (loss of natural quality of the coastal environment). Then, adopting the formula stated in *Memon v Christchurch City Council* the court, or the local authority at first instance, can ascertain the net benefit of the marine farm as follows:
>
> Nb (farm = ps + cs + pe – ne
>
> where:
>
> nb (farm) = net benefit of a marine farm
>
> ps = producer surplus
>
> cs = consumer surplus
>
> pe = positive externalities
>
> ne = negative externalities.

[172] See the rather compelling argument by Michael Pickford in "Economic Efficiency and the RMA"[217] that consent authorities, or at least the Environment Court, may have been leaving out some important producer's costs.

[173] Lawyers have to be careful that their prejudices[218] against figures do not blind them to the power and utility of CBA. As Professor Cass Sunstein – a professor at Harvard and senior advisor to President Obama – wrote in *Risk and Reason*:[219]

> … Some people think of cost-benefit analysis as a form of cold, barely human calculation, treating health and life as mere commodities and envisioning government as some kind of huge maximising machine. On the contrary, I urge that cost-benefit analysis should be seen as a simple pragmatic tool, designed to promote a better appreciation of the consequences of regulation. A government that uses cost-benefit analysis is certainly entitled to consider who is helped and who is hurt.
>
> …
>
> Properly understood, cost-benefit analysis is no theology. It is instead an effort to assist both government and citizens, in the hope of ensuring the risk regulation will actually promote its purposes. If, for example, proposed fuel economy standards will significantly reduce greenhouse gases but also lead to smaller and less safe cars – and thus produce over a thousand extra deaths each year – officials and citizens should be aware of that fact.

He also wrote that the arguments for CBA are not simply on economic grounds but also "… as a corrective for cognitive limitations and a response to demographic need".[220]

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217 M Pickford "Economic Efficiency and the RMA" (2014) 18 NZJEL 149.

218 Does this make an (unjustified) assumption about the base rates of lawyers who are maths-phobic?

219 C Sunstein *Risk and Reason* (2002) Cambridge UP Preface ix.

220 C Sunstein *Risk and Reason* (2002) Cambridge UP p 88.

Figures