Understanding perspectives of scientific uncertainty: informing ethical practice in hazards communication

Emma E. H. Doyle[1]*, Jessica Thompson[1], Stephen Hill[2], Matt Williams[2], Douglas Paton[3†], Sara Harrison[2], Ann Bostrom[5], Julia Becker[1]

[1]Joint Centre for Disaster Research, Massey University, NZ; [2]School of Psychology, Massey University, NZ; [3]Charles Darwin University, AUS; [4]GNS Science, NZ; [5]Evans School, U. Washington, USA. [†]Sadly passed away 24th April 2023. *e.e.hudson-doyle@massey.ac.nz

We present findings related to ethics found during a review of effective communication of model uncertainty. This led to primary research exploring people's mental models of uncertainty associated with natural hazards science with a goal to enhance audience relevant communications.

Varied understanding of what scientific uncertainties are, and where they come from, in natural hazards advice affects people's trust in and use of that advice.

>> Official guidelines (e.g., IPCC) indicate that ethically we should be open and transparent about any associated uncertainties. This enhances trust and credibility and is ethically and morally appropriate as it enhances decision-making capability.

>> However, some critics highlight communicating uncertainty may sometimes be inappropriate, it could deter action, affect risk perception, increasing worry and pessimistic judgements, introducing doubt, and reducing decision satisfaction.

>> What is the best approach? Should we communicate uncertainty or not? When is it appropriate? When isn't it? What is the most ethical way to communicate uncertainty?

Lessons from the literature on ethics (Doyle et al., 2018a)

>> Communication is "ethically acceptable only when it aims to be accessible to, and assessable, by its audiences" (Onara O'Neill, 2002 p. 350)

>> Five ethical principles for communicating science under uncertainty (Keohane et al, 2014):

1) Honesty; 2) Precision; 3) Audience Relevance; 4) Process Transparency; 5) Specification of Uncertainty About Conclusions

>> A typology system should be used to guide a scientist communicator through a process of identifying and classifying, articulating, and prioritising critical uncertainties.

>> This prevents assumptions that the statistical output provides a comprehensive account of uncertainty.

>> Example typology schemes categorise the level, nature, and sources of uncertainty (e.g., Walker et al., 2003; Kwakkel et al., 2010; Janssen et al 2005)

>> There is no "ethical principle supporting the highlighting of quantifiable aspects of uncertainty over the non-quantifiable aspects" (Keohane et al., 2014, p361)

>> Value judgements exist in methodological choices, optimization, metrics of success, problem solving, evaluations, conclusions >> stakeholders may not be aware of these inherent biases, especially as it is impossible to remove social and ethical values from forecasts (Winsberg, 2012)

>> Different disciplines have inherently different ethical standards for communicating uncertainty, e.g., science/risk assessors vs. law vs. journalism >> different priorities for communication. (Austin et al, 2015).

>> A typology needs to transparently communicate these subjective uncertainties, communicate the range of judgments, and degree of consensus or not.

>> examples exist that convey the value-ladenness of any assumptions, through scores for qualification of knowledge base, as well as the value-ladenness inherent to practical aspects, epistemic, disciplinary-bound epistemic, and socio-political issues (the social history of uncertainty) (e.g.,Janssen et al 2005; Kloprogge et al, 2011)

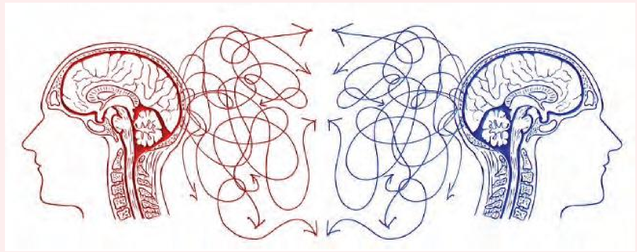
>> To be effective, scientists, communicators and other stakeholders should actively collaborate with users through

>> engagement and participatory approaches to co-develop typologies for their needs,

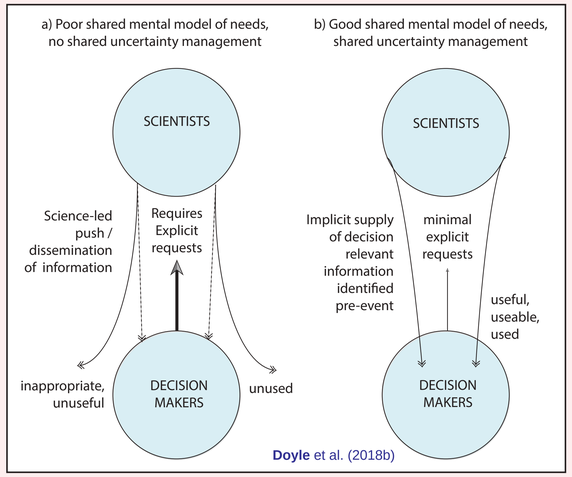
>> and working towards developing shared uncertainty management schemes.

>> A code of practice should be developed to encompass uncertainty estimation, engagement process, and translational discourse, which considers funding, leadership and diverse ethical standards, and work towards increasing tolerance of decision-making uncertainty.

Shared uncertainty management: mental models



We each have different mental models of how the world works. We can develop shared mental models through collaborative exercising and scenarios, shared experience, and engagement processes. Having a shared mental model enhances communication, whether we are communicating risk, science, uncertainty, or beyond; improving our ability to communicate in a decision-maker centred way.



Doyle et al. (2018b)

However, we have little understanding of people's initial mental models and how they understand uncertainty associated with natural hazards science.

These mental models act as a lens to interpretation. Thus, we want to understand the diversity in people's mental models of scientific uncertainty, so we can improve our communications in terms of what is said and how its framed, and ethically enhance audience relevance.

Eliciting mental models of scientific uncertainty (Doyle et al., 2023, in review)

Three-phase interviews (31 in total; in person / zoom / online whiteboard), see also Doyle et al., 2022:

1) Free thought response direct elicitation: *Define uncertainty*

2) Mental model mapping & brainstorming: T*hinking about natural hazards science, where do you think uncertainty comes from?*

3) Semi-structured: *Philosophy of science, epistemological and ontological understanding; views on effective communication*

Physical scientists, boundary and knowledge transfer scientists, social scientists, policy, planners, engineers, emergency management practitioners, legal, public, anthropologist, teacher.

>> Reflexive thematic analysis: code interviews and maps

References: Images from Pixabay

Austin et al. (2015) Environ. Law Report. News Anal, 45, 10105; **Doyle** et al. (2018a) Int. J. Disaster Risk Reduction 33, 449-476; **Doyle** et al. (2018b) Proceedings of ISCRAM Asia Pacific Conference. **Janssen et al. (2005)** Water Science and Technology, 52(6), 125–131; **Keohane** et a;. (2014) Polit. Philos. Econ. 13, 343-368; **Kloprogge** et al. Environ. Model Softw. 26, 289-301; **Kwakkel et al. (2010)** International Journal of Technology, Policy and Management, 10(4), 299-315; **Walker et al. (2003)** Integrated Assessment, 4(1), 5–17. **Onara O'Neill** (2002) Autonomy and Trust in Bioethics, Cambridge University Press. See also: **Doyle** et al. (2022) Int. J. Disaster Risk Reduction 77, 103084. And **http://tinyurl.com/doyle-papers**

Sources of Uncertainty: Theme 1, The Data

Not enough data

- Limits of science,
- Limits of technology,
- Limits of models,
- Funding
- Time constraints

Uniqueness of events

- Context: spatial, temporal
- Hazard
- Layers of complexity
- Nonreplicable unique
- Perishable observations

Interpretation of data

- Conclusions
- No one right answer
- Understanding *how* something is interpreted
- "Who's in the room"

Theme 2: The Actors

scientists

- Expertise / reputation
- Trust / qualifications / peer review
- Scientific method
- Motivations
- Litigation
- Trust in "science" vs. individuals

media

- Online variety
- Which expert?
- Conflicting advice
- Can impact receptiveness: false balance

Communication & communicators

- Salience
- Language / understanding
- Central pathway
- Meaningless numbers or statistics *"what is this 1/50? Is it in terms of timing? Is it in terms of size?"*

Theme 3: known unknowns

Range of outcomes

- Risks / consequences / outcomes
- Hazard Event: When, where, who
- Advice: What, when, to whom
- Which will be salient
- Disciplinary differences
- Ethics

Human responses

- Unknown responses
- Impact decisions
- Influence risk assessments
- Disagreements on decisions
- What gets researched

Unknowns

- Spatial, temporal specificity of knowledge
- Contexts
- Constraints
- "Within the environment of time"
- > linked to emotions

Also: >> Cross cutting influences on sources of uncertainty: Governance and funding; Communication Network; Linking to outcomes; Emotions; Time; Trust; Societal Factors

>> Sit with uncertainty "you always have uncertainty. Event the best science is uncertain" (Boundary scientist), "it encourages other scientists .... that actually improves the science" (Teacher). >> advocated for transparent reporting of advice

Effective communication of scientific uncertainty, relies upon understanding different audiences of scientific information and how their mental models develop and change over time, including their assumptions, values, perspectives, concerns, needs, and world views.

>>Be led by decision-makers perspectives and needs – decision-relevant communication.

Next: How do above themes vary amongst different audiences of science? How do we adapt communications to them? How do we increase uncertainty tolerance?

This research was supported by Massey University Research funding 2020, 2021, & 2022; and public research funding from the Government of New Zealand. EEHD is supported by the National Science Challenges: Resilience to Nature's Challenges | Kia manawaroa – Ngā Ākina o Te Ao Tūroa 2019–2024. We are forever grateful for the invaluable insights and laughter our colleague Douglas Paton shared with us as a friend and colleague. Douglas sadly passed away 24 April 2023; for tributes: **https://www.forevermissed.com/profdouglas-paton/about.**