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Framing risk for environmental science and environmental scientists

David Viner reflects on the complex area of risk and its crucial role in effective decision-making.

'Risk: The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems.'

DEFINING RISK

This widely used definition both clarifies and clouds how environmental scientists can discern and address risk. While it provides a broad basis of understanding, it also raises numerous questions: what is risk composed of; where can it be found; is it stand-alone, systemic, or can it be both; how can we deal with it when we encounter it?

The term 'risk' is multi-dimensional yet simultaneously often used in a transferable way to define the sum of a series of components: hazard, exposure, vulnerability, (and sometimes) response. For environmental scientists to usefully examine, assess and respond to this multitude of risks, there must first be clarity about its definition. One conceptualisation of risk based on the framework used by the Intergovernmental Panel on Climate Change (IPCC) was first reported in the Special Report on Extreme Events (see **Figure 1**).[1] This framework has undergone rigorous scrutiny, leading to a tightening of the definition of the components of risk. Modifications have been added – including addressing the dynamic nature of these elements, which themselves must be defined and addressed individually before risk can be properly understood.

The components of risk are broadly defined as:[2]

Hazard: The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury or other health impacts as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.

Exposure: The presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social or cultural assets in places and settings that could be adversely affected.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Risk, therefore, results from *dynamic* interactions between multiple parts. Against the tendency of the numerous risk assessments used within the environmental science and practitioner communities to date – which have considered risk as relatively static and qualitative – each risk component is subject to uncertainty in terms of magnitude and likelihood of occurrence, and each is likely to change over time and space due to interactions with socio-economic systems and the subjectivity of decision-making. When appreciated in this manner, risk is no longer condensed into merely a function of impact and likelihood of occurrence – an easily constructed and communicated but ultimately oversimplified framing.

The IPCC suggests several scenarios within which discussion of risk is suitable and in line with its definition. Firstly, the term should be used when 'explicitly considering potential adverse consequences and the uncertainty relating to those consequences'.[3]

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The more clearly adverse consequences are characterised in terms of magnitude, scale, distribution, reversibility and the nature of uncertainty, the more useful the risk concept is. Risk assessments are also fundamental to informing decision-makers of how different action paths can reduce or exacerbate adverse consequences. Within this, best practice stipulates that risk is not made synonymous with hazard, but instead focuses on the *consequences* of hazards. Finally, risk is not the generic term for anything bad that may happen now or in the future. This is often conflated with the urgency needed to address many risks. Urgency most often stimulates prompt risk management. However, as conditions approach a crisis state, urgency can weaken decision-making rather than support it. Rushing decisions and courses of action will often produce unintended consequences.

MANAGING RISK

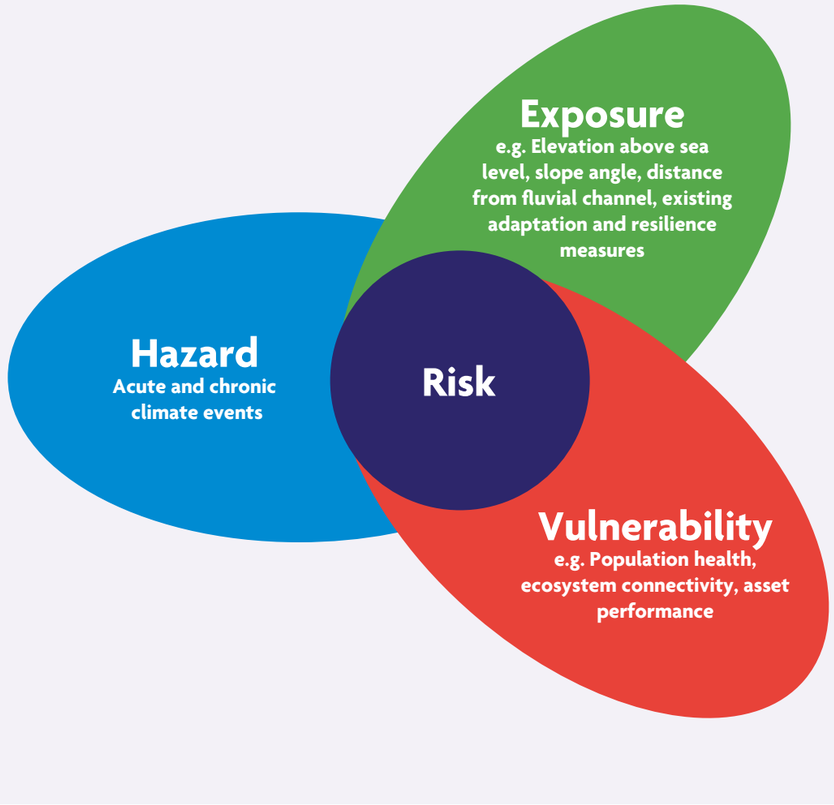
Managing risk appropriately is becoming increasingly important as humankind continues to disrupt delicately balanced environmental systems. Decision-support tools and decision-analytic methods are available and are being more widely applied to managing climate risks in varied contexts and across a range of spatial and temporal scales, including in the presence of deep uncertainty. These tools and methods have been shown to support deliberative processes, where stakeholders jointly consider factors such as the rate and magnitude of change and the uncertainties, associated impacts and timescales of adaptation needed along multiple pathways and scenarios of future risks.[4]

In many places, consideration of risk is now enshrined in law or government standards. In the UK, the Climate Change Risk Assessment (CCRA) is a rigorous and lengthy five-year analysis of risks and opportunities relating to the environment, legally instigated by the Climate Change Act 2008. Government standards in risk assessment and subsequent knowledge are being strengthened with the third assessment, CCRA3, delivered earlier this year.[5]

Although risk can appear to be a technical, specialist subject, it touches every corner of the environmental sciences. The CCRA3 considered no less than 61 risks, grouped into five major categories:

- Natural environment and assets;
- Infrastructure;
- Health, communities and the built environment;
- Business and industry; and
- International dimensions.

This issue therefore includes articles relating to all these categories, contributed by authors working in diverse environmental fields. The issue opens with Joseph Lewis demystifying the complex dynamics



▲ **Figure 1. Risk components. (© David Viner)**

and theories of risk and uncertainty at a deeper level, presenting a case for mainstreaming systems literacy in our approach to tackling environmental problems.

An interview with Luke Kemp follows, explaining the value of studying the most extreme and catastrophic risks we might face and revealing the deep parallels and interactions between climate and socio-political risks. Kemp offers a thought-provoking insight into the ways we conceptualise and communicate risk, with an emphasis on how democratic deliberation is essential to reducing future threats.

Mark Workman and colleagues tackle the processes on the other side to science, navigating a route through the complex research–policy interface and discussing how risk can be better translated to make more effective decisions under uncertainty.

Duncan McLaren's inspection of solar geoengineering considers the role of risk framing. McLaren weighs up the possible merits and pitfalls of risk–risk analysis when applied to a high-stakes, controversial topic, interrogating whether arguments surrounding geoengineering represent a false binary for climate governance.

With a global demographic shifting to urban areas, and this trend expected to only increase in intensity over time alongside climate change, consideration of environmental risks specific to urban areas is crucial. David Dodman shares his personal thoughts, including his views on the unique challenges cities face, the importance of community participation in building resilience and the possible barriers to risk-sensitive adaptation.

In a case study that demonstrates the complex chain of risks that can develop in the work of environmental scientists, Conor Armstrong and Adam Bamford relay the remediation process for a domestic property following an oil spill. In particular, they explore the role of guidance and contaminant testing, demonstrating how and why risk assessments can help overcome hurdles and uncertainties.

Providing a thorough view of risk within a pressing global topic, Nicky Jenner and Pippa Howard plunge into the potential dangers of deep seabed mining. This analysis arrives at a time of great debate, where calls for a mining moratorium or total ban compete with a push to attain the rare earth metals that lie on our seafloor.

The presence of risk in every corner of environmental science warrants that we pay close attention to it. With a firm grasp of risk and all its component parts, the environmental sector may be able to translate its crucial knowledge into the most effective decisions yet. ES

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