Risk, resilience and response

Cities

Cambridge Forum
for Sustainability and the Environment

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Cambridge Forum for Sustainability and the Environment

A rising world population, declining resources and a changing climate are all reshaping where we live and how we live. So how do we respond?

This key question is the focus of a new Forum in the University of Cambridge which aims to stimulate cross-disciplinary conversations about some of the planet's most pressing global sustainability challenges and to bring fresh ideas and perspectives to research which will help to prepare for and address those challenges.

On a global scale, we need to find a way in which 7 billion people, expected to rise to 8 billion by 2030 and 9.6 billion by 2050, can live a high quality of life that is less demanding on our planet. And to adapt, be efficient and be sustainable, we need to know where to place our energies – nationally and globally – to meet the challenges the future will bring. Unfortunately there is no silver bullet: the solutions will need to be 'multi-pronged' and multi-disciplinary, requiring knowledge from many different sources.

'Sharing the knowledge' and catalyzing those connections are two of the goals of the Forum, which is Chaired by Professor Lord Martin Rees and has 25 core members who work in areas ranging from energy, biodiversity and food security to anthropology, architecture, history and economics.

One of the Forum's aims is to bring people together who would not usually meet each other but who are working in areas which overlap enough to stimulate an interesting discussion. Each month, during term time, three expert 'witnesses' are invited to help us to explore a particular area. They tend to be from outside Cambridge, and by inviting a rich mixture of policy and decision-makers from governments, researchers and business and technical experts, the Forum aims to derive fresh and innovative perspectives and generate new trans-disciplinary research questions.

Our themes

The general theme of all the Forum discussions is 'sustainability in an uncertain future' and specific topics change each academic year. In our first year, we brought together a rich mixture of policy and decision-makers, technical experts and researchers to talk about sustainable cities. In October 2014, our focus shifted to a second topic, 'Land-use change', which aimed to stimulate connections between three of the University's Strategic Initiatives: Cambridge Conservation Initiative, the Cambridge Global Food Security Initiative and Energy@Cambridge. During these meetings, we explored the challenges we face as we place ever increasing and sometimes competing demands on land and natural resources.

Our third topic was 'Risk, resilience and response', and each term we explored a different theme. In addition to the meetings outlined in this report, in October, November and December we discussed food and water security and supply chain resilience in meetings jointly hosted with the Joint Research Centre (JRC). In April, May and June we explored energy resilience and ways in which bioenergy (based on photosynthesis) can be used as a deployable and sustainable energy source for off-grid situations'.

Forging New Connections

Our topic for the year was risk, resilience and response. In January, February and March 2016, we focused on resilience in cities and ways in which big data and technology will shape the way we view and live in them in the future.

In the first two meetings, 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 to short-term shocks and long-term changes in the environment. In the final meeting, we turned to catalyzing change and ways that cities can become more resilient in practice.

This summary provides an overview of these three discussions and some of the 'wicked problems' and questions they generated.

Year 3: Risk Resilience, and Response

Between January and March 2016:

8	**26**	**600+**
Expert witnesses, including a policy expert from Willis Group, a member of the Joint Research Council (JRC) and the Director of the Centre for Risk Studies, and people from…	**University departments, Centres and Initiatives and…**	**People have come to public events co-hosted by the Forum to debate, ask questions and talk about what they think future cities should and could be like.**

Meeting themes

Layers of data

The first meeting for our overarching topic of cities started by exploring new ways to bring together data sets from different sources and to build models to assess both risk and resilience in cities and to formulate responses.

Our first witness was **Professor James Jackson**, Professor of Geophysics, Geodynamics and Tectonics and Head of the Department Earth Sciences. He joined **Dr Elisabete Silva**, a Senior Lecturer in Planning in the Department of Land Economy, and **Professor Danny Ralph**, Professor of Operations Research and Academic Director of the Centre for Risk Studies (CRS) in the Judge Business School.

Emerging technologies

In the second meeting in the cities series, witnesses helped us to think about how we can bring different kinds of data sets together to assess vulnerability and risk in cities.

Our first witness was **Rowan Douglas**, the CEO of Capital, Science & Policy Practice at Willis Group, a global risk advisor, insurance and reinsurance company. He also spoke briefly on behalf of **Dr Ana Gonzalez Pelaez**, a Fellow at the Cambridge Institute for Sustainability Leadership (CISL), who was not able to come to the meeting. He was joined by **Dr Emily Shuckburgh**, a climate scientist and deputy head of the Polar Oceans Team at the British Antarctic Survey.

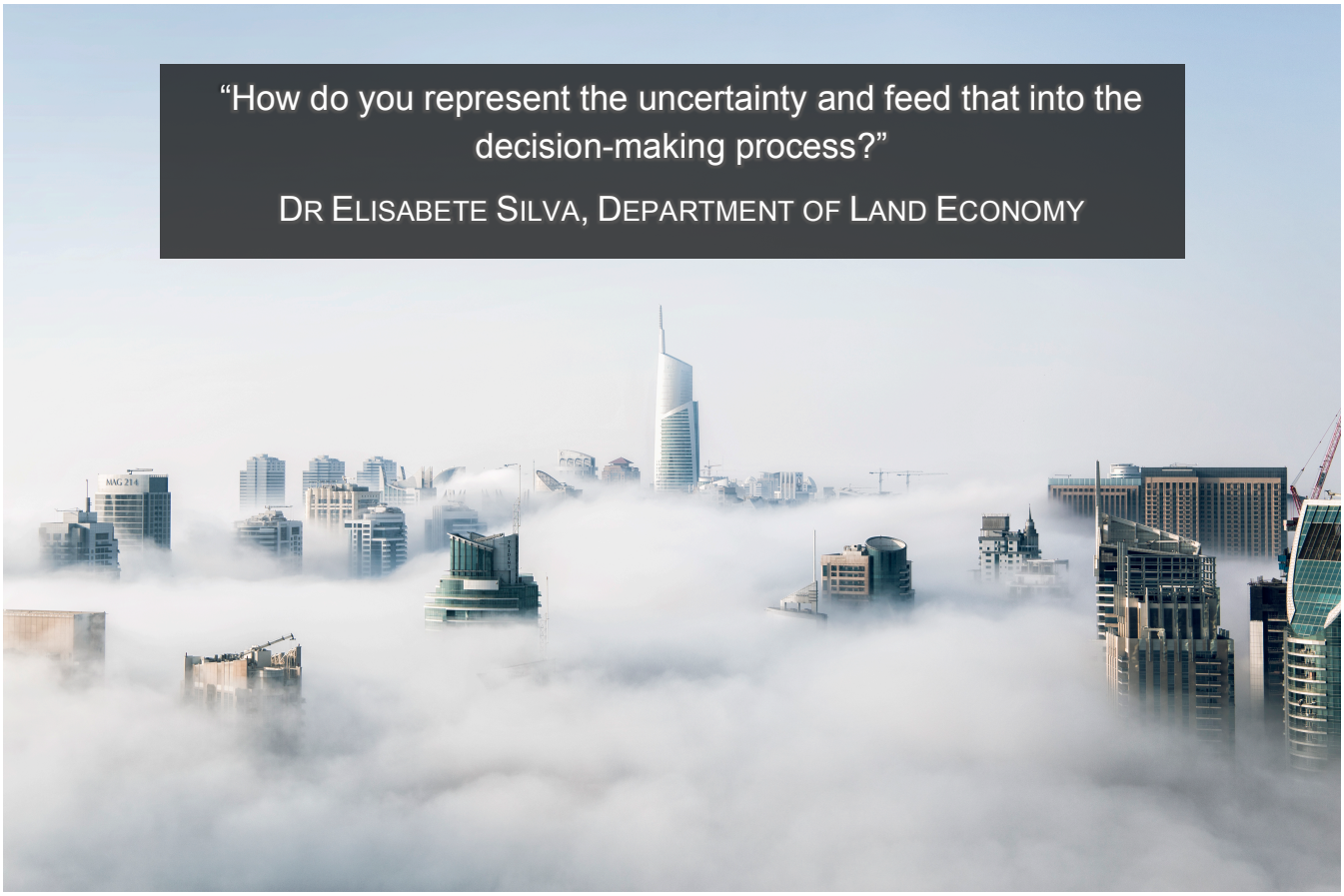
Catalyzing changes in cities

For the last meeting in the series the three witnesses helped us to explore what resilience means on the ground and how cities can become more resilient in practice.

Our first witness was **Sérgio Freire,** representing the GHSL project from Global Security and Crisis Management Unit of the European Commission's Joint Research Centre (JRC). He joined **Dr PB Anand** (Anand Prathivadi Bhayankaram) from the Centre for International Development, University of Bradford and **Professor Michael Batty**, Bartlett Professor of Planning at University College London and Chair of the Centre for Advanced Spatial Analysis (CASA).

Theme Summary

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, 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 stated 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. 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 Professor James Jackson highlighted. There is a disparity in the 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.

Choosing the best metrics for modelling risk requires on-going 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 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.

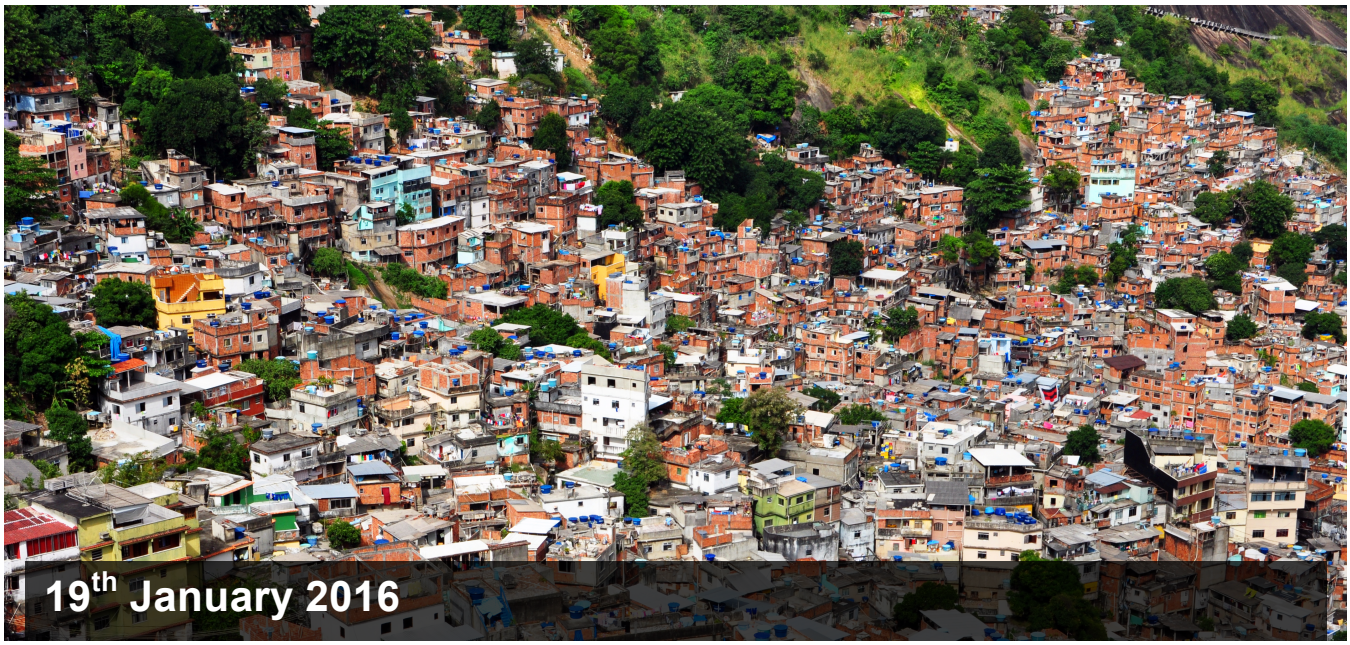
There were numerous **other challenges considered with regards to metrics.** The interactions between different and successive catastrophes need more analysis, as do the direct and indirect effects of catastrophes outside the original impact centre. Events which have a wider impact, such as the eruption of the Icelandic volcano, Eyjafjallajökull, introduce more complexity and uncertainty into the models. 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 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 explored another use of **big data as an emerging tool** in the context of transport planning. By being able to stream real time data for London public transport a synthetic baseline can be created, against which disruptions can be compared and resilience to the system assessed.

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**. Currently 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. Development planning needs to liaise with the insurance industry to increase resilience integration. Datasets need to be widely available, and the hoarding of data by private companies might diverge from wider societal goals such as inclusivity.

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 needs to be involved in the decision-making regarding which areas can or cannot be sensibly protected from disaster due to 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 throughout the forum, and it was observed that the role of an institution like Cambridge University and its various academic units, including this Forum, should be to help bridge these levels.

Layers of data



Research gaps

This forum examined what is needed to improve the ability of planning systems and decision makers to incorporate knowledge of risk into developing appropriate response measures and resilient systems for shaping cities. This encompassed the difference between developed and developing contexts and new ways to model risk.

Discussing earthquake risk, **Professor James Jackson** suggested exposed countries (mainly on the Pacific Rim) are well prepared due to greater wealth, awareness of the threat and actioned policy. The damage suffered is mainly counted in capital. Conversely, Continental Asia faces problems that lead to a high death rate after an earthquake. These include the following: the large geographic distribution of earthquakes (leading to local complacency); concentrated population in geologically sensitive areas; lack of communication between, or responsibility taken by, various stakeholders (e.g., scientists, engineers, policymakers and the public); reliance on baseless short-term earthquake prediction as a mitigation strategy; and competing short-term priorities. A complex mixture of corruption, poverty and particularly a lack of education must be tackled to rectify these problems.

Dr Elisabete Silva examined problems linked with risk, resilience, the planning system and datasets. Risk and risk reduction are complicated metrics and often need to be related to social economics. These create datasets that are aspatial and these can conflict with spatially explicit planning systems. Additionally there are conflicting scales of time. To successfully incorporate resilience the planning system needs to utilise dynamic data and metrics; however, most datasets and metrics currently used are static. To combat this, we need to create adaptive models and, in turn, flexible policies that account for changing scenarios produced by dynamic data.

Professor Danny Ralph introduced the work of the Centre for Risk Studies in assessing the risk of economic loss in 300 major world cities as a result of a wide variety of catastrophes (including earthquakes, pandemics, war, market crashes, etc.). A key aim is to make tools for visualising and managing systemic risk that can be used by ordinary firms and organisations. Such an assessment helps identify and confront areas where there is a lack of knowledge or models. It is crucial to try and discuss all threats to challenge gaps in current governmental and risk management thinking. A critical problem is the challenge of understanding resilience, particularly when a thorough assessment starts to extend towards broad topics such as social, commercial or legal mechanisms. Furthermore, translating resilience indexes into practical steps to build resilience needs further examination.

Wicked problems and questions generated by the open discussion

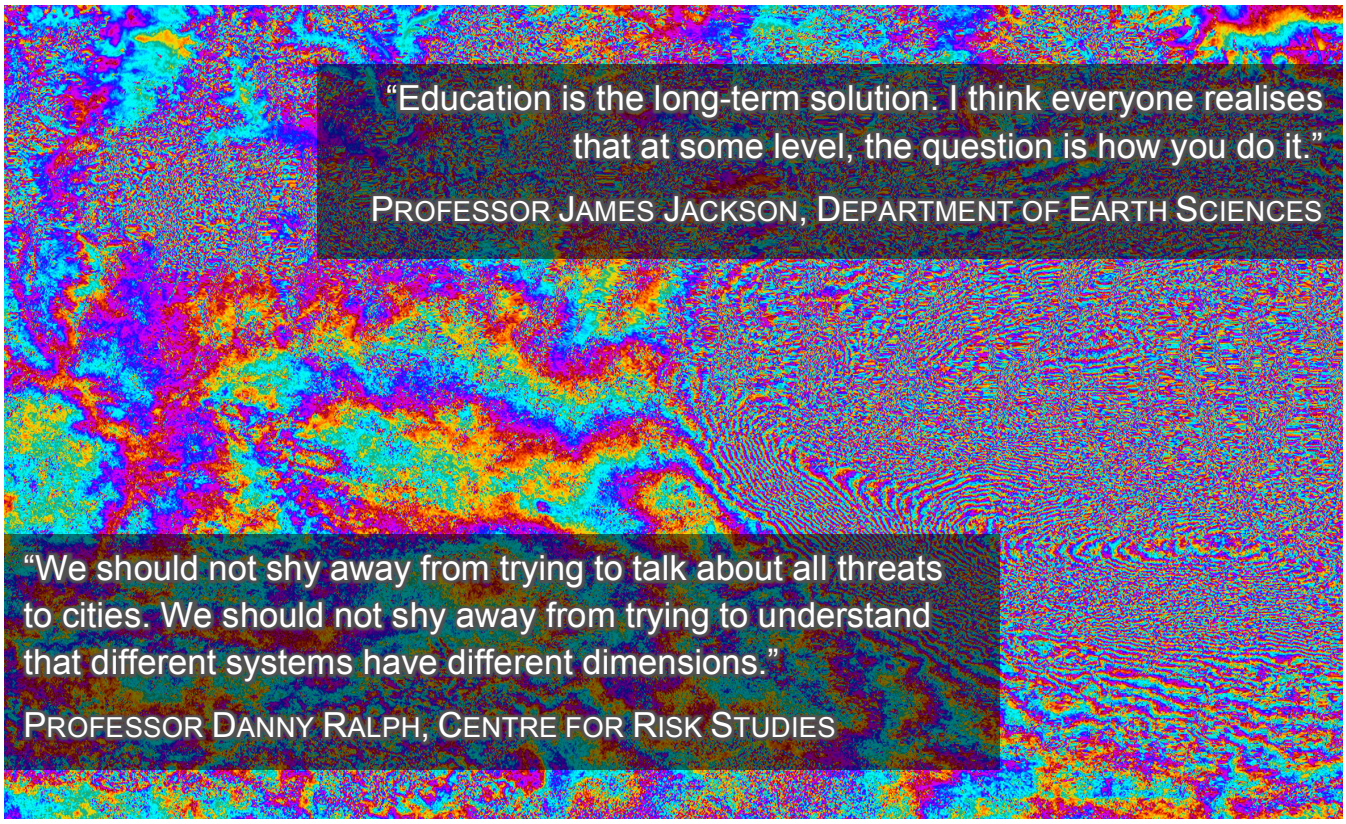
Dr Anand (whose profile can be found in the second meeting) offered an extended comment on the first two witness perspectives. He highlighted recent research into the correlation between corruption and earthquake mortality and suggested there needs to be more preparedness and systems which enable quick responses to disaster. Society as a whole needs to decide in a transparent manner what is considered an acceptable or optimal level of risk, as not all risk can be mitigated. As things stand, redistribution after a disaster is favoured over mitigation beforehand, and this balance needs to be shifted. Engagement with public and private mechanisms is crucial for this process. With regards to the data dynamism in planning systems, Dr Anand had three questions: **can we adapt static datasets for quasi-dynamic usage**, **can planning systems and decision-making become dynamic in their responses to data**, and **can planning systems adapt to the dynamic expectations of various individuals to shape a city?**

How can we make planning systems more adaptive? Big data combined with dynamic data means that modelling scenarios are constantly being updated, but often planning systems are not flexible enough to incorporate these changes without substantial delays. Perhaps a more flexible system incorporating certain milestones will allow dynamic models to be fully utilised.

How can knowledge about risk and resilience be shared at an urban planning level? Cities and institutions are not effective at learning from each other. Risks such as telecommunication issues after a disaster or air traffic control issues in cities with central airports are entirely predictable but experience is not effectively imparted to other decision makers.

What is the role of insurance in creating resilience? The population is generally not fully aware of risk which can lead to complacency when rebuilding or creating mitigation measures. Planning is crucial to increasing resilience, but integrated development plans are not always put into practice. The insurance industry and the development process need better cohesion at government and developer or constructor levels. Social insurance as opposed to private insurance is also a possibility that should be considered. A related question is how can we overcome short-term timeframes? Insurance policy and modelling practices or government election cycles can mean long-term resilience is overlooked.

How can we increase levels of community trust and cohesion at all levels of society? A collective response helps a community cope with a disaster. Additionally, in terms of mitigation strategies, the public need to understand and trust decisions concerning when an area can or cannot be protected from disaster on account of cost or resources.



What is the relationship between different catastrophes? Having two successive 1 in 50 year events may increase or decrease the overall effect of the catastrophe and the relationship between events needs further modelling. **How can we model direct and indirect effects of catastrophes on areas outside the original impact centre**? For example, the Icelandic volcano, Eyjafjallajökull, affected air transport across Europe and a pandemic, war or economic crisis would have wide-ranging impacts. This introduces more complexity and uncertainty into a model.

How much redundancy or resilience should be built into infrastructure? There is a balance between added cost versus the reduction in risk. Unexpected shocks to a system can have an overwhelming effect as properly implemented engineering construction usually performs well when dealing with known risk, as opposed to unforeseen events. Where the consequences of disaster are high or functionality will be needed post-disaster, such as in a nuclear power plant or hospital, it is preferable to overdesign buildings. However, overdoing this approach can have unintended consequences; for example, too much rigidity in a building affected by an earthquake may cause such internal damage that the building is rendered dysfunctional.

How do we introduce redundancy into social systems? Redundancy in physical systems is relatively easy to model. But incorporating elasticity into socio-economic systems is more challenging and often overlooked. Expecting logical behaviour from individuals in a crisis is unrealistic. Thus, better preparation on the behalf of planners is needed so that physical resilience measures are used appropriately.

Witness profiles

Professor James Jackson

Professor of Geophysics, Geodynamics and Tectonics, Head of the Department of Earth Sciences, University of Cambridge

James is an earth scientist whose work mainly attempts to understand the deformation and geological evolution of the continents. He uses earthquakes, space-based geodesy and imagery, as well as observations of landscape and Quaternary geology, to investigate the tectonic processes that shape the continents. He is part of the Dynamic Earth and Geohazards group (formerly the COMET project), the National Centre for Earth Observation and the Centre for the Observation and Modelling of Earthquakes and Tectonics. He is also the lead PI on the Earthquakes without Frontiers Project, a joint NERC-ESRC consortium working to help increase resilience to earthquakes in countries in Asia.

Professor Danny Ralph

Professor of Operations Research, Academic Director of the Centre for Risk Studies (CRS), Judge Business School, University of Cambridge.

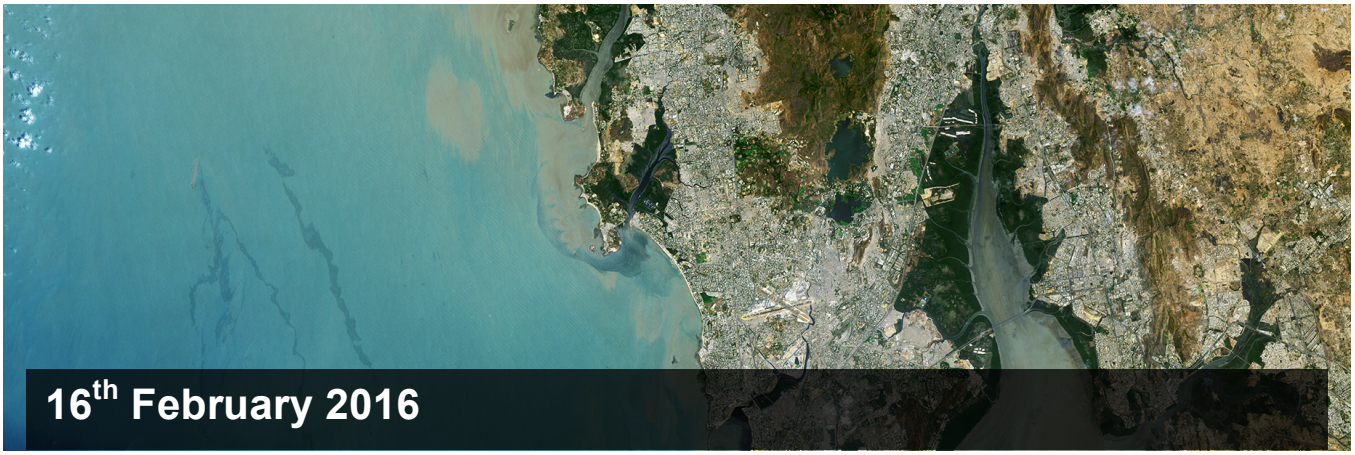
Danny is a founder and director of the CRS and Professor of Operations Research at Cambridge Judge Business School. He is also a member of the Australian Mathematical Society, INFORMS, the Mathematical Optimization Society and SIAM. He was editor-in-chief of Mathematical Programming (Series B) from 2007–2013 and has served on the editorial boards of Mathematics of Operations Research and the SIAM Journal on Optimization. He is interested in risk aversion in electricity markets, risk in business decision-making and methods and models for optimisation problems and equilibrium systems.

Dr Elisabete A Silva

University Senior Lecturer, Department of Land Economy, University of Cambridge

Elisabete's research interests are centred on the application of new technologies to spatial planning, especially city and metropolitan dynamic modelling through time. She is a Fellow of the Royal Institution of Charter Surveyors, a member of the Royal Town Planning Institute, the Chair of the AESOP NTTG research working group and is currently the Chair of the AESOP "Best Paper Price Committee" which nominates the best annual paper published amongst 48 peer review journals.

Risk and vulnerability



Research gaps

This forum examined the link between risk and sustainability. Insurance frameworks pertaining to risk were posited as a means to create coherence between financial, legal and political structures, underpinned by a scientific analysis. The forum also considered how our understanding of the environment affects human rights.

Rowan Douglas initially praised the work of various Cambridge groups (CSaP, CISL and CRS) and emphasised the role of Cambridge University in continuing to bridge the gap between academia and the wider world. The reinsurance industry has gone from relative ruin to relative resilience as a result of smarter capital, scientific revolution—including catastrophe risk modelling—and public policy revolution. It now caters for a 1 in 200 year risk. Rowan contends that sustainability and resilience should be looked at through this prism of risk and that desirable aims can be attained through better management of risk. As such, there must be a coherent framework for managing risk, which must link science, finance, law and public policy.

Dr Emily Shuckburgh discussed the challenges the scientific community faces in order to provide the evidence needed to support resilience, particularly in relation to weather and climate events. Only 10–20% of public sector climate finance is spent on adaptation rather than mitigation measures. This is caused by gaps in finance, technology, knowledge and will. There are four areas for improvement to support resilience. First, there is a need to gather and process more data, particularly that which is local and impact relevant. Second, the metrics for risk, mitigation and adaptation must be revaluated. Third, instruments that account for uncertainty in decision-making must be found. Finally, the interface between science and legal and political decision makers needs greater scrutiny.

Rowan also spoke briefly on behalf of **Dr Ana Gonzalez Pelaez**. Despite uncertainty, we have a reasonable understanding of environmental and climate risks. The Human Rights Council asserts that natural disasters only become disasters as a result of human action leading to exposure and vulnerability. Also, groups such as the UN and OECD have led globally to ensure that governments and businesses become legally responsible for failures to protect human rights in the face of climate risks. By extension, natural disaster risk resilience should become a human rights issue for the public and private sectors.

Wicked problems and questions generated by the open discussion

Is the '1 in 200 years' criterion for insurance always appropriate? Such a criterion may overlook large, rare risks. For insurers, 1 in 200 years represents a minimum capital requirement but most companies will consider longer-term risks. Although the insurance industry has found this metric useful, society has to decide on what is appropriate as a minimum standard of resilience in different contexts (e.g., for insurance, New Zealand has now increased its standard to 1 in 1,000 years). A minimum requirement may force organisations to assess and disclose their risks and hold contingent capital or resources and promote conversation about managing extremes.

Is climate change currently too difficult for society to manage? How do you engage communities that are not directly affected by disaster? Perhaps an improved understanding and disclosure of risk will help people make informed decisions.

How do we manage uncertainty? In creating a coherent framework how do you deal with techno-scientific risks which may be new and qualitatively different than previously categorised risks or more abstract challenges like the threat to biodiversity or mental health issues in society? Furthermore, **how do we build resilient systems without knowing the exact risk?** Is there a danger that by having metrics you neglect

areas that are less quantifiable? Often assessment gets reduced to a cost benefit analysis which can overlook things that cannot be easily valued. **How can you insure something when its scale or value is not yet known?** In part, the insurance industry always attempts to value any risk regardless of the knowledge base (guessing rather than ignoring if necessary), and one proposed solution is to do more work in valuing and legislating protection for our more abstract assets such as ecosystem services. A focus on exposure to loss rather than the actual hazard also mitigates some of this uncertainty. Creating coherency with regard to our language and frameworks and incorporating them into legal, financial and other major human systems is crucial. Ideally this would include open platforms for modelling being made available to the wider community.

Are we capable of handling complex data? We can often take steps to simplify our data to give global conclusions (such as average temperature), but for creating adequate response frameworks you need more local information which increases the need for data and managing uncertainty. Machine learning may help in this regard but it is not at the stage where it can replace judgement, policy and meaning abstraction.

What is the exact relationship between risk, the government and the individual? Is there a danger that our current situation creates a narrative whereby the government acts as 'hero' protecting the individual in need of rescuing, thus negating individual responsibility?

Should we be using a utilitarian framework to value our future? There are different ethical theories which could influence how we would understand and value human benefit and wellbeing. Risk, resilience and sustainability are all concepts that garner meaning from ethical and political choices. Can such terms be considered purely technical when different people will imagine and accept different futures and risks?

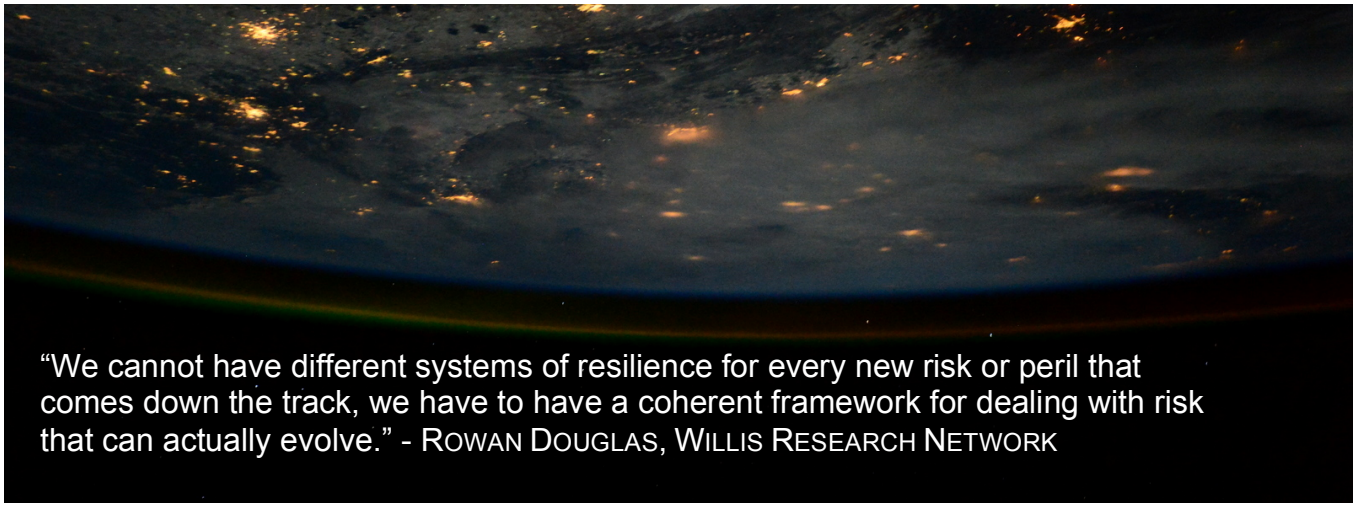
Witness profiles

Rowan Douglas
CEO, Capital, Science & Policy Practice and Chairman, Willis Research Network, Willis Group

Rowan leads the Capital, Science and Policy Practice at Willis Group which confronts large-scale challenges of risk, resilience and sustainable growth at global and local scales. He founded the Willis Research Network in 2006 which is now the world's largest collaboration between public science and the finance sector. Rowan also chaired the UN International Strategy for Disaster Reduction Private and Financial Sector Working Group which prepared the second UN Hyogo Framework for Action Agreement in 2015 as well as the World Meteorological Organisation Expert Advisory Group on Financial Risk Transfer.

Dr Emily Shuckburgh
Deputy Head of the Polar Oceans Team, British Antarctic Survey (BAS)

Emily is a climate scientist and deputy head of the Polar Oceans Team at BAS, which is focused on understanding the role of the polar oceans in the global climate system. She holds a number of positions at the University of Cambridge, including fellow of Darwin College and the Cambridge Institute for Sustainability Leadership and associate fellow of the Centre for Science and Policy. Additionally, she is a fellow of the Royal Meteorological Society and co-chair of their Climate Science Communications Group. She has also acted as an advisor to the UK Government on behalf of the Natural Environment Research Council, and in 2016 was awarded an OBE for services to science and the public communication of science.



"We cannot have different systems of resilience for every new risk or peril that comes down the track, we have to have a coherent framework for dealing with risk that can actually evolve." - ROWAN DOUGLAS, WILLIS RESEARCH NETWORK

Catalyzing changes in cities

Research gaps

The presentations examined defining resilience and effective responses to hazards, the use of big data in managing transport systems and the use of satellite data to model and compare development. The discussion explored issues concerning private versus public data sources and what is needed to make a resilient city.

Dr Prathivadi B. Anand used case studies to demonstrate the challenges of defining resilience. A city's resilience is dependent on time horizons, the conditions it is subject to and the system (physical, institutional, social, etc.) under stress. For example, in December 2015, Chennai suffered record rainfall which was in contrast to the more common hazard of drought. Problems with communication network protocols and infrastructure led to slow early response. This was evidence of fragility and vulnerability: two concepts related to resilience. There can also be competing/complementing types of resilience, such as that of institutions and social networks. After a catastrophe, or when new information is available, resilience can be reassessed. This data can be used to analyse consequences, create stress tests and question delays in creating a response to risks. During the discussion, Dr Anand clarified that resilience is not a threshold but a subjective continuum.

Professor Michael Batty suggested that cities are intrinsically resilient as they are built by a resilient humanity. Like Dr Anand, he also highlighted the changing nature of resilience, which is dependent on its time and spatial conditions. Big data is an emerging tool, and Professor Batty discussed the streaming of real time data for London's public transport. By creating a synthetic baseline, disruptions and their effect on the behaviour of commuters can be measured in comparison to the norm. For example, during the 2012 Olympics people adapted to the increased thoroughfare by changing their normal routes. Despite limitations (such as incomplete data), we can use big data to build a more comprehensive picture of travel.

Sérgio Freire sought to illustrate the connection between resilient cities, policy and data. First he considered the fundamental definition of a city: how many are there, where are they located and what are their sizes, shapes, outlines and names? Using Landsat imagery, combined with other sources of population and building data, his team has mapped four periods between 1975 and 2014 to capture 'time slices' of the earth's development. This provides valuable information on the changing makeup of urban areas and activities and the ability to compare development across the globe.

Wicked problems and questions generated by the open discussion

How do we create a hierarchy of resilience? Do we take a human rights perspective and start with the sanctity of life? Should the needs for a resilient city be decided by its people rather than governments?

How do you decide what data you need to assess a resilient city? Each city faces its own challenge, so the nature of resilience and the method of assessment are continually changing.

How do you decide which data you need? Which comes first, theory or data? Big data may be incidental to the problem and we need more experience of it. Traditional datasets (e.g. GDP per capita) do not measure more complex issues such as inequality or social cohesion.

Are private caches of data acceptable? Large companies have huge data resources compared with some public projects. Can we assume such players are benign and their agenda aligns with goals such as inclusivity? How can government and civil society catch up?

Is nuance lost in big data? Particularly in relation to environmental risk and the individual.

Levels of trust in institutions are important: A lack of trust can lead to public disengagement

Witness profiles

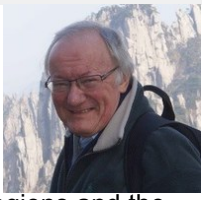
Dr Prathivadi B Anand

Reader in Environmental Economics and Public Policy, Bradford Centre for International Development, University of Bradford

Dr Anand is a specialist in environmental economics and public policy for promoting equality, human development and sustainability. He has over 25 years of professional experience including 8 years in public and private sector positions. A Reader at the University of Bradford since 2007, he was also the team leader and principal author of the Mongolia National Human Development Report 2011 for UNDP. He has played key roles in the Caribbean Development Bank programme (2006–09) and Tajikistan (2004–07). Prior to this he led and delivered a special programme for the Ministry of Finance and Economic Development of the Federal Government of Ethiopia (2002–04) and the Federal Ministry of Finance in Nigeria (2005).

Professor Michael Batty

Professor of Planning and Chairman, Centre for Advanced Spatial Analysis, Faculty of the Built Environment, University College London (UCL)



Michael is, by training, an architect-planner. He is currently Bartlett Professor of Planning (Emeritus) and Chairman of the Management Board of the Centre for Advanced Spatial Analysis (CASA). He has been at UCL since 1995 building up CASA as an interdisciplinary centre focused on the development of mathematical and computer methods in geographical information science, urban and regional modelling and the scientific theory of cities. His most recent book *The New Science of Cities* is published by MIT Press (2013). His interests include in the city planning, the development of computer models of cities and regions and the scientific theory of cities.

Sérgio Freire

Scientific/Technical Project Manager, DG Joint Research Centre (JRC), Institute for the Protection and Security of the Citizen (IPSC), Global Security and Crisis Management Unit

Sérgio Freire is a geographer and he focuses on developing applications of the JRC's Global Human Settlement Layer (GHSL) in the context of disaster exposure, risk and vulnerability analysis, including modelling population distribution at a range of spatial and temporal resolutions. His current activities also include global mapping and characterization of human settlements, and developing satellite-based indicators to support monitoring of Sustainable Development Goals. He has previously worked at the National Center for Geographic Information (Portugal), at the Portuguese Geographic Institute, and at Universidade Nova de Lisboa, researching land use and land cover mapping, developing integrated forest fire risk methods and extracting features from high-resolution satellite imagery for urban planning.

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