Communicating scientific uncertainty

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Source: Fischhoff and Davis, PNAS, 2014

Communicating scientific uncertainty

- Uncertainty in scientific assessment must be
  - Characterised
  - Assessed
  - Conveyed
- Decisions

  (i) about action thresholds: Is it time to act?

  (ii) with fixed options: Which is best?

  (iii) about potential options: What is possible?

Fischhoff and Davis, 2014

Why communicate uncertainty

- Decision making involves uncertainty
  - in facts – what will happen when we make a choice?
  - in values – what do we want when we cannot have everything?

- Unless uncertainty is known
  - a DM can place too much confidence in experts and face unexpected problems
  - or a DM can place too little confidence in experts and miss opportunities and resources to collect information has been waisted

When communicate uncertainty

- Dont communicate with more or less detail than the DM need
- May require to communicate more things than are usual within a field, things that are assumed or ignored
- May require to communicate less about details academics like to discuss about
- i.e. both simplifying and complicating normal scientific discurse
- ALSO – reduce to talk about uncertainty in association to decision-relevant elements
- All uncertainty must be uncovered

How to communicate

- Characterise uncertainty
- Assess uncertainty
- Convey uncertainty – create messages that afford DM the detail that their choices warrant
- Persuasive
  - when DM wants to change other DMs behaviour
  - shading or hiding uncertainty might be justified
- Non-persuasive
  - Goal to help people to make decisions that serve their own, self-defined best interests
  - Honesty is the only policy

What to communicate

- Depends on the decision
- Decisions about action thresholds – binary decision problem YES/NO
- Decisions with fixed options – K alternatives
- Decisions about potential options – strategy A, B or C

Decisions about action thresholds

- Characterise: Uncertainty in both facts and values
- Assess: e.g. Probability of making errors
- Convey:
  - Recommend a choice
  - using clear and mutually understood terms
  - the knowledge behind (lots of data or mostly expert judgement)
  - make sure why changes in recommendations are understood

Decisions with fixed options

- Characterise:
  - Uncertainty in facts
  - which variables/parameters are most influential – identify relevant sources to uncertainty
  - Identify which way to describe uncertainty that is beneficial to the DM
  - Limitiations of the analysis
  - Identify opportunities to reduce uncertainty
- Assess:
  - Statistical method to assess variability based on data or simulation model outputs
  - Use methods to seek concensus in conclusions and uncertainty
  - Communcate accuracy of predictions (in addition to precision)
  - Use structured procedures for expert knowledge elicitation
  - Ask experts to audit input information for their vulnerability to sources of uncertainty
- Convey:
  - Make summaries of uncertainty in conclusions
  - Beware of heuristics and biases
  - Acknowledge low quality in underlying information
  - Balance precision/imprecision to the clarity for concepts used

Decisions about potential options

- What does the DM need to know to make a good decision
- Uncertainty can trigger an action
- Characterise
  - Express relevant causalities in e.g. influence diagrams
  - Identify source to uncertainty (data, models, limitations)
- Assess
  - Quantify uncertainty in input, parameters and output using e.g. probabilities and MC simulation
  - Evalute influence of assumptions
  - Summarise generic uncertainties from the problem at hand
  - Evaluate sources to uncertainty which usually are excluded (e.g. by qualitative methods, NUSAP)
- Convey
  - Make sure the DM understand how the system works (e.g. using a mental model of the domain)
  - Educate the DM so they grasp the science well enough to create and evaluate options
  - Show numbers when needed to support a claim

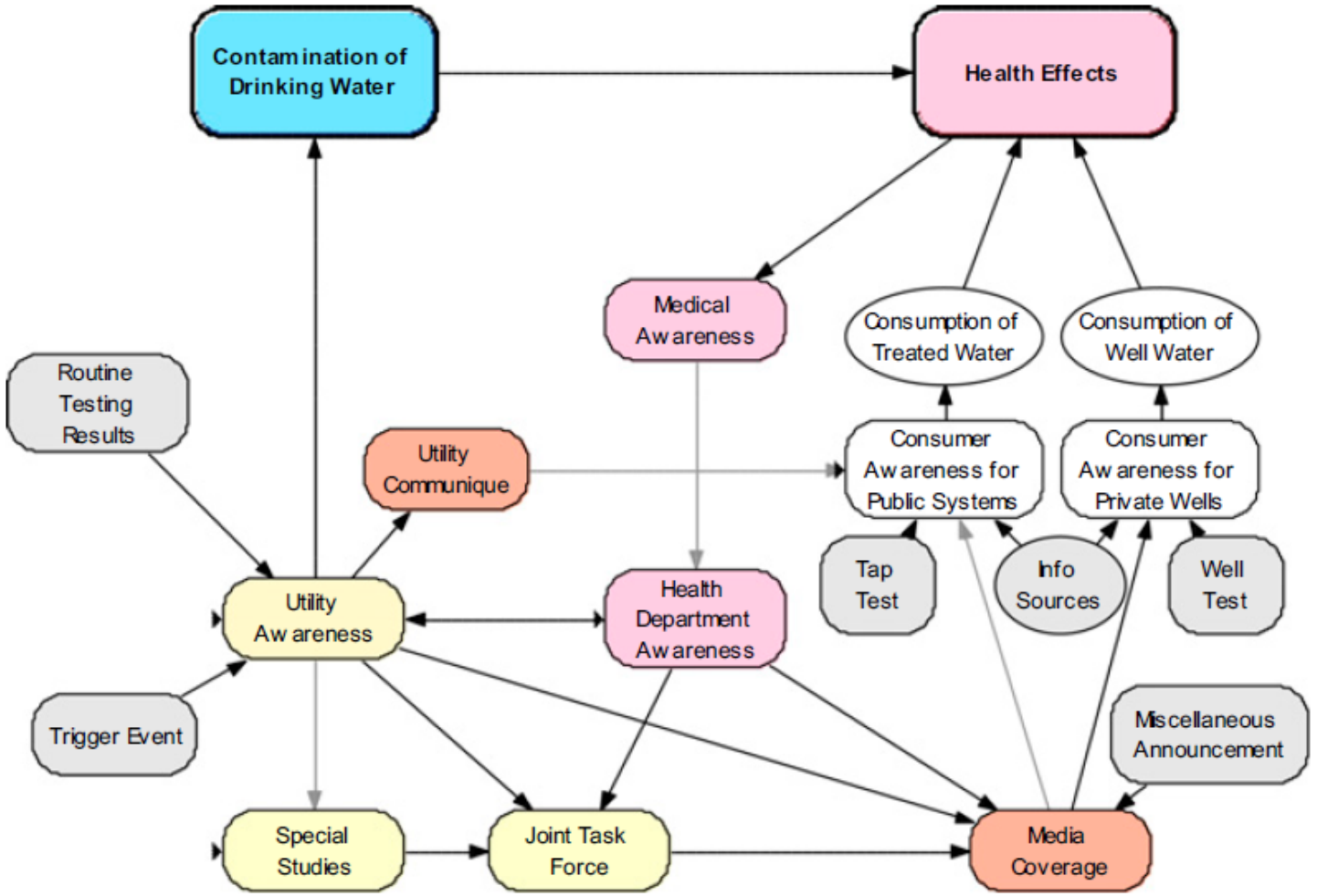

Fig. 3. Influence diagram showing the expertise needed for systematic assessment of the uncertainty in responses to drinking water contamination. (Reproduced with permission from ref. 43.)

A protocol for summarising scientific uncertainty

1. Identify key outcomes for decision makers and how to measure them
2. Summarise evariability
3. Summarise internal validity
4. Summarise external validity
5. Summarise the strenght of the basic science (e.g. NUSAP)
6. Summarise uncertainty (e.g. probability distributions or credibel intervals)

Approach uncertainty sceptisism

Table 3. Frequently asked questions addressing four concerns of scientists reluctant to express their uncertainty in credible-interval form

Concern 1	If I give credible intervals, people will misinterpret them, inferring greater precision than I intended.
Response	Behavioral research has found that most people (*i*) like receiving explicit quantitative expressions of uncertainty (such as credible intervals), (*ii*) can interpret them well enough to extract their main message, and (*iii*) misinterpret verbal expressions of uncertainty (e.g., "good" evidence, "rare" side effect). For audiences that receive the reports created with the protocol (Table 2), understanding should be greater if they receive credible intervals than if they have to infer them (63).
Concern 2	People cannot use probabilities.
Response	Behavioral research has found that laypeople can often provide reasonably consistent probability judgments if asked clear questions and extract needed information if provided with well-designed displays (41, 60, 74). Whether they do so well enough to satisfy their decision-making needs is an empirical question, which should be answered with evidence rather than speculation.
Concern 3	My credible intervals will be used unfairly in performance evaluations.
Response	Such judgments can protect experts from unfair evaluations, unjustly accusing them of having conveyed too much or too little confidence, especially when supported by the rationale for those judgments. The protocol provides such protection—if the experts' management stands behind it.
Concern 4	People do not need such judgments.
Response	Decision makers must act with some degree of uncertainty. Not helping them means preferring the risk of having them guess incorrectly over the risk of expressing oneself poorly.