Institution: University College London (UCL)

Unit of Assessment: 7 – Earth Systems and Environmental Sciences

Title of case study: Extreme weather services benefiting industry and humanitarian relief

1. Summary of the impact

Research conducted within the Aon Benfield UCL Hazard Centre has underpinned the development of innovative extreme weather services for the real-time monitoring of global tropical storms and European extreme weather. These services have achieved significant commercial and humanitarian impacts worldwide. Within the REF impact period these impacts included £1.319 million of income generated by sales of commercial products; 24,000 subscribers receiving free storm alerts and/or seasonal forecasts; seasonal forecasts distributed to reinsurance companies worldwide; and a contribution to lives saved in Bangladesh from tropical storm Mahasen (2013). Twenty-two international organisations have also benefited from the commercial extreme weather services; for example, they support the claims division at RSA in assessing risk, allocating resources and detecting fraudulent weather claims; and they enable the Norwegian Hull Club to alert its portfolio of over 9,200 vessels worldwide to steer clear of approaching dangerous storms.

2. Underpinning research

Extreme weather events, such as tropical cyclones, are major causes of great weather disasters. Research conducted within the Aon Benfield UCL Hazard Centre has resulted in improved, novel and timely forecasts, as well as risk information, for tropical cyclones worldwide and for European extreme weather.

The underpinning research developed incrementally since the late 1990s. The initial catalyst was a paper [1] press-released by the American Geophysical Union proposing a novel explanation for the very active 1995 Atlantic hurricane season. This study was the first to recognise the influence of sea surface temperatures (SSTs) between west Africa and the Caribbean in August and September on North Atlantic hurricane activity; forecasts of these SSTs are now employed by most leading providers of seasonal hurricane outlooks. This research breakthrough attracted funding that led in 2000 to the creation of the freely available Tropical Storm Risk (TSR) prediction service. TSR's initial service focus was seasonal forecasting, but from 2003 this expanded to include innovative real-time warning and monitoring products for live tropical storms worldwide [2].

Multiple UCL research insights underpin the TSR service developments. These include (1) recognition and quantification of the significant spatial impacts of El Niño Southern Oscillation (ENSO) on hurricane and typhoon occurrence and landfall [3]; (2) development of the first seasonal forecast model for U.S.-striking hurricanes to offer significant precision, through the discovery of significant wind patterns in July that either favour or hinder evolving hurricanes reaching U.S. shores [4]; (3) first quantification of the link between changes in SST and changes in hurricane activity [5]; (4) first demonstration of the business benefits to insurance of skilful seasonal U.S. hurricane forecasts [6]; (5) first provision of tropical storm windfields (forecast and immediate post-event) in terms of peak 3-second gust (this being better linked to loss than 1-minute or 10-minute sustained winds); and (6) first computation and provision of probabilistic real-time warning and loss information for tropical storms worldwide, including (a) an innovative 'wind speed probability' graphical product which maps the likelihood that any point will be struck by hurricane and/or by tropical storm strength 1-minute winds up to five days in advance, (b) innovative storm email alerts that are triggered by the likelihood a given location will be struck by winds of a given magnitude, and (c) an innovative forecast loss product which provides, by U.S. state and from five days before hurricane landfall, the probabilities that the insured loss will exceed different thresholds.

The work described above enabled the team to begin research on a second extreme weather risk service, EuroTempest, in 2004, after recognising that a service such as TSR did not yet exist for European weather extremes but would be highly valuable, especially in relation to windstorms, which account for 75% of European insured losses. The expertise and knowledge gained from TSR was used to develop similar real-time innovative warning and risk products for European extratropical storms, and for rainfall and temperature extremes.

Key UCL researchers: the research insights and product developments were instigated and led by Mark Saunders (Lecturer 1997-1998; Senior Lecturer 1998-2005; Professor 2005-present), with input from the following research associates: Adam Lea (2002-present), Benjamin Lloyd-Hughes (1999-2008), Christopher Merchant (1998-1999), Budong Qian (2001-2002), Paul Rockett (1999-2002), Frank Roberts (1997-present) and Peter Yuen (2004-2007).

3. References to the research

[1] Statistical evidence links exceptional 1995 Atlantic hurricane season to record sea warming, M. A. Saunders and A. R. Harris, *Geophys. Res. Lett.*, 24, 1255-1258 (1997) doi:10/b3jq3w

[2] Global Tropical Storm Tracker, M. A. Saunders, F. P. Roberts and P. C. Yuen (2004) - available online: www.tropicalstormrisk.com

[3] Atlantic hurricanes and NW Pacific typhoons: ENSO spatial impacts on occurrence and landfall, M. A. Saunders, R. E. Chandler, C. J. Merchant and F. P. Roberts, *Geophys. Res. Lett.*, 27(8), 1147-1150 (2000) doi:10/d98qtg

[4] Seasonal prediction of hurricane activity reaching the coast of the United States, M. A. Saunders and A. S. Lea, *Nature*, 434, 1005-1008 (2005) doi:10/c3282z

[5] Large contribution of sea surface warming to recent increase in Atlantic hurricane activity, M. A. Saunders and A. S. Lea, *Nature*, 451, 557-560 (2008) doi:10/fqk66m

[6] Forecasting stronger profits, N. Hilti, M. A. Saunders and B. Lloyd-Hughes, *Global Reinsurance* (July/August 2004) - available at: http://www.tropicalstormrisk.com/docs/GlobalRe2004.pdf

References [1], [4] and [5] best indicate the quality of the underpinning research.

Key research grants/contracts:

(i) £102,000 awarded to M. A. Saunders. Statistical predictability of North Atlantic sea surface temperatures. Awarded by the NERC (grant GR3/R9925). Award period: 2000-2003.

(ii) £1,160,000 awarded to M. A. Saunders. To support underpinning research to develop and maintain the Tropical Storm Risk extreme weather forecasting and warning services. Awarded by the Benfield Group, Royal & Sun Alliance and Crawford & Company. Award period: 2000-2012.

(iii) £206,000 awarded to M. A. Saunders. To support underpinning research to develop a European windstorm live tracker and to develop EuroTempest Ltd. Awarded by the Benfield Group and Royal & Sun Alliance. Award period: 2004-2007.

4. Details of the impact

UCL's research on extreme weather has underpinned significant commercial and humanitarian impacts around the world. Central to the process of developing the research into successful products and services were marketing, regular clear presenting and, most importantly, the steady gaining of credibility through the demonstration of accuracy, reliability and independence.

There were a number of important contributions to achieving credibility: (1) TSR winning two prestigious insurance industry awards: the British Insurance Awards for London Market Innovation of the Year (2004) and for Risk Management (2006); (2) TSR successfully predicting the very active 2004 and 2005 Atlantic and U.S. hurricane seasons (which prompted Lord Leven, the Chairman of Lloyd's, to state that "TSR are the first to offer a level of precision which is of practical use"); and (3) TSR being selected to provide real-time alert feeds to Reuters AlertNet, the global humanitarian news portal, and its warnings helping to save many lives from Cyclone Sidr's devastating impact on Bangladesh in November 2007.

The gaining of credibility was a key factor in the decisions to launch the commercial ventures EuroTempest Ltd (ET) in 2007 and Tropical Storm Risk Business (TSRB) in 2009. Products from TSRB are disseminated to customers via annual licences managed by UCL Business (UCLB), the technology-transfer company of UCL, and complement the publicly available TSR storm alerts, seasonal forecasts and warnings to humanitarian organisations, which are disseminated via online web feeds and email alerts. ET and TSRB received a total income of £1.319 million from sales of

the commercial services between 1 January 2008 and 31 July 2013 [A].

Extreme weather alerts and forecasts informing decision making: As of 31 July 2013, there were around 22,000 TSR storm alert subscribers and around 2,000 TSR seasonal forecast subscribers [B]. A market survey conducted in 2010 showed that 85% of users of TSR services rated the storm alerts at either 4 or 5 (on a scale of 1 to 5) in terms of accuracy, ease of understanding, meeting their needs, timeliness and overall satisfaction [C]. Hundreds of the storm alert subscribers are companies around the world who employ the alerts, with other information, in their risk awareness and decision making. These companies cover a wide range of industries and activities, from shipping and construction, to manufacturing and golf course maintenance [C]. During the REF impact period the TSR website also received over 9.5 million visits [D].

TSR's seasonal forecasts are widely reported and followed in the (re)insurance industry and contribute to the anticipation of upcoming risk and to insurance pricing. The service is regarded as one of the top three forecast providers for North Atlantic hurricane outlooks [E]. For example, Risk Management Solutions (RMS) – one of the two largest global catastrophe modellers – included TSR forecasts in their "2013 Atlantic hurricane season outlook" white paper [E], which was distributed to their clients (who include 85% of the top 40 global reinsurance companies and 80% of the top 10 global reinsurance intermediaries).

Companies benefiting from TSRB and ET commercial services: Between 1 January 2008 and 31 July 2013, TSRB and ET data were incorporated into the commercial products and systems of 22 international organisations [A], and therefore contributed to the financial benefits accrued by these organisations. These companies comprise 20 in insurance and reinsurance, one in global telecommunications and one that is a technical service provider for the global oil and gas industry. Thirteen of these companies are/were subscribers for at least three successive years [A]. Five examples of companies that have benefited significantly are:

1) TSR products enhance the ImpactonDemand platform sold by Aon Benfield – the world's leading reinsurance intermediary – by providing live feeds and historical footprints of global tropical cyclone tracks. ImpactonDemand is a highly innovative and versatile platform that enables Aon Benfield's many clients to visualise and quantify their exposures to risk, and perform sophisticated, detailed data analysis to drive insightful business decisions. Their Managing Director of Product Development and Applied Research said: "The input from TSR underpins the mission of Aon Benfield Research […] to deliver relevant research that helps insurers and reinsurers to build their understanding and management of risks." [F]

2) Lloyd's – the world's specialist insurance market – uses TSR products in its services to its 57 managing agents (which comprise much of the London insurance market). The company's Head of Exposure Management and Reinsurance noted: "The regular hurricane updates are invaluable in providing early warning of potential impacts. The additional business service […] gives us an independent early view of likely losses from live hurricanes. This assists us with catastrophe response planning, media liaison and regulatory discussions." [G]

3) The Norwegian Hull Club (NHC) – one of the largest marine insurers in the world – uses TSR products in alerting its portfolio of over 9,200 vessels worldwide to steer clear of approaching dangerous storms. NHC started using TSR products after losing two vessels in September 2009 due to tropical storms and a "lack of storm awareness" by vessel masters, which cost the company over US$12 million. This experience caused the company to introduce measures to ensure that such losses did not happen again, and it "identified TSR as providing the desired type of reliable, regularly updated and easily understandable tropical storm warning information." NHC's Director of Communications and Client Services said: "The TSR warning information is embedded within the NHC in-house satellite data assimilation system and is dispatched to vessel masters and management companies to warn of approaching dangerous storms in an easy understandable (Google Earth) format. This system provides 24/7/365 operational monitoring and advice [...] Since September 2009 the NHC have not experienced another total loss from tropical storms!" [H]

4) At SCOR – a leading global reinsurance company – TSR products have enabled, since 2010, the "rapid dissemination of new information [relating to tropical storms] across interested parties throughout the business, including underwriting, claims and senior management personnel." SCOR's Head of Natural Catastrophe Risk Modelling added: "the free storm tracking TSR website

is the 'go-to' source used by the many underwriting organisations with natural catastrophe portfolio risk." [I]

5) The claims management team at RSA – a FTSE 100 company providing insurance products and services in 32 countries worldwide – greatly benefit from "EuroTempest's accurate and timely forecasts of the loss from high winds before and immediately after a windstorm event striking Europe […] in assessing risk and in allocating resources." RSA's Head of Technical Services reported that the claims division has for several years employed "EuroTempest's database of weather observations across the UK in order to help validate weather related claims by postcode." [J]

Influencing humanitarian work and contributing to saving lives: TSR warnings and data have contributed to preparedness work and the reallocation of funds for tropical storms affecting several countries worldwide since January 2008. A recent example is tropical storm Mahasen which struck Bangladesh in May 2013. TSR warnings and data for Mahasen triggered successful preparedness and disaster risk management work in Bangladesh and Myanmar by teams from Plan International (one of the largest children's humanitarian organisations in the world) [K]. According to the United Nations (UN), this preparatory work by humanitarians for Mahasen contributed to the saving of "countless lives" in Bangladesh, where an estimated one million people were evacuated from 13 coastal districts in the 24 hours before the storm hit [L].

5. Sources to corroborate the impact

[A] Financial data from UCL Business is available on request – corroborates the income from the commercial services, and the number and names of customers. Note that the income stated in the case study is the total income generated minus the share (£65,850) taken by UCL.

[B] A spreadsheet corroborating the numbers and types of subscribers is available on request.

[C] The results of the 2010 market survey, which also corroborate the range of subscribers to the storm alerts, are available on request.

[D] A spreadsheet corroborating the number of website visits is available on request.

[E] RMS white paper "2013 Atlantic hurricane season outlook": http://bit.ly/16sVNpq – corroborates that RMS use TSR forecasts and that TSR is regarded as one of the top three providers. Similar industry reports and news stories corroborating TSR's forecasting status are available on request.

[F] Supporting statement from Managing Director of Product Development and Applied Research at Aon Benfield – corroborates that Aon Benfield are using TSR products in their services to clients through their ImpactOnDemand platform. Available on request.

[G] Supporting statement from Head of Exposure Management and Reinsurance at Lloyd's – corroborates that Lloyd's benefit from using TSR products. Available on request.

[H] Supporting statement from Director of Communications and Client Services at NHC – corroborates that NHC use TSR products to alert their portfolio of vessels. Available on request.

[I] Supporting statement from Head of Natural Catastrophe Risk Modelling at SCOR – corroborates that SCOR benefit from using TSR products. Available on request.

[J] Supporting statement from Head of Technical Services at RSA – corroborates that RSA benefit from using EuroTempest data within their claims division. Available on request.

[K] Plan International document "Plan ready to respond to Tropical Storm Mahasen" (12 May 2013): http://bit.ly/1cbBODF – corroborates the use of TSR in providing an early alert for Mahasen that triggered preparedness and disaster risk management work by Plan International teams (see image caption).

[L] UN news release (20 May 2013): http://bit.ly/1eGpecY – corroborates the benefit of the preparatory work to the people of Bangladesh.