

**“We cannot have different systems of resilience for every new risk or peril that comes down the track. Instead, we have to have a coherent framework for dealing with risk that can actually evolve.”**

Rowan Douglas, Willis Research Network

## Taking a long term view of cities

*How can cities become more resilient and how might big data shape the way we view and plan them in the future?*

### At a glance

The overarching theme of our third topic was ‘risk, resilience and response’ and between January and March 2016, we focused on cities. These meetings built on some of the questions that framed our discussions during our first topic, sustainable cities. Expert witnesses from the worlds of policy, research and industry helped us to explore the role that technology and big data could play in making cities more resilient to short term shocks and long term changes in the environment

In January and February, we discussed new ways to layer social, economic and environmental datasets in order to assess risk and resilience in cities, and how vulnerable they are. In March, we turned to catalyzing change and ways that cities can become more resilient in practice.

This article provides an overview of key emerging themes and some of the ‘wicked problems’ and questions generated during these discussions. Some of the themes related to big data are explored in more detail in our ‘Cities of the Future’ report’, published on our website: [www.cfse.cam.ac.uk](http://www.cfse.cam.ac.uk).

### Understanding risk and resilience

One of the key topics of the three meetings was the level of our current understanding of the nature of risk and resilience. This was encapsulated by Dr Emily Shuckburgh, Deputy Head of the Polar Oceans Team at the British Antarctic Survey, who identified four areas that need improvement so as to support resilience: more data collection and processing, particularly at the local level; metrics for risk, mitigation and adaptation; instruments for considering uncertainty in decision-making; and the interface between various key stakeholders of the scientific, legal and political community, amongst others. The complexity of the topic means that resilience and risk are subjective continuums, which should be reassessed after catastrophes, rather than exact thresholds.

Dr Prathivadi B. Anand, a specialist in environmental economics and public policy from the University of Bradford,

argued that there is a societal need to transparently decide what risk is acceptable and cost effective, as well as how much redundancy or resilience should be built into infrastructure. Mitigating every risk is impracticable. Striking a balance in this area is challenging as overdesigning can have unintended consequences, but is often desirable in buildings which need to function after a disaster. The general population is often not aware of risk, which can lead to complacency with regard to mitigation measures. Likewise, knowledge and experience about risk and resilience also needs to be shared between cities and institutions to increase overall preparedness for disasters.

Professor Danny Ralph, who introduced the work of the Centre for Risk Studies, also stressed this need. In 2016, the Centre examined the economic loss of 300 major world cities resulting from catastrophes, and this process emphasised where there was a lack of knowledge and models that need to be addressed in risk management thinking, such as the difficulty of assessing all systems including the social, commercial and legal sectors. Assessing systems in across different areas, sectors and levels, is also a challenge, as highlighted by Professor James Jackson, Professor of geophysics, geodynamics and tectonics in the Department of Earth Sciences. He argued that there is a disparity in the

### Key questions

Through our discussions, we identified three key questions where more research is needed:

- **How can we make urban planning systems more adaptive and how can knowledge about risk and resilience be shared at an urban planning level?**
- **How much redundancy or resilience should be built into urban infrastructure and how do we introduce redundancy into social systems?**
- **How can we model direct and indirect effects of catastrophes on cities if they are outside the original impact centre?**

preparedness of countries exposed to earthquakes on the Pacific Rim and those in Continental Asia. The former are aware of the threat and have the wealth to enact policy. The latter, amongst other problems, struggles with complacency because of the large geographic distribution of earthquakes. In these areas, different approaches to mitigation and adaptation will be needed.

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***“We should not shy away from trying to talk about all threats to cities and from trying to understand that different systems within those cities have different dimensions.”***

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Professor Danny Ralph,  
Centre for Risk Studies, University of Cambridge

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## Layers of data

Choosing the best metrics for modelling risk requires ongoing work, although the insurance industry perhaps provides a useful exemplar for considering risk. It has adopted catastrophe risk modelling and a consistent regulated framework which enforces consideration of 1 in 200 year risks. Rowan Douglas, the CEO of Capital, Science & Policy Practice at Willis Research Group, argued that sustainability and resilience should be viewed through this prism of risk and creating a coherent set of frameworks, metrics and a common language that links all the various sectors beyond just insurance is crucial. The specific metric of 1 in 200 year risk may not always be suitable as it can overlook large, rare risks. Again, society needs to consider what is an appropriate standard and how this may vary according to the local context. In New Zealand the standard for insurance is now 1 in 1000 years. Imposing minimum requirements on other organisations outside the insurance sector would force organisations to assess and disclose their risks and be fiscally responsible. More broadly, protection from climate risk could be considered a human right and the UN and OECD are starting to move in this direction.

There were numerous other challenges considered with regards to metrics. The interactions between different and successive catastrophes need more analysis, as do the direct and indirect effects of catastrophes outside the original impact centre. Events which have a wider impact, such as the eruption of the Icelandic volcano, Eyjafjallajökull, introduce more complexity and uncertainty into models and methods of incorporating such events need to be developed. A number of other uncertainties with regards to risk and resilience were also raised: How can new events that have no past analogue be modeled? How are abstract and less quantifiable challenges, such as threats to biodiversity of mental health issues in society, assessed and costed?

Sérgio Freire, a geographer working in the Global Security and Crisis Management Unit of the European Commission's Joint Research Center (JRC), discussed the manner in which big data can be useful to answer some surprisingly fundamental questions about the state of global development that are necessary for understanding our current exposure to risk: what is a city, how many and where are they and what are their sizes and shapes? Professor Michael Batty, Bartlett the Professor of Planning at UCL, explored another use of big data as an emerging tool in the context of transport planning. For example, data from London's public transport could be compared to a synthetic baseline to assess the resilience of the system in real time.

## Planning future cities

The use of big data is not without its difficulties. Incorporating risk metrics and dynamic big data into planning systems is another challenge that was emphasised by Dr Elisabete Silva, a Senior Lecturer in Planning in the Department of Land Economy. She argued that current planning systems are static and there needs to be flexibility in policy and decision-making to allow for changing scenarios and quick responses to dynamic data.

Big data and planning systems also need to adapt to the dynamic expectations of individual residents. For risk and resilience concepts to be successfully adopted there has to be communication and trust between communities and policymakers. The public has to understand, and help decide, where certain areas can or cannot be sensibly protected from disaster because of a lack of finance or resources. This relationship between the various stakeholders, ranging from the government to the individual, including industry, law and finance was consistently mentioned, and it was agreed that an institution like Cambridge University could help bridge these levels.

**The Cambridge Forum for Sustainability and the Environment** was established in 2013 in the University of Cambridge. Chaired by Lord Martin Rees, it meets once a month, bringing together thought leaders from the worlds of research, policy and industry to talk about some of the great sustainability challenges the world faces in the future and the research pathways which will help to prepare for and address those challenges.

**Secretariat:** Prof. Paul Linden (Director); Dr Rosamunde Almond (Executive Secretary); Dr Konstanina Stamati and Dr Lizzie Tyler (Acting Executive Secretaries during maternity leave); Simon Patterson (Content Writer).

**Forum members for this topic were drawn from 14 University centres, departments and Initiatives**, including: Prof. Alan O'Neill (Cavendish Laboratory); Prof. Alison Smith and Prof. Howard Griffiths (Dept. of Plant Sciences); Prof. Danny Ralph (Centre for Risk Studies); Dr Emily Shuckburgh (British Antarctic Survey); Dr Helen Curry (Dept. of the History and Philosophy of Science); Dr Hildegard Diemberger (Dept. of Social Anthropology); Prof. Ian Hodge (Dept. of Land Economy); Prof. Ian Leslie, (Computer Laboratory); Dr Jake Reynolds and Polly Courtice (Cambridge Institute for Sustainability Leadership); Dr Julian Huppert (POLIS); Prof. Koen Steemers (Dept. of Architecture); Dr Miles Parker, (CSaP); Prof. Peter Guthrie (Dept. of Engineering); Dr Shailaja Fennell, Lecturer (Centre for Development Studies); Prof. Susan Owens (Dept. of Geography).

We would like to thank everyone who took part in Forum meetings related to this topic, especially the expert witnesses and guests who joined us from across and outside Cambridge:

**Witnesses:** Prof. James Jackson (Dept. of Earth Sciences, University of Cambridge); Prof. Danny Ralph (Judge Business School); Dr Elisabete A Silva (Dept. of Land Economy, University of Cambridge); Rowan Douglas (Willis Research Network, Willis Group); Dr Emily Shuckburgh (British Antarctic Survey); Dr Prathivadi B Anand (University of Bradford); Prof. Michael Batty (University College London); and Sérgio Freire (Global Security and Crisis Management Unit, EC Joint Research Centre).

**University guests:** Prof. Andy Hopper (Computer Laboratory); Prof. Ash Amin (Dept. of Geography); Dr Bonnie Wintle and Dr Shahar Avin (Centre for the Study of Existential Risk); Dr Marla Fuchs (Research Strategy Office); Prof. Peter Tyler (Dept. of Land Economy) and Dr Tom Herbstein, (Cambridge Institute for Sustainability Leadership) and early career researchers, including Gerry Casey, Hannah Baker and Kristin MacAskill (Dept. of Engineering and Mingfei Ma (Dept. of Architecture)

**Guests from outside Cambridge:** Dr Alejandro Palermo (Royal Society of Chemistry); Prof. Charlie Kennel (CSaP) and Emily Miles (Defra).