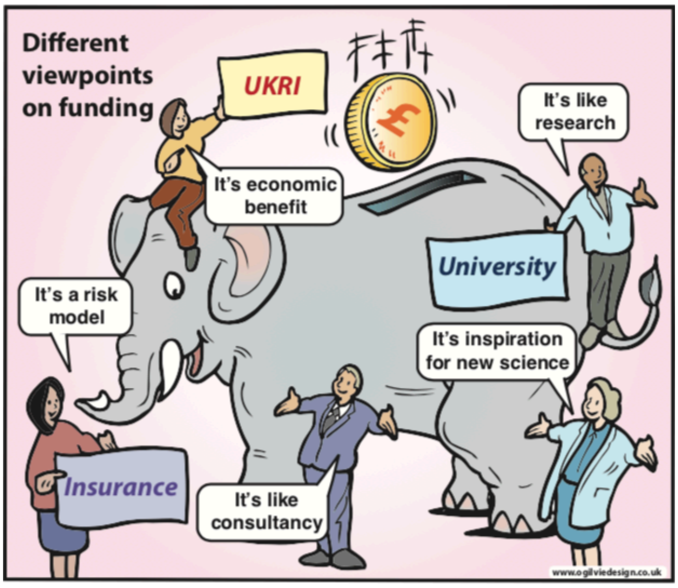
Investing In Science For Natural Hazards Insurance



Main Points

- Limited cash contributions from industry can leverage substantial (e.g. £10s of million) UKRI government funding to support university-industry collaboration if this will demonstrably benefit the UK economy (i.e. have 'impact').
- To secure UKRI funding, (re)insurers and university scientists must better understand how research can be of value to both the sector and individual researchers.
- Industry 'catastrophe' risk models for natural hazards are the dominant means of scientific input into decision-making in organizations holding (re)insurance risk.
- However, dialogue is mainly between in-house specialists (e.g. teams creating firms' own views of risk) and model developers, with university scientists less frequently consulted.
- Thus, exciting opportunities to improve the flow of science into insurance using UKRI funding could be unlocked by identifying mutual benefit in tasks that avoid yet complement established industry mechanisms to access science.
- UKRI requires a clear pathway to provide evidence of real-world (re)insurance benefits (e.g. improved decision-making, new skills) back to the academic.
- For scientists, work is justified if it facilitates or inspires novel and world-leading research.

Overview

Natural perils (e.g. hurricanes) can cause losses >$100 billion per year. Modelling these risks is a key part of the global (re)insurance sector's decision-making and, critically, includes peer-reviewed environmental science that is primarily created in universities. Yet, how can university-based scientists and (re)insurers best work together to increase the flow of science into risk models in light of their differing priorities and existing tools and expertise within industry? Specifically, what is the role of government funding for collaborations, and how can these communities work together to secure it? This briefing aims to foster more frequent and diverse collaborations by building mutual understanding, firstly outlining the communities' respective interests, then describing the basics of science usage in decision-making within (re)insurers, and finally introducing how these might lead to opportunities and partnerships within the current university and funding landscape.

Insurance interest

Natural hazards such as hurricanes and earthquakes are perils that pose great risks, causing up to $100s of billions of damage yearly[1,2]. Insurance is a financial mechanism that spreads these risks, mitigating the consequences. 'Catastrophe models' are tools to probabilistically assess such risks and thus facilitate their transfer[2]. Used since the 1980s, these models are underpinned by peer-reviewed environmental science of natural hazards, combining this with socio-economic and financial expertise. Catastrophe models are now a vital part of risk regulation both internally within organisations holding risk and externally (e.g. by Bank of England), in a framework formalised by the Solvency II regulations[3,4]. Risk-holding organisations are required to have their 'own view' of their risks and robustly validate the basis of this view. Peer-reviewed science is important in developing this view.

Government & university interest

Globally, political interest in converting research excellence into commercial success[5,6] and societal impact[7] is increasing. So, even in countries where notable efforts are already made (e.g. UK, Australia[8]) a desire exists to improve the flow of science into policy and business decision-making practice through university-business collaborations.

Debate continues about how to incentivise, deliver, monitor, and support this flow[5,9]. In the UK, government funding is coordinated by *UK Research and Innovation* (UKRI), with innovation referring to the translation of science into real-world change, which is termed 'impact'[10]. Universities are strongly incentivised through the REF assessment[11] to demonstrate such impact; critically, the use of science must be suitably documented, evidenced, and tied to the original research.

This study

This study used a session at the Oasis Loss Modelling Framework (LMF)[12] conference on 14th Sept 2018 to collect data objectively documenting how views of natural hazard risk are formed and used in the (re)insurance community. Data relating to the following questions were collected, and integrated into the discussion below, which also draws upon recent research and the authors' experience as appropriate.

- Why is science used in the insurance industry? And, what is its relationship to other factors when making key decisions?
- How does science propagate into decision-making?
- What are the potential barriers to better engagement?
- Where lies the greatest opportunity for UKRI funding to facilitate impact, i.e. real world change?

The Oasis LMF conference session

In the session devoted to this study, 28 participants with 440 years collective insurance sector experience, ranging from 4-41 years, contributed data. The main risk-holding organisations (i.e. primary insurers and reinsurers) were well represented (Fig. 1a). It is notable that past experience of research science and working at companies who specialise in making catastrophe models is common. The main functional areas within a (re)insurer (see Figs. 1b and 3) are also all well represented, although Underwriting & Pricing is the least so in current roles. Participants' seniorities span from new risk analysts to board level, excepting board-level representation for (re)insurers, with scientists being statistically indistinguishable from other participants in seniority.

So, participants were scientifically literate technical specialists, including scientists, broadly spanning the range of seniorities in organisations they represent. This *de-facto* sample selection by using the Oasis meeting, including its bias, was entirely intentional. These individuals are the most likely to directly engage with environmental science, and give a perspective from the technical specialists associated with the creation, evaluation and use of catastrophe models.

Session methodology & definitions

In Activity 1, participants ranked factors [1-5 scale] relating to the use of environmental science in making decisions within their immediate team. Activities 2 & 3 asked for a wider view, using pre-defined frameworks (i.e. Figs 2 & 3). Votes (black dots) were placed where the most important decision-making takes places in terms of organisational characteristics (Fig. 2) and critical functions (Fig. 3). Similarly, the dominance of scientific inputs to decision-making was ranked [1-3 scale] within these landscapes, with information about seniority and time-scale of decision-making also collected in Activity 3.

All data are self-reported, individual, and restricted to organizations/functions that participants had experience of, namely as employee, client, or strong informal contact within the past 5 years. Defining if an issue is 'material' (i.e. important) was deliberately left to each participant's judgement, other than that it should depend on the perceived size and number of decisions.

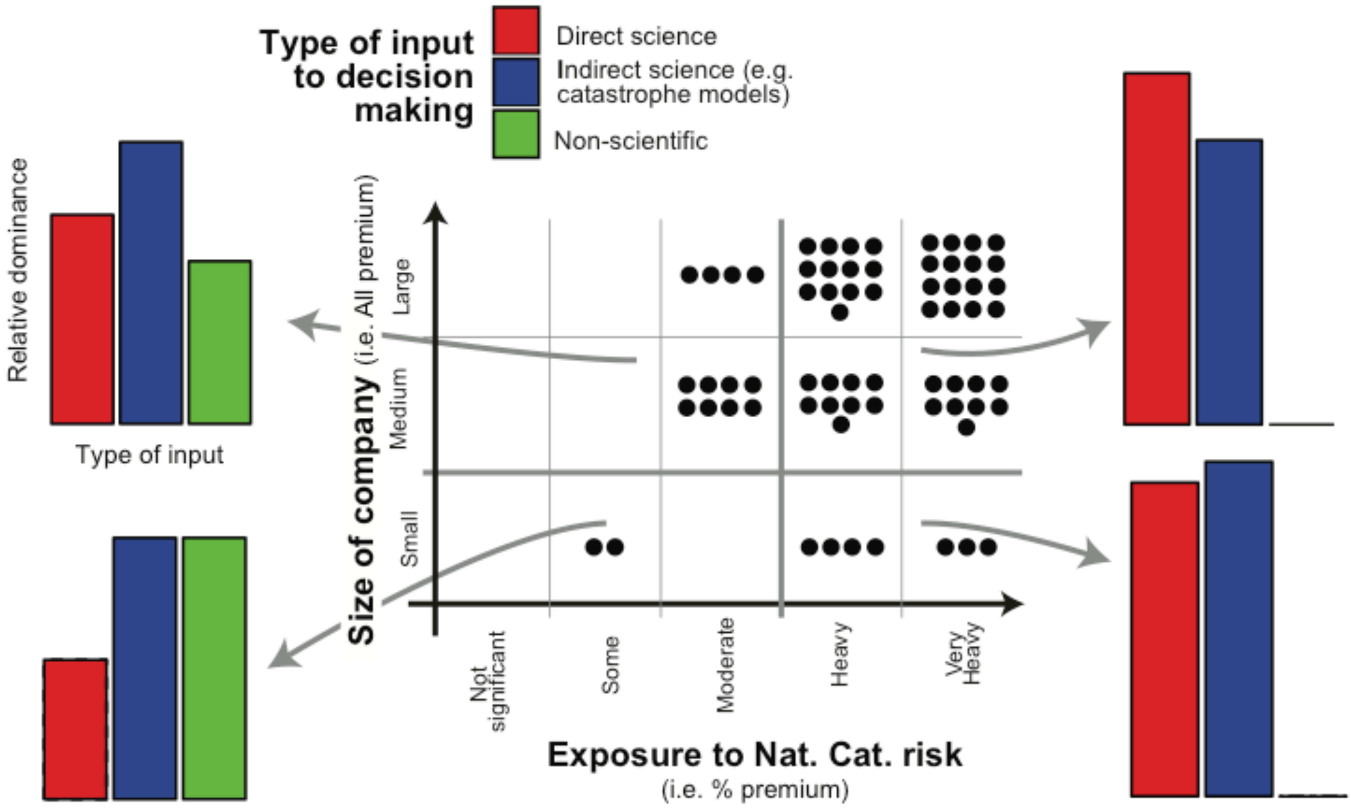
A distinction was made between direct inputs from science, indirect scientific inputs to decision-making, and cases where non-scientific factors dominated. *Direct* engagement was defined as that with university-based scientists (e.g. in a research collaboration or on an internal committee), in-house research publishable in peer-reviewed journals, or deep interaction with the published scientific literature. *Indirect* science was defined as the use of catastrophe models or inputs from external translators (e.g. brokers, consultants). '*Non-scientific*' inputs could include claims experience, 'gut feel', or personal judgement based on that individual's past experience (e.g. of business, company processes).

Fig. 1: Participants' past and current experience.

Why is science used in the insurance industry? And, what is its relationship to other factors when making key decisions?

Within participants' teams, despite the variety of individual circumstances, environmental science is used positively in decision-making; namely, use as a 'driver'/'reassurance' was ranked above 'shield'/'regulation' (p = 0.02, Wilcoxon, unpaired, 1-tailed). However, it was ranked as less important ($p < 0.01$) than 'Business Factors' for both operational (i.e. day-to-day) and strategic decision-making.

Fig. 2: Organisational view of making key decisions within (re)insurance by risk holders using environmental science. Dots are votes for the most material (i.e. important) areas, and colour coding relates to type of input to decision-making. Activity 2**.**



Overall, indirect science is perceived as the dominant input into decision-making in organizations holding (re)insurance risk (Figs. 2 & 3). The black dots on the right-hand side of Fig. 3 show that its influence (i.e. via in-house use of catastrophe models or external translators) is thought to exceed a combination of in-house science or inputs from external (i.e. mainly university-based) scientific experts, even in this peer-group. So, although direct scientific input is most dominant in larger and more exposed (re)insurance companies (Fig. 2, multivariate linear models, $p < 0.05$), it is still used as a support to two main inputs (i.e. claims data, in-house catastrophe model use – Fig. 3). This is consistent with the authors' experience, where larger organisations are more likely to have in-house teams including people with PhD experience to engage with science (e.g. academics), whilst smaller companies tend to look to modelling companies to provide accessible science.

How does science propagate into decision-making?

Fig. 3 demonstrates that the strongest direct interaction that exists is with the 'Model Adjustment' function, which then propagates science internally[2]. So, university-based scientists should be aware that these industry colleagues are likely the key conduit through which (re)insurers can be engaged.

However, black dots on the left hand side of Fig. 3 show that participants clearly judged the 'Underwriting & Pricing' to be where the most material decisions were made, and here direct science appears less important in decision-making (coloured bars). Thus, there is a second step to reach decision-makers.

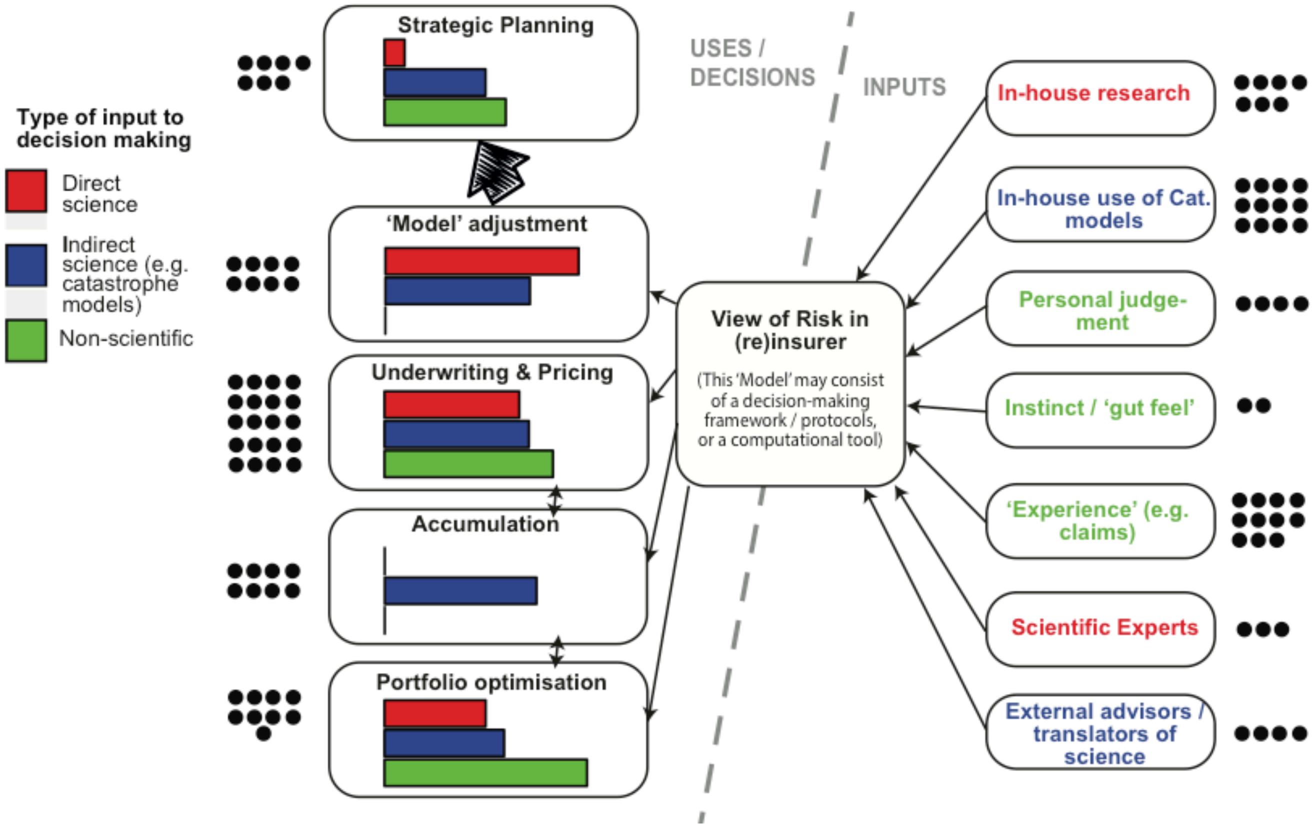
A disconnect is also observed. Although direct input from university-based science is evidently desirable if resources allow (Fig. 2), in-house scientific research is used at least twice as often as engagement with external scientists (Fig. 3 right-hand side, black dots).

Notably, direct scientific input into 'Strategic Planning', which participants associated with 'senior management' or 'board-level', is limited. Likely this is because direct science is just one of many considerations in decision-making at this senior level and may need translation before it can be considered since a limited number of the individuals at this level have scientific experience. A follow-up analysis was done of CEO & Chief Risk Officer (CRO) biographies (i.e. on company's websites, Bloomberg profiles, and LinkedIn) as they are the key conduit from technical analyses to senior decision-making. Of the 38 companies recorded by participants, 1 in 5 of identified educational backgrounds (BA/BSc to doctorate level) were broadly scientific (e.g. any science, engineering, psychology, but *not* maths), with no evident distinction between CEOs and CROs. This drops to 1 in 20 for explicit mentions of environmental science pertinent to natural hazards (interpreted broadly and liberally) within educations *or* other elements of biographies. This is in line with the authors' experience that senior decision makes typically do not speak the language of scientists, and *vice versa*. This is, arguably, a cultural barrier.

What are the potential barriers to better direct engagement?

The Dowling Review of 2015[5] is a recent UK review of the drivers of and the varied barriers (e.g. different time-scales, lack of time, identifying appropriate partners) to university-

Fig. 3: Functional view of making key decisions within (re)insurance by risk holders using environmental science. The inputs and functions in Fig. 3 are interpretive simplifications derived from chapters 2 and 5 of *Natural Catastrophe Risk Management and Modelling*[2]. Dots are votes for the most material (i.e. important areas), and colour coding relates to type of input to decision making. Activity 3.



business research collaboration. Additionally, some studies have specifically focussed upon academic motivations[e.g. 13] and issues of aligning with their incentive strucutures[9]. This note adds a view regarding risk-holders in the insurance sector.

The composition and current seniority of participants at the Oasis session (e.g. Fig. 1) demonstrates that neither familiarity with science nor ability to understand it are barriers to key functions in most main (re)insurers engaging with science.

A first barrier to direct engagement with university-based scientists is simple, and evidenced by Fig. 3 (black dots, right hand side); if the relevant science has been packaged into a useful form such as a catastrophe model, then where is the need? Thus, it is necessary to identify tasks that avoid yet complement well-established industry mechanisms, which have developed to distil business-orientated outputs. Investigating a peril newly-identified as an insurance risk or providing a hazard dataset to cross-check a catastrophe model are examples of this, but practitioners consider it important that outputs are in a format directly usable by the industry.

To shed more light, it is critical to make a distinction between the people actually making the decisions (Underwriting & Pricing, and executive management) and those supporting them (actuaries and modellers). The latter engage with science more directly on behalf of the former (e.g. in the Model Adjustment function, see above), providing model outputs, and leading to a paucity of *direct* engagement with science within the most important decision-making functions (Fig. 3). This distance between decision makers and university-based science might make creating the conditions for successful collaborations (e.g. awareness, securing internal resources, providing evidence of impacts) less easy.

Where lies the greatest opportunity for UKRI funding to facilitate impact, i.e. real world change?

Pragmatically, Fig. 2 confirms that large and heavily exposed companies have both the incentive and capability to be most engaged with scientific research funded by UKRI, facilitating real-world impact. For all companies, however, the authors' experience suggests that the key to exploiting opportunities lies in developing effective partnerships, developing areas of shared interest, initiating new relationships, and overcoming the misnomer that large financial resource (e.g. cash contributions) is necessary to access university-based science.

Effective partnerships

Effective partnerships are mutually beneficial, and likely built on projects that are co-designed to be attractive to insurer and university-based scientist in terms of delivery and research.

Effective delivery of science in a collaboration with an active university-based scientist must involve improved actions and decision-making within stakeholders, i.e. (re)insurers, *and* the provision of evidence of this 'impact' back to the scientist[7,9]. Thus, whilst Fig. 3 identifies technical specialists in view of risk 'model' evaluation roles as a key conduit, buy-in must penetrate as far as decision makers to foster projects that are viable for scientists to participate in. However, each project must still also facilitate or inspire novel and world-leading science, for example by giving scientists access to data or posing new research questions[9]. Without both of these, a project is consultancy or perhaps commercialization (e.g. Lloyds' Lab https://www.lloydslab.com/) rather than a potentially UKRI funded research collaboration with scientists.

The trick is to ensure mutual benefit in terms of outputs at as many of the interim stages as possible[9], with ideas and access routes outlined below.

Identifying shared Interests

Identifying shared interests is fundamental to creating mutual benefit. It is non-trivial, but is the crux of effective partnerships. Efforts to do this could be through individual relationships, insurance sector initiatives (e.g. Lighthill Risk Network, Willis Research Network, Oasis Hub) or workshops at academic meetings to identify key scientific questions of current interest to insurers (e.g. about Extra-Tropical Cyclones[14]). Existing initiatives have been successful, but are still comparatively limited in scope given the potential number of academic partners.

Initiating individual-level relationships

Successful university-business collaboration requires mutual understanding, built upon shared vision and long-term trusting personal relationships [e.g. 5]. The question is then how to initiate these. Figs. 2 & 3 identify for university scientists the type of organization and job role (i.e. 'Model adjustment' or 'view of risk') that relevant insurance colleagues may occupy. Reciprocally, Hillier *et al*. (2018)[9] focus on explaining academics' drivers, and list illustrative pragmatic actions, with outputs of use to both university-based scientist and insurer (below). The paper also explains *why* they might be effective to allow (re)insurers to better evaluate any additional suggestion they may have. A few possibilities include:

- Offer a scientist a position on an advisory panel.
- Ask a scientist to provide training.
- Give a scientist access to in-house expertise or data.
- Collaborate via student (e.g. MSc, PhD) projects, or their training; e.g. PhD students in the CENTA DTC[15] are required, and funded, to do a 2-4 week placement on work that does not directly contribute to their PhD research.

Illustrative UKRI opportunities

A few recent UKRI initiatives illustrate some of the 'innovation' opportunities available. These are largely funded by government, with 'in-kind' contributions from industry (e.g. practitioner time to steer the work, access to expertise or data).

- 2017 - NERC, DFID, ESRC: '*Building resilience to natural disasters using financial instruments*' £2 million
- 2018 - Industrial Strategy Challenge Fund: '*Next Generation Services Research Programme*' (Accountancy, Legal Services, Insurance) £20 million.
- Annual - NERC '*Innovation Placements*' scheme. ~£1 million.
- UKRI *Future Leaders Fellowships*. £900 million over 5 years.

Future insights desirable

This briefing includes an indication of *where* within an insurer (i.e. what function) direct engagement with peer-reviewed science is undertaken, but not exactly which tasks may benefit from working with university-based scientists. Initial suggestions from an UKRI-sponsored meeting of 45 insurers and academics at SCOR in Feb 2017 included

- Answering specific questions, e.g. for perils or territories that are not part of core catastrophe model offerings.
- Providing a set of hazard footprints (i.e. intensity and spatial extent for events), vulnerability curves, or exposure datasets.
- Evaluating catastrophe models; i.e. challenging, approaches or assumptions, for example on clustering of events.
- Model validation e.g. against historic losses, or *possibly* for regulatory purposes (i.e. Solvency II).

Some of these are contested, and further work is needed to understand exactly the tasks in which university-based scientists could (or should not) contribute to insurers' processes. In particular, work could investigate the need and desire for engagement with university-based scientists at senior levels within (re)insurers (e.g. Chief Risk Officers).

Open Access (Paper & non-textual anonymised data):
https://doi.org/10.17028/rd.lboro.c.4322666

Endnotes

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