



# Environmental models, regional planning and projects: building a reliable evidence base

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BUILDING BETTER  
HOMES, TOWNS  
AND CITIES

Ko ngā wāhi Kaitiaki he  
whakamāhorahora



This presentation draws from two separate projects reported in:

Wallace, P. J. Managing model uncertainty, assumptions and limitations in Waikato Regional Council decision making - final report from legal decisions review (Client report prepared for Waikato Regional Council) (Faculty of Arts and Social Sciences, University of Waikato, 2017).

Özkundakci, D., Wallace, P., Jones, H. F. E., Hunt, S., & Giles, H. (2018). Building a reliable evidence base: Legal challenges in environmental decision-making call for a more rigorous adoption of best practices in environmental modelling. *Environmental Science & Policy*, 88, 52-62. doi:<https://doi.org/10.1016/j.envsci.2018.06.018>.

Wallace P. and White, I. 2018. Research Briefing: Revealing the impact of predictive models as decision support tools in environmental planning. Wellington: National Science Challenge, Building Better Homes, Town and Cities.

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Environmental models, regional planning and projects: building a reliable evidence base



# Models

- Predictive environmental models are commonly used as decision support tools to assist decision makers contemplate future states and actions
- Where novel technologies are employed and/or where receiving environments are not well-studied, environmental models may be the single or most influential source of expert evidence available to support a decision maker.



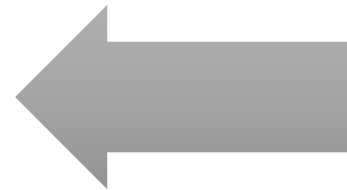
# Regional Issues

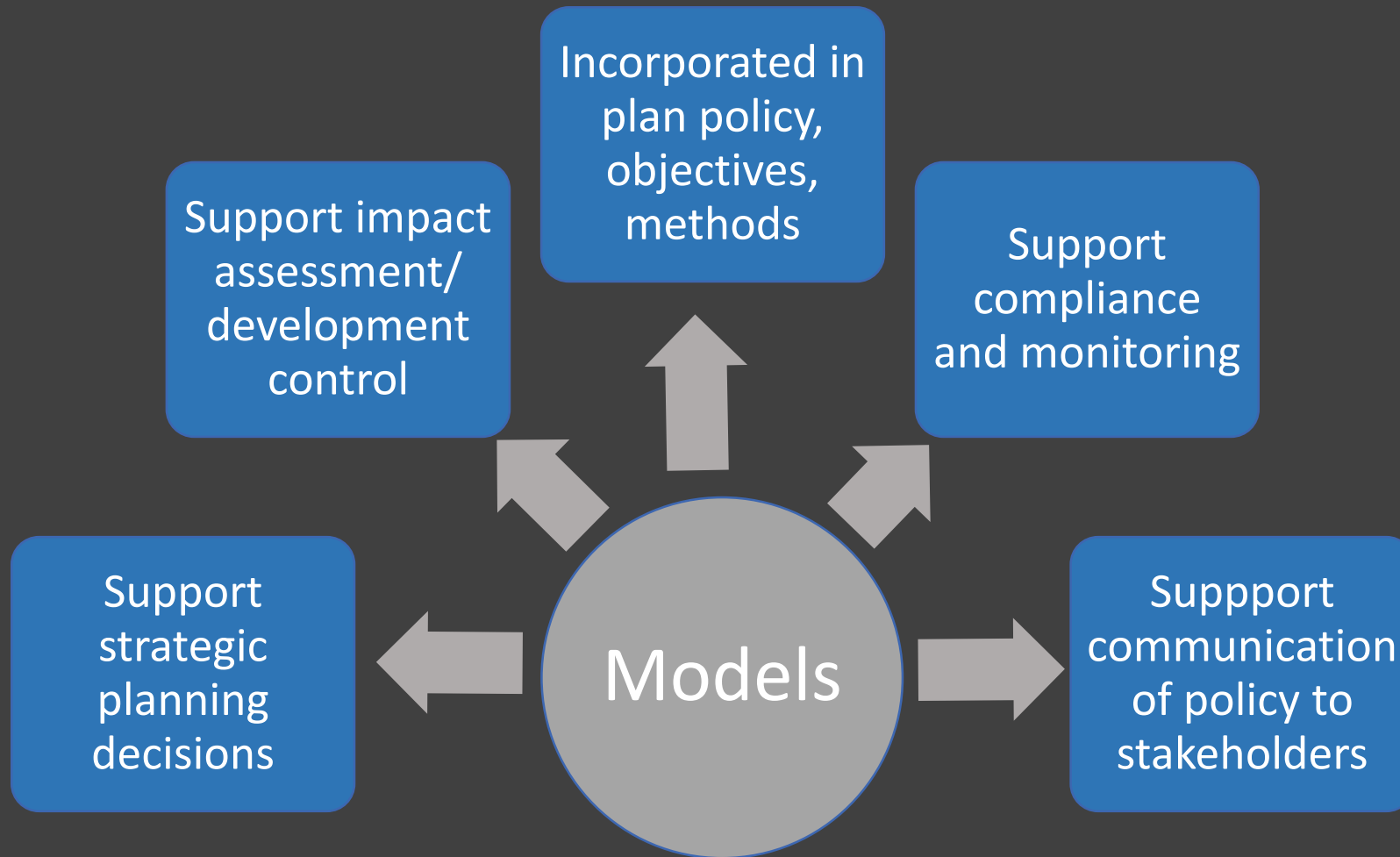
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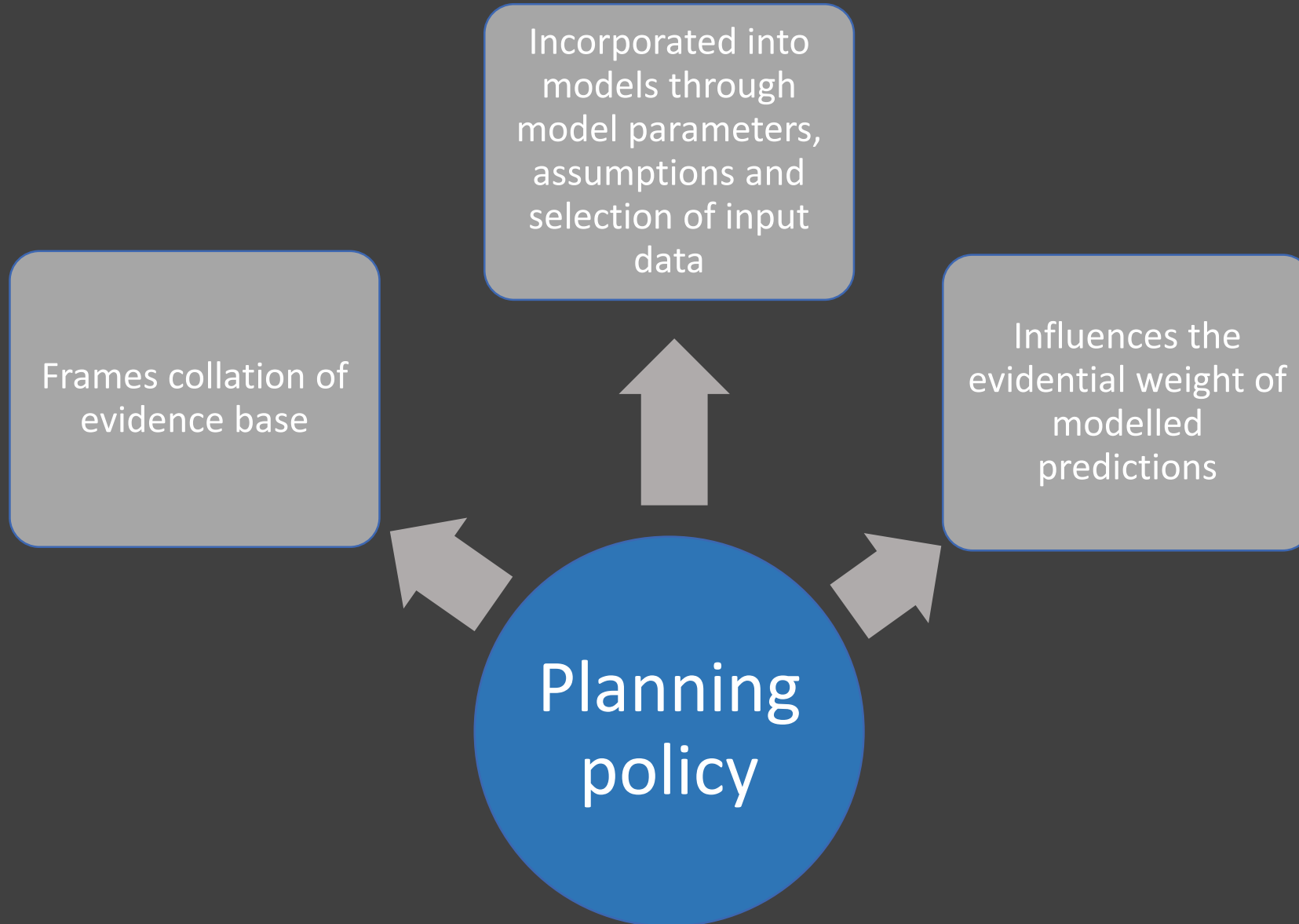
Complex  
interrelationships

Models

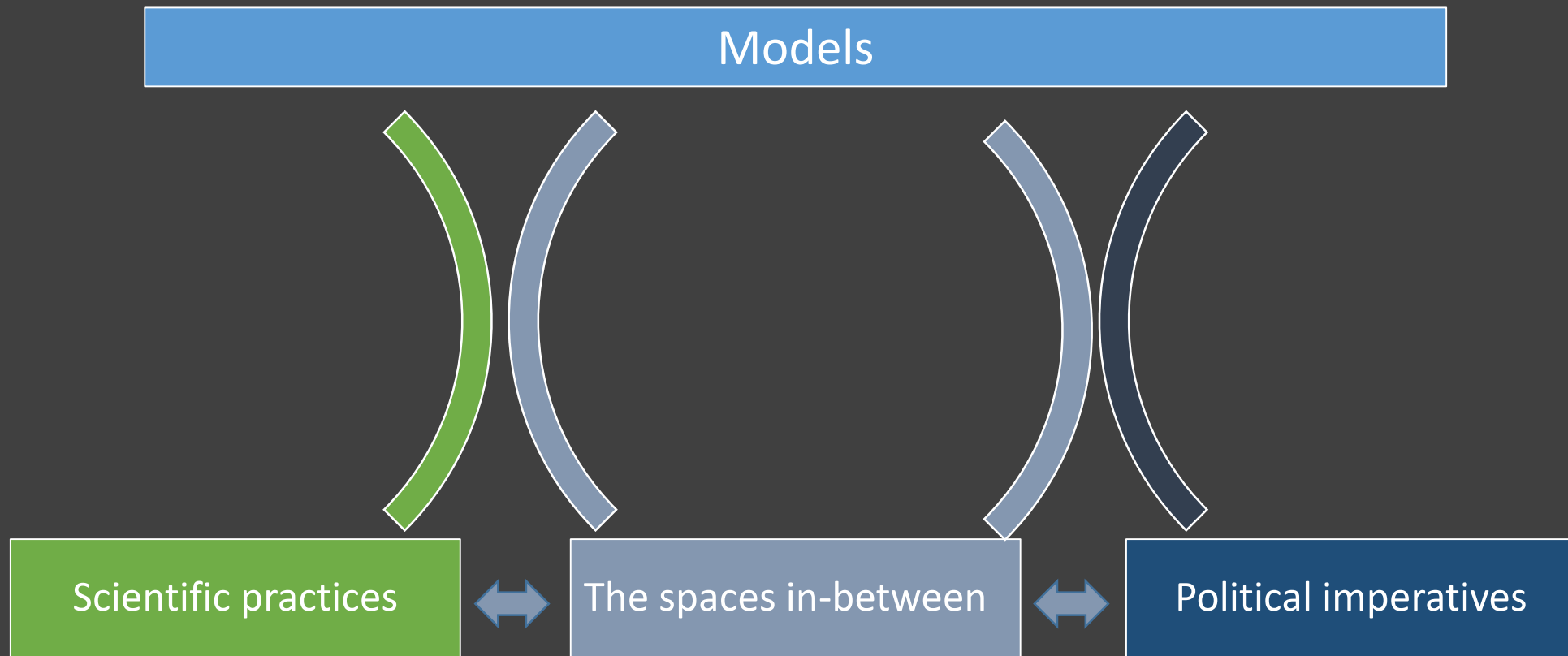
Planning  
policy







# Complex pressures across the science-policy nexus





# Law

- “...all models are wrong, but some models are useful”
  - (*Sustain our Sounds Inc. v New Zealand King Salmon Company Ltd* [2014] NZSC 40 at [132]).
- The overriding factor in the development of a sound model is whether the model when adduced in evidence is of “substantial help” to the decision maker (Evidence Act 2006).
- The key factors are the relevance, reliability and probative value of the model, each of which can be affected by process and substance flaws.



# Substantial help

- Whether or not the evidence is of substantial help will then be assessed through consideration of reliability and probative value.
- Reliability describes the extent to which a decision maker may rely upon the evidence in reaching a decision, and may be affected by various factors such as the skill and experience of the witness and the nature of scientific testing conducted, including mechanisms applied for attaining scientific rigour such as validation/corroboratorion.
- The third factor probative value can include questions of relevance and reliability, because essentially it is an assessment of the weight or value of the evidence. This is a matter for the decision maker to weigh on the facts and with regard to all the evidence.



# Method

Systematic analyses of recent decisions of NZ courts and Boards of Inquiry

The combined analyses screened in excess of 800 New Zealand environmental decisions and then analysed 85 of those decisions identified as of particular interest in terms of modelling practice.

Study framework adopted: US Environmental Protection Agency (USEPA) *Legal Aspects of Environmental Modeling* (Council for Regulatory Environmental Modeling 2009)

**Table 1**

Types of legal decisions, proceedings, activities and challenges to environmental models analysed in this study.

Type of decision maker, proceeding, activity or challenge	Number of decisions	Percentage of decisions
<i>Decision maker</i>		
Environment Court	44	65%
Environmental Protection Authority	13	19%
High Court	5	7%
Court of Appeal	4	6%
Supreme Court	2	3%
<i>Type of legal proceedings</i>		
RMA consent appeals	29	43%
RMA plan appeals	16	24%
Notice of requirement	8	12%
EEZ consents	4	6%
Judicial review	3	4%
Enforcement	2	3%
Miscellaneous	6	9%
<i>Type of activity or subject matter</i>		
Urban zoning	8	12%
Wind farm	6	9%
Aquaculture	5	7%
Roading	5	7%
Water take	4	6%
Marine activities (other than aquaculture and fishing)	4	6%
Geothermal activities	3	4%
Hydroelectric dam	3	4%
Subdivision	3	4%
Stopbank/spillway construction	3	4%
Discharge to water	3	4%
Fishing	3	3%
Bridge construction	2	3%
Miscellaneous <sup>a</sup>	17	25%
<i>Type of challenge made to environmental models<sup>b</sup></i>		
Substantive challenge - scientific components	56	67%
Substantive challenge - evaluation process	16	19%
Substantive challenge - model application	11	13%
Process challenge - model development process	0	0%

(Özkundakci, D., Wallace, P., Jones, H. F. E., Hunt, S., & Giles, H. 2018).

# Review findings – highlighted a range of modelling practices which may impact the quality of expert evidence

Scientific components of models	Extent of evaluative techniques applied in model development	Model application
<p>Quality of input data and associated assumptions and parameters</p> <p>Rigorous science a key modelling success factor</p>	<p>Processes of independent peer review, validation techniques, expert agreement and consistency in approach strengthen the evidence base.</p> <p>Historical success of a model of value</p>	<p>Applying a model out of context – different geographical location, different system, season, time frame or species may weaken the evidence base</p>

# Substantive challenge

## 1. Science component

- Most common form of challenge are the science components
- Challenges usually arise with one expert challenging one or more components
- Assumptions, inputs, parameters-wide variety of different examples and tend to reflect the rigour of the underlying science
- Incorrect calculations, outdated data, absent or excluded data, strongly qualitative aspects etc.





## Substantive challenge 2. Process evaluation

- Challenges to the reliability and or probative value of the model due to a lack of evaluation of the modelling process
- Verification and validation problems manifest
- First use models commonly have reduced reliability and probative value



## Substantive challenge 3. Model application

- For example when a model was applied on an area wide basis in a manner that resulted in site specific characteristics being under-estimated, or where a model for one type of fish stock was applied to another fish stock
- Model application can strongly affect relevance



# Clarity and Consistency of Key Terminology

- Make sure everyone is speaking the same language:
- e.g. theoretical housing capacity v feasible enabled housing capacity:
  - *Albany North Landowners v Auckland Council* [2017] NZHC138 at [37]

# Stepping out of the silo

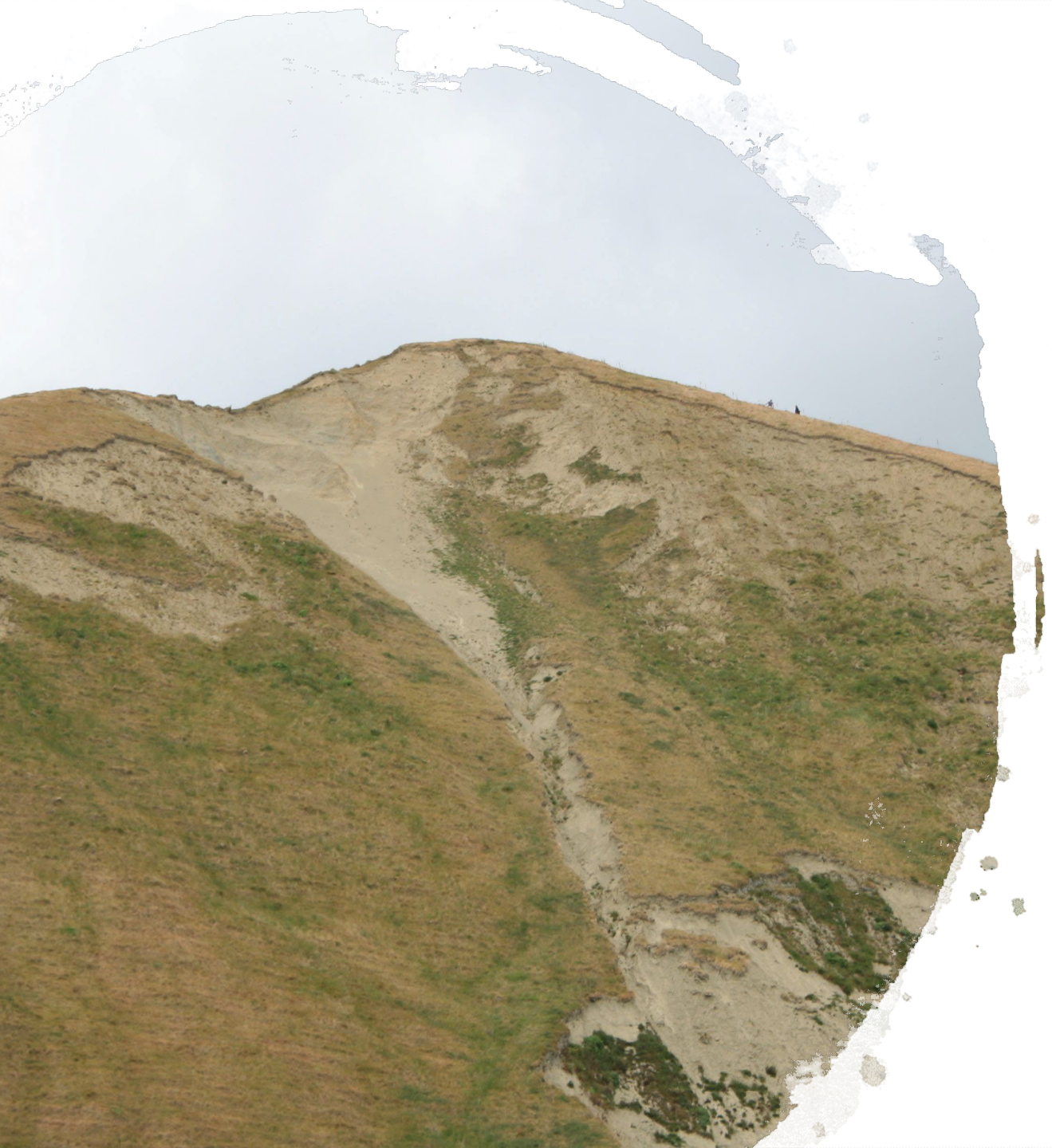
Importance of Integration

Modelled evidence should not be viewed in isolation – the need to anticipate the interconnected nature of both development and the natural and physical environment, and potential for cumulative effects

*Okura Holdings Limited v Auckland Council*  
[2018] NZEnvC 87 at [293]

Photo credit: Ross Martin





# Models and clear policy direction

Models are inherently uncertain. If decisions are occurring in a policy vacuum, or in a weak directive environment, then predictive modelling evidence may take on greater weight in shaping outcomes.

Strong policy objectives are a good way to manage uncertainty and complexity.

Tipping the balance on uncertainty:

*Okura Holdings Limited v Auckland Council* [2018] NZEnvC 87 at [375].

# Qualitative aspects

- Models with highly qualitative elements may be less reliable and may interfere with, or supplant, the role of the decision-maker in weighing the evidence
- Problems with rendering qualitative matters into numerical models are clearly identified in the decisions, usually influencing reliability and probative value.
- Models which are inconsistent with or unconscious of policy settings may create policy by default





# Summary

- Models are highly influential decision support tools pervasive in environmental planning decisions
- Key modelling success factors which can strengthen the evidence base
  - Models can assume hidden power - reduction in qualitative assumptions and connection of model development to policy settings may avoid models assuming de facto decision-making power or interfering with the role of decision makers.
  - Models are inherently uncertain, and the policy context is strongly determinative
  - Modelled evidence should not be viewed in isolation but in the context of the wider environment, cumulative effects and the intent of the policy settings
  - When casting decisions for the future the value of predictive modelling is clear, but so too is the importance of rigorous scrutiny of the outputs and clear communication of limitations to decision makers.



# Factors which strengthen models as DST

- Adoption of best modelling practice at the outset of the development
- Rigorous science
- Careful evaluative techniques
- Awareness of policy settings in development
- Design for purpose - application for purpose
- Collaboration in design
- Careful documentation of the modelling process
- Clear communication of model limitations to users/decision makers
- Administrative practices which support consistency in adoption of best practice
- Supplementary sources of evidence