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Scientific commentary: Strategic analysis of environmental policy risks—heat maps, risk futures and the character of environmental harm

G. Prpich, J. Dagonneau, S.A. Rocks, F. Lickorish, S.J.T. Pollard *

Environmental Science and Technology Department, Centre for Environmental Risks and Futures, School of Applied Sciences, Cranfield University, Bedfordshire, MK43 0AL, UK

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ABSTRACT

We summarise our recent efforts on the policy-level risk appraisal of environmental risks. These have necessitated working closely with policy teams and a requirement to maintain crisp and accessible messages for policy audiences. Our comparative analysis uses heat maps, supplemented with risk narratives, and employs the multidimensional character of risks to inform debates on the management of current residual risk and future threats. The policy research and ensuing analysis raises core issues about how comparative risk analyses are used by policy audiences, their validation and future developments that are discussed in the commentary below.

1. The policy-level analysis of environmental risk

The strategic appraisal of environmental risks within government is increasingly influential in informing debates on investment priorities, evidence-gathering and resource allocation. Strategic risk analysis in this sense refers to the high-level analysis of environmental risks captured within a policy domain. Researchers in this field encounter a number of questions posed of policy-level risk analysis: How should governments appraise the broad fields of public risk that they share responsibility for with others? What confidence do we place on the high-level analysis of policy risks given the inherent uncertainties? How should we evaluate the future magnitude of extant risks and the significance of risks on the far horizon? Do visualisations of risk, made crisp and accessible for policy makers, help or hinder debates on risk policy? Our investigations have caused us to rethink accepted principles of risk analytics and metrics *a priori* and exposed tensions of interest to a wider policy audience.

For decision makers, comparing risks and opportunities and then acting on this analysis is a necessary feature of their role (Defra, 2011). What distinguishes one risk, or opportunity, from another is its character (Klinke and Renn, 2002; Sparrow, 2008), not only its magnitude, dimensions (of likelihood, consequence and uncertainty) and significance but also the means by which it might be realised, how likely it is to come to fruition (or not), the individual mechanisms by which this might occur, the knock-on consequences that may emerge and how it is understood and managed by those that engage with it (Pollard et al., 2004). Researchers have referred to the attributes of character that a risk may possess including latency (delayed onset of harm), reversibility (of damage) and the stock at risk (the number or value of receptors to which harm is posed; Environment Agency, 2005) Frameworks for analysing strategic risks also exist that seek to represent the multidimensional features of environmental risks using analytic, schematic and narrative forms for policy makers so they can be meaningfully compared (US Environmental Protection Agency, 1987; Morgan et al., 2001; Klinke and Renn, 2002; Andrews et al., 2002; Pollard et al., 2004; Environment Agency, 2002, 2005). Our adaption of Klinke and Renn's (2002) risk characterisation for the German Council on Global Change (1998; Prpich et al., 2011), which has seen limited application in England and Wales, allows for the positioning of multiple strategic policy risks, appraised in the short term (Jan 2012), on to a single risk 'heat map' (Fig. 1(A); Science Advisory Council, 2012).

2. Using 'heat maps' to inform discussions on environmental risk management

Schematics are useful tools for communicating risk and widely used in corporate (Willis et al., 2004, 2010), political (e.g. Cabinet Office, 2010, 2012; World Economic Forum, 2011) and public spheres

* Corresponding author. Tel.: +44 1234 754101.
E-mail address: s.pollard@cranfield.ac.uk (S.J.T. Pollard).

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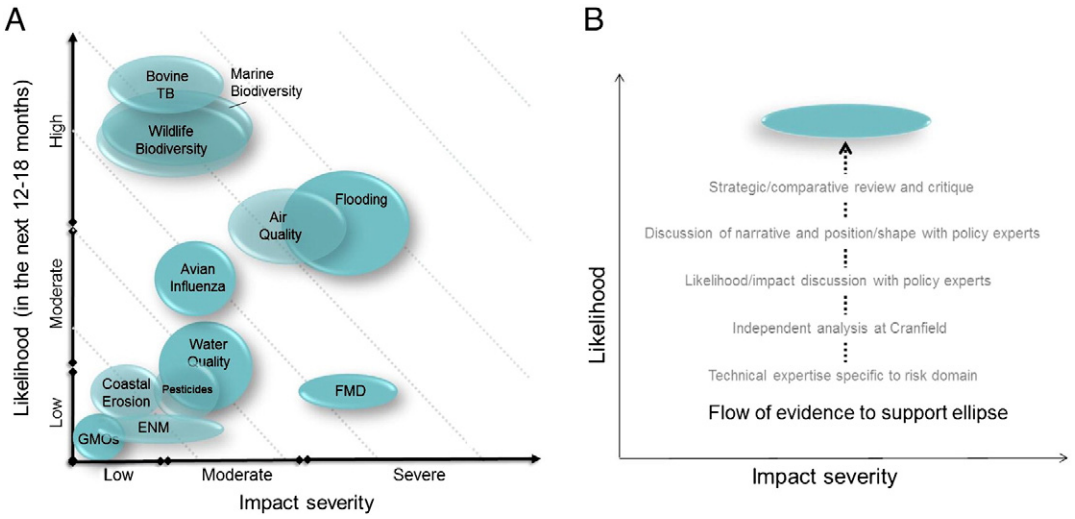

Fig. 1. (A, B) An illustrative appraisal of 12 strategic environmental risks for Defra (Science Advisory Council, 2012) employing the study of Prpich et al. (2011). Ellipses reflect the relative magnitude and 2-dimensional uncertainty in likelihood and consequence for residual policy risks, assessed over a 12- to 18-month horizon (from Autumn 2011) assuming existing risk management measures in place. Their positions are informed through a flow of supporting evidence, independent analysis and deliberative process (Fig. 1(B)). GMOs, genetically modified organisms; Bovine TB, tuberculosis; ENM, engineered nanomaterials; FMD, foot-and-mouth disease.

(Spiegelhalter et al., 2011) to inform debates on strategic decision-making under time limited constraints. Visuals like Fig. 1(A), which embody a suite of individual risks, cannot be precise because each ellipse (in this case) embodies a range of impacts and uncertainties. There is a vibrant debate about the utility of risk heat maps in the practitioner literature, and one must guard against their use in isolation of, or in substitute for, other risk analyses that exist in parallel, say, for example, the nationally significant 'import risk assessments' that evaluate the risks of animal disease incursions across national borders. The debates on strategic risk appraisal can be condensed into a discussion on whether concise visualisations help decision makers or not, given the complexity of policy-level risk. Pragmatists usually argue for the value of these analyses, accepting a degree of methodological compromise, so to inform discussions on risk comparisons and risk management strategies. A more purist view seeks a complete analytical risk characterisation but can fall foul of the varying degrees of data quality, much of which is poor resolved, in spatial or temporal terms, at the policy level because it represents an overarching national policy picture. Seeking to straddle these positions, we have supported our visuals (Fig. 1(A)) with a narrative on the character of the risk and current risk management strategy (Prpich et al., 2011). At best, each ellipse (frequently reduced to a deterministic point in many analyses) indicates a central tendency (position, dimensions) for the set of risks it represents. The presentational challenge is to reconcile the complexity of these policy-level analyses, as informed by a hierarchy of analysis and discussions (Fig. 1(B)), with a utility of application for policy audiences, for the purpose of discussing current and future risk management strategies (Government Office for Science, 2011). For example, risks within the air quality policy domain (Fig. 1) may be episodic or ongoing; their harms immediate or latent. The practical need is to assemble the complexity of these issues into a single policy area and assess them as one over a designated time frame. A common question asked of policy makers when considering residual risk, that is, the risk that remains with existing management measures in place, is how likely is this policy area to 'flare up' (through a manifestation of residual risk) over the next 12–18 months, and what impact may this have, given the risk management measures in place? These assessments embody considerable and some unresolvable uncertainties, but expert judgement can be made accepting this rather than holding out for an analysis of the discrete probabilities and consequences that might arise from any set of events and unknowns (Government Office for Science, 2011). Complete confidence cannot be guaranteed, but a meaningful judgement can be made on which to base future risk management decisions.

Decision makers desire a structured and supportable basis for acting on the risks posed by a policy area over a given future. At this level, a quantitative assessment of the likelihoods of all possible events, processes and trends captured within a policy area over a 12- to 18-month period is not possible because not all events can be assessed and aggregated completely, nor fairly. More value may be had in employing a semi-structured, heuristic approach that is fit for purpose and resource efficient in decision terms. This type of framework (Prpich et al., 2011) relies on experts synthesising a large body of evidence and then arriving at a summary characterisation of risks for a policy domain, which can be then compared with other risks across a policy portfolio, accepting the compromises required. Critically, this approach becomes a means for the organisation to debate ongoing or emerging risks with their board, along with a discussion of the effectiveness of current management strategies and future management actions. To be useful, this discussion must focus on risks that are, or are not, manifested and those risks that are, or are not, appropriately managed by reference to their extent and character. Trading off the relaxation of controls in one risk area with the tightening of interventions elsewhere is a component of these debates and open up the prospect of seizing opportunities (for resource allocation, for targeted evidence gathering) in resource-constrained times.

Assessing policy risks requires a compromise in how likelihood is considered. An event-based definition of likelihood, in isolation, will not provide the differentiation that decision makers require to understand the risks within their policy portfolios; risks that also have exposure likelihoods and likelihoods of harm in the event of exposure, for example. Apart from floods, and possibly animal disease incursions, the data for other policy areas (at least for England and Wales) are insufficient at a policy level to support a sophisticated risk analysis. Our attempts to reconcile issues of data paucity and presentational clarity by employing the elicited views of technical policy experts holding specialist domain expertise have compared well against an *a priori* evidence-based analysis using the open literature (Fig. 2, for foot-and-mouth disease risks). Notwithstanding that environmental impacts and consequences are difficult to predict and manage, the