Feeding the world

How can food supplies and supply chains be made more resilient?

At a glance

The overarching theme of our third topic was 'risk, resilience and response' and between October and December 2015, we focused on food water security and supply chain resilience. These three meetings were jointly hosted with the Joint Research Centre (JRC) of the European Commission and formed the core of a pilot activity under a new Memorandum of Understanding between the two institutions to enhance inter-institutional collaboration.

'Green growth and sustainability' was chosen as the pilot topic and the Forum worked with JRC and University Strategic Initiatives, including the Cambridge Conservation Initiative and the Global Food Security Initiative, to develop a series of meetings and projects to explore potential areas for future collaboration. The three co-hosted Forum meetings formed the focal point of this programme and each month, expert witnesses and guests from the JRC came to Forum meetings and helped to shape the theme as a whole.

This summary provides an overview of some of the 'wicked problems' and questions generated during these discussions. Additional outputs put these questions in a broader context and explore potential future collaborations between the JRC and Cambridge.

Taking a global view

The quality and quantity of data were both recurring themes throughout the discussions. In the first meeting, Professor Alan O'Neill, the founding Director of the NERC National Centre for Earth Observation, highlighted that big data is providing new kinds of datasets and opportunities to measure resilience and risk at a global scale in real-time and at high resolution. However, the volume, complexity and heterogeneity of large-scale datasets also pose challenges for both researchers and policymakers. As a result, there is a need to train more data scientists who are not only technical experts but also familiar the underlying environmental, social and economic issues.

This will enable them to know both what questions to ask and how the data can be used to answer them. Although innovation and developing new techniques is important, solving some of these problems may not necessarily involve more advanced technology. Dr Matt Smith, an ecologist who works in the Computational Science Lab and Microsoft Research, suggested that some of the data challenges we face are quite basic and technical solutions already exist, perhaps in other fields. Finding ways to apply existing technology to solve problems is therefore as important as developing new technologies.

In addition, Thierry Nègre, the Head of the Food Security (FOODSEC) Group at JRC, suggested that, despite the recent advances in data collection, there is an issue with the scarcity and quality of data in areas such as food security or food production. This was, particularly in developing contexts because of issues such as the lack of resources or funding and institutional barriers rather than due to any particular technological limitations. This compromises the ability to develop accurate models in key areas. The limitations posed by institutional barriers with regard to both data collection and effective use of data was mentioned frequently throughout the meetings.

Turning data into information

A related problem was that of turning data into useful information and then communicating that information in a meaningful way to end-users. Currently, there is a disconnect between the amount of data, the information gleaned from these data and people's ability to turn theory into practical solutions. For example, satellite programmes such as the new Copernicus 'family' of satellites are generating vast amounts of high resolution data which will enable us to see global environmental changes in a way never before possible. Being able to process and analyze data on such a massive scale is a huge challenge in itself. Turning those data into information people can use to make decisions adds another layer of complexity. Craig Mills, the CEO of Vizzulaity, described the work his company does to visualise complex scientific datasets to create clear,

Key questions

Through our discussions, we identified four key areas where more research is needed:

- **How can we move from tracking historical trends in food and water supplies to identifying emerging risks and create future projections and scenarios?**

- **Decisions are taken at multiple scales from local to international. What place does satellite data have in decision-making at all of these scales and is it feasible to use it to make local scale decisions?**

- **Given the pace of change, how do we collect and analyse data in a way that feeds into policy processes in time to be most effective?**

- **What role can citizen science play a role in this 'new world' of open, big data?**

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Catalyzing collaboration

To help facilitate the collaboration between JRC and Cambridge, an EPSRC Institutional Sponsorship Grant was given to a joint project between the Forum and the Global Security and Crisis Management Unit at JRC. This four-month project employed a Cambridge-based research assistant, Adrià Descals Ferrando, to start to explore questions which could be answered by overlaying two of JRC's remote-sensing datasets:

Global Surface Water Explorer, which measures changes in the location and persistence of surface water globally, by region or for a specific area.

Global Human Settlement Layer, which provides information about where people live, how big settlements are, how they have changed over time and the density of built up areas.

Both of these have unprecedented levels of spatial detail for global data (30m resolution) and span the last 30 years. The project explored ways in which combining data from both of these could provide information to inform policy, such as tracking progress towards the Sustainable Development Goals, and enable faster responses to environmental extremes and acute threats.

Taking a systems approach

The resilience of food chains was examined, and Dr Mukesh Kumar, from the Institute for Manufacturing, identified three principle areas of concern: crop failure, product failure and supply chain failure. This was echoed by Professor Jaideep Prabhu from the Judge Business School who discussed food waste in developing countries stemming from supply chain issues, such as the lack of information for farmers concerning neighbouring areas and consumer requirements as well as the need for a better cold chain.

Throughout the three months the need for a multidisciplinary approach to food security was emphasised, by Dr Francois Kayitakire. He leads a team working on resilience and on food and nutrition security assessment at JRC and he argued that there are a number of interrelated issues that must be considered as part of a system approach. These range from conflicts surrounding resources to the need for income-related social protection to help bolster access to food. Our goals and the means to achieving them should therefore orientate around a problem, rather than a discipline. This general approach was echoed by Dr Drew Purves, an ecologist who now works for Google Deepmind. He emphasised that food must be part of a global system, particularly given the increasing risk posed by climate change. It was also repeatedly stated that a long-term view is needed to build resilience in food and water systems, although short-term interventions are also needed when an immediate impact is required.

communicable messages that people can interact with and understand. He and his team often have to work closely with researchers to ensure that the messages from the data are clear and simple while still maintaining its scientific integrity. Presenting complex information is a real challenge and both technological solutions and way the results are communicated needs to be adapted to suit the target audience. More research into how data affects decision makers was also recommended, as there can be external factors that override the influence of scientific advice on policy decisions.

Using big data effectively and ethically was another recurring theme. Stephen Peedell, a specialist in geospatial information technology from the Land Resource Management Unit at JRC, argued that remotely sensed data does not replace the need for ground sensors and information, but instead compliments it. Remote sensing data will always needs to be 'ground-truthed', and aligning it with economic, social and biological data provides both context and cements connections between changes in the environment and the effects on people's lives. Consequently, there also needs to be better links between large-scale datasets and data that are gathered at a more local level.

There were also concerns over the proprietary nature of some datasets, issues regarding data standards and data confidentiality. Publicly funded institutions such as the Joint Research Centre have open data policies and strict guidelines surrounding data standards as well as the infrastructure to provide technical and content updates and support. Other data providers, such as private companies, do not have such obligations and can choose which data they put in the public domain, for how long and the conditions they attach to using it. Privately held data contains a wealth of detail and information and there is a danger that if these datasets are not openly and transparently made available, opportunities to address local and global scale challenges may be lost. Sharing data may raise confidentiality concerns, but these should be weighed against the potential value derived from data being examined from a wide range of perspectives.

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) and Simon Patterson (Content Writer and Editor).

Forum members for this topic were drawn from 15 Departments, Centres and Initiatives, including: Prof. Alison Smith (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. Doug Crawford-Brown and 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. Paul Dupree (Dept. of Biochemistry); Prof. Peter Guthrie (Dept. of Engineering); Dr Shailaja Fennell (Centre for Development Studies) and Prof. Susan Owens (Dept. of Geography).

Witnesses:.Stephen Peedell, Dr Francois Kayitakire and Thierry Nègre (JRC); Dr Mukesh Kumar (Institute for Manufacturing, University of Cambridge); Prof. Alan O'Neill (Cavendish Laboratory, University of Cambridge); (JRC), Dr Matthew Smith (Microsoft Research), Craig Mills (Vizzualaity), (JRC), Prof. Jaideep Prabhu (Judge Business School) and Dr Drew Purves (Google Deepmind).

Internal guests: Dr David Coomes and Dr Will Simonson (Dept. Plant Sciences); Prof. Keith Richards and Therese Rudebeck (Dept. of Geography); Dr Marla Fuchs (Research Strategy Office); Dr Martin Roberts (Cambridge Centre for Sustainability Leadership); Dr Nazia Mintz-Habib (Centre for Development Studies) and Kirsten Van Fossen (IfM).

External Guests: Gregoire Dubois and Dr Pamela Kennedy (JRC); Daria Dadam (BTO); Dr Gavin Shelton, (FFI); Dr Graeme Buchanan (RSPB); Prof. Neil Burgess and Tim Wilkinson (UNEP-WCMC) and Simao Belchior (Vizzuality).

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