Institution:
University of Cambridge

Unit of Assessment:
UoA16

Title of case study:
Cambridge University Centre for Risk in the Built Environment

1. Summary of the impact (indicative maximum 100 words)

The Cambridge University Centre for Risk in the Built Environment (CURBE) investigates techniques to identify, monitor and assess risk. Since 1997, CURBE's research contributed to real-world applications that reduce detrimental impacts of natural and manmade hazards, including the recent Haiti earthquake. Collaborators and users of the underpinning research include the British Council, the Government Office for Science, the US Geological Survey and Federal Emergency Management Agency in the USA, UN Habitat and private modellers and insurance companies involved in risk such as Risk Management Solutions and Willis Re.

2. Underpinning research (indicative maximum 500 words)

The underpinning research was conducted principally by Professor Robin Spence (Professor of Architecture since 1997), Dr Emily So (Research Assistant from 2005-09, University Lecturer from 2012) within the Cambridge University Centre for Risk in the Built Environment (CURBE). The scientific research at CURBE has been instrumental in managing and reducing risk and will continue to save lives.

Mainly concentrating on natural hazards such as earthquakes, floods, volcanoes and tsunamis, the fundamental research at CURBE seeks to reduce the risk of these perils, by analysing past events, developing new methods of modelling and bringing together close cooperation between architects, engineers, earth scientists and public health specialists.

Much of this work has been conducted jointly with Cambridge Architectural Research (CAR) Ltd (of which Spence and So are Directors), who has contributed modelling and data analysis expertise to extend the basic research undertaken at CURBE into applications. Two major research areas which have exploited CURBE's long understanding of earthquake risk are presented here.

The first is in the assessment of vulnerability of buildings, the likely building damage and human casualties from earthquakes. Spence pioneered the work in the classification of damage by classes of building and levels of damage (Coburn and Spence, 2002). The methodology and data developed by CURBE are central to models in use today for both pricing and exposure-limitation in insurance and reinsurance; the Global Earthquake Vulnerability Estimation System (GEVES), (Spence et al., 2008) being one. Fundamental to the methodology is the collection and analysis of empirical data. UK's Earthquake Engineering Field Investigation Team (EEFIT) which was co-founded by Spence in 1982 is now partly funded by EPSRC as the council's on-going commitment to bettering seismic data collection and research. EPSRC has also funded CURBE members on visits to damaged areas after the Pisco, 2007, Wenchuan 2008, Samoa, 2009, L'Aquila 2009, Haiti, 2010 and Tohoku, 2011 earthquakes.

The estimation of earthquake induced casualties is crucial to planning mitigation and emergency management strategies. This work was first carried out in *LessLoss* (2005-2007 EU funding, Spence as PI). So has since been actively involved in the assessment of human casualties, improving understanding of how casualties occur in natural disasters and providing key parameters for loss estimation models.

The second related area is in the innovative use of remote sensing for post-disaster damage and recovery. In *Use of remote sensing for earthquake damage assessment* (2001- 2004 EPSRC funding, Spence as PI), then-newly available high-resolution satellite images were analysed, and a range of techniques (manual and computerised) for preparing damage mapping were developed. The skills developed by Saito (2001 -2012) are currently used for the World Bank's post disaster needs assessment.

CURBE's skills in remote imagery interpretation were further strengthened in *Monitoring of post disaster recovery* (EPSRC 2008-2010, Chenvidyakarn as PI). The techniques developed for

assessing post-earthquake damage were applied for the first time to monitor the process of recovery. CURBE subsequently obtained EPSRC Follow-up funding (2010-2011, Ramage as PI) to develop these techniques into tools suitable for use by agencies working in the field, and EU funding for SENSUM (So as PI), a Framework to integrate Space-based and in-situ sENSing for dynamic vUlnerability and recovery Monitoring (2013-2014).

3. References to the research (indicative maximum of six references)

Major publications

1. Coburn, A. and Spence, R., 2002. Earthquake Protection (2nd edition), Wiley, ISBN 0-471-49614-6
2. Spence, R, So, E. and Scawthorn, C. (editors), 2011. Human Casualties in Earthquakes: Progress in Modelling and Mitigation, Springer Science.
3. So, E and Spence, R., 2012. "Estimating shaking-induced casualties and building damage for global earthquakes" Bulletin of Earthquake Engineering, DOI: 10.1007/s10518-012-9373-8, ISSN: 1570-761X.
4. Spence R, 2007. "Saving lives in earthquakes: successes and failures in seismic protection since 1960" Bulletin of Earthquake Engineering, Springer, 5/2, May 2007, 139-251.
5. Spence, R., So, E., Jenny, E., Castella, H., Ewald, M. and Booth, E., 2008. "The Global Earthquake Vulnerability Estimation System (GEVES): an approach for earthquake risk assessment for insurance applications" Bull of Earthquake Engineering Vol 6 (3) pp 463-483.
6. Tompkins, E.L., Penning-Rowsell, E, Parker, D., Platt, S., Priest, S., So, E., Spence, R., 2012. Institutions and disaster outcomes: successes, weaknesses and significant research needs (WP9), Report to Government Office for Science: Foresight Disasters project.

Recognition of research contribution

Professor Robin Spence was elected ***President of the European Association of Earthquake Engineers*** *2002-2006* and Vice President 2006-2010), and delivered the prestigious ***Mallet-Milne lecture*** at ICE in 2007. Dr Emily So was awarded the ***Shah Family Innovation Prize*** in 2011 in recognition for her work in the field of earthquake engineering and risk mitigation. So was awarded a ***Mendenhall Fellowship*** at the USGS and spent two years at the National Earthquake Information Center contributing to the development of PAGER (2009 - 2011).

4. Details of the impact (indicative maximum 750 words)

Public Safety

Saving lives from natural disasters is a priority and drives CURBE's research both nationally and internationally. The Foresight report entitled "Reducing Risks of Future Disasters: Priorities for Decision Makers" included a work package co-authored by CURBE members (Tompkins et al., 2012). The initiative was launched by the Government Office for Science in the UK (December 2012), and in it, Professor Sir John Beddington says,

"…The good news is that science has the potential to play an increasingly important role in [Disaster Risk Reduction] DRR. Science tells us why disasters happen and where many of the risks lie, and for some disasters we can even forecast when they will occur."

Internationally, through 15 years of research in assessing earthquake damage and vulnerability studies, CURBE is an authority in earthquake loss estimation models. The application of loss modelling for governments and international development agencies is relatively new; CURBE's work is an integral part of GEM, the Global Earthquake Model.

GEM is a public-private partnership to develop new open-access tools for earthquake loss modelling, suitable for use at a national, city and community level. Launched in 2009, it is the largest earthquake research programme in operation globally today and its strategy for risk assessment has been informed from the start by participation of CURBE in developing the methods for the underlying risk components. Dr So is working with CAR to develop the GEM Earthquake Consequences Database[G].

"*.. through the efforts of Prof Robin Spence and Dr Emily So ... our community now has at its disposal not only an open transparent repository of data and information on the impacts of tens of major past earthquakes around the world, but also a set of tools and standards that may be used in the years to come…"*

Secretary General, GEM[A]

Humanitarian Response

Leading the field of global practitioners in mass-casualty assessment after earthquakes, So is part of the team developing the U.S. Geological Survey's Prompt Assessment for Global Earthquakes Response (PAGER) [F] programme. PAGER provides an alert less than 30 minutes after an event has occurred, based on an estimate of the number of deaths or extent of economic losses due to ground shaking following an earthquake. Funded by USAID, these prompt alerts inform the White House and FEMA as well as UN agencies on likely impacts of earthquakes around the world. Alerted of the likely severity of the event, the precious few hours immediately after the Haiti earthquake in 2010 were used by the Office of U.S. Foreign Disaster Assistance (OFDA) to mobilise monetary and physical aid, well before the Haitian government requested help:

"*This work continues to be critical as our response actions integrate the very rapid assessment and alert levels provide by PAGER… This results in our ability to expedite assistance and potential save lives…"*

Senior Physical Scientist, FEMA Region VIII, Mitigation Division[B]

The innovative use of post-event damage mapping using remote sensing has been used by agencies to direct post disaster decisions. The techniques developed by Saito were used to assess the total damage and cost in Haiti and guided the World Bank in raising the required funding for loans (Saito et al., 2011). Ultimately the Haitian people benefited through the aid provided for reconstruction. Mapping techniques acquired through CURBE projects were used to directly assist the British Red Cross and UN Habitat with their recovery efforts in Haiti:

"*Cambridge research work was critical in terms of advocacy and advice to the Government of Haiti and resulted directly in the decision by the Prime Minister's Secretariat to recognise the area as a new permanent settlement and a political priority"*

Senior Technical Advisor, UN Habitat Haiti[D]

Commercial impact

The insurance industry relies on catastrophe loss estimation models to estimate potential financial losses to its assets at risk, and to properly price the risks. Insurance companies like ACC for Wellington in New Zealand (Cousins et al. 2008) directly benefit as they are able to expand their market with more accurate risk pricing, and ultimately the purchasers of insurance are able to offset their risks, and get payments for rebuilding in the event of an earthquake.

"In the domain of catastrophe risk, loss estimation and the impact of that research on society in general and insurance/reinsurance industry in particular, your work has been very prominent and well used as well as well referenced by the governments, academic researchers and the insurance industry. …If I have to mention few teams around the world who have made major contributions in this field, Cambridge team and the two of you will always be featured in the top three…."

Founder & Senior Advisor, RMS, Inc.[E]

Spence worked with Willis Re to develop the risk model which underpins the Turkish Catastrophe Insurance Pool through which two million previously uninsured households are today insured against earthquake damage. As part of the Willis Research Network, CURBE continues to engage with users to focus research on applications and reducing risk through different media[C].

5. Sources to corroborate the impact (indicative maximum of 10 references)

A. Letter from Secretary-General, Global Earthquake Model (www.globalquakemodel.org).
B. Letter from Senior Physical Scientist, FEMA Region VIII, Mitigation Division, Department of Homeland Security.
C. Letter from Chairman of Willis Research Network, Willis Re., UK.
D. Letter from Senior Technical Advisor, UN Habitat, Haiti.
E. Email from Founder of Risk Management Solutions, USA.
F. USGS PAGER http://earthquake.usgs.gov/research/pager/team.php
G. GEM Global Earthquake Model Consequences Database http://www.globalquakemodel.org/what/physical-integrated-risk/consequences-database/