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Using mental models as a tool to understand perspectives of scientific uncertainty and effectively communicate natural hazards science advice.

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Science communication associated with natural hazards risk contains many levels of complex, interacting, uncertainties. These uncertainties arise due to variabilities between systems, lack of scientific knowledge, comprehension, incomplete information, and undifferentiated alternatives. Uncertainties also occur due to relationships, roles, responsibilities, and needs. This is compounded by the evolving nature of response needs and changing communication networks. Further, varied understanding of what scientific uncertainty is, and where it comes from, affects people's trust in and use of science advice. Thus, official guidelines, such as the International Panel on Climate Change and the World Meteorological Organisation, indicate that to communicate ethically, we should be open and transparent about any associated uncertainties. However, to communicate uncertainty effectively across diverse audiences, users, and decision-makers, we must understand and adapt to the different ways people perceive that uncertainty.

We thus conducted mental model interviews to understand perspectives of uncertainty associated with natural hazards science. Participants ranged from officials involved in decisions around natural hazards in Aotearoa NZ, through to scientists and the public. The interviews included three phases: an initial elicitation of free thoughts about uncertainty, a mental model mapping activity, and a semi-structured interview protocol to explore further questions about scientific processes and their personal philosophy of science. Two phases of data collection and analysis occurred. In phase 1, an initial qualitative analysis considering a cohort of 25 participants led to the construction of key themes, including: (a) understanding that, in addition to data sources, the 'actors' involved can also be sources of uncertainty; (b) acknowledging that factors such as governance and funding decisions partly determine uncertainty; (c) the influence of assumptions

about expected human behaviours contributing to ‘known unknowns’; and (d) the difficulty of defining what uncertainty actually is. Additional influences on perceived uncertainty were also recognised, and require further research, including: an individual’s understanding of societal factors; the role of emotions; using outcomes as a scaffold for interpretation; and the complex and noisy communications landscape.

To investigate how views on uncertainty varied with familiarity with, and experience in, science an additional 6 interviews were conducted with non-scientists. This enabled a secondary qualitative investigation in Phase 2, exploring how mental models of uncertainty varied with levels of science expertise. This considered all participants across both data collection periods (n=31). Participants were categorised across three cohorts: Scientists, Science-Literate, and Lay Public. A comparative qualitative analysis of their mental model maps identified an increase in map organisation with science experience, suggesting greater science training results in a more developed and structured mental model of uncertainty. There were also substantive differences, with Lay Public participants focused more on perceptions of control, safety, and trust, while Scientists focused more on formal models of risk and likelihood. These findings are presented to enhance hazard and risk communication, alongside the design of our interview methodology, which could be adapted for participatory and co-development research and to identify decision-relevant communication approaches.