Willis Research Network

Willis Towers Watson

Willis Research Network: The Science of Managing Extremes

2019

Foreword

After a decade of relative calm, hurricanes revisited North America and the Caribbean with a vengeance over the last two storm seasons: Harvey, Irma, Maria in 2017, then Florence and Michael wrought unprecedented destruction in 2018, and as I write, a category 4 storm, Willa, bears down on the Pacific coast of Mexico. Elsewhere droughts brought macro-economic impacts in Argentina and Australia; extreme floods affected southern India; wildfires ravaged world-wide, Europe was reminded of heat stress, and a summer of extreme events which ended with Super Typhoon Jebi stretched even Japan's high levels of resilience. The recent IPCC report on risks of 1.5 C global mean temperature rise has reiterated the impending and strategic threats faced by many regions, economies and communities, now, and in the coming decades.

Our review of the 12th year of the Willis Research Network includes some of our extensive work with academic partners on weather and climate risks that will lie at the heart of understanding and managing these growing challenges. 2019 will see a renewed international emphasis on adaption and resilience to physical climate risks - complementing mitigation and low carbon transition priorities - driven through processes such as the G20 FSB Task Force for Climate Related Financial Disclosures and culminating at a special UN Summit with Heads of Government in September. The hard won lessons and capabilities of climate and risk modelling from the re/insurance sector and our evolving technical landscape will play a key role in informing and delivering on the policy and commercial responses that are required. The Willis Research Network, with the Risk Modelling Steering Group of the Insurance Development Forum, is operating at the very heart of these promising developments.

This digest also covers examples from wider areas of our research funding including earthquakes and tsunami, quantifying political risks and developing tractable frameworks for understanding and evaluating systemic risks, scenarios and interdependencies.
We hope you enjoy the reading across this wide spectrum as much as we have enjoyed compiling it.

The Willis Research Network was founded in 2006 and it is a pleasure to be part of an initiative that has had a sustained impact over many years. Its success and reputation have been driven by long-term relationships and commitments based on a shared mission and mutual respect across public, private and academic sectors. It is a distinctive platform to confront the even larger and more complex risk challenges we will need to address in the future.

On behalf of my Willis Towers Watson colleagues our thanks to all our academic members and industry partners for their collective contributions over the last year and my own thanks to the Willis Research Network Steering Group and management team for their focus and efforts during 2018. We look forward to another significant year of research, collaboration and impact in 2019.

Rowan Douglas CBE FRGS
Chairman, Willis Research Network

About Us

The Willis Research Network (WRN) is an award-winning collaboration between academia and the finance and insurance industries.

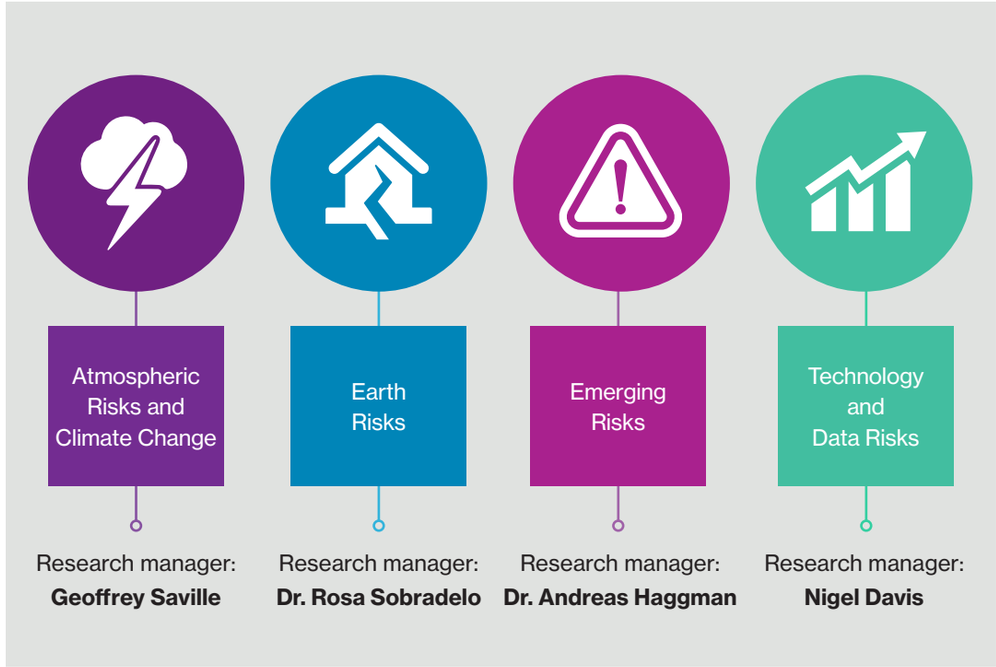
The WRN integrates public science with the risk management community to enhance our collective ability to understand, evaluate and manage risk (extreme natural catastrophes, climate variability, emerging risks...) and to provide credible scientific expertise to improve decision-making across the industry.

Initially developed within Willis Re to support our Willis Re view of risk, it is now growing to support our advisory services to corporate clients.

The WRN is currently working on programmes and projects across more than fifty science partners worldwide, to confront the full spectrum of modelling challenges of this domain. Our industry continues to evolve and the pace of improvement in understanding is astounding. However, key risk management issues are still not fully known and no single institution has the resources or breadth of knowledge to answer these matters. Willis Towers Watson has a wide range of internal expertise, but we feel that the challenges of understanding risk and resilience are still best met working in partnerships and embracing the skills of people across the globe. The WRN continues to build on the strength of its partnerships, delivering and incorporating solutions into insurance sector models, methodologies and transactions to improve the market's understanding, resilience and coverage of risk.

The WRN Research Hubs drive a number of research programmes which in turn manage several WRN research projects, producing academic and industrial research outputs. Outputs include data, models, applications, peer-reviewed journal articles, financial instruments and conferences. Alongside the longer term research programs, we continue to identify projects with tangible outputs for our clients within realistic time frames, allowing us to deliver solutions when they are needed.

The Willis Research Network Key Research Hubs



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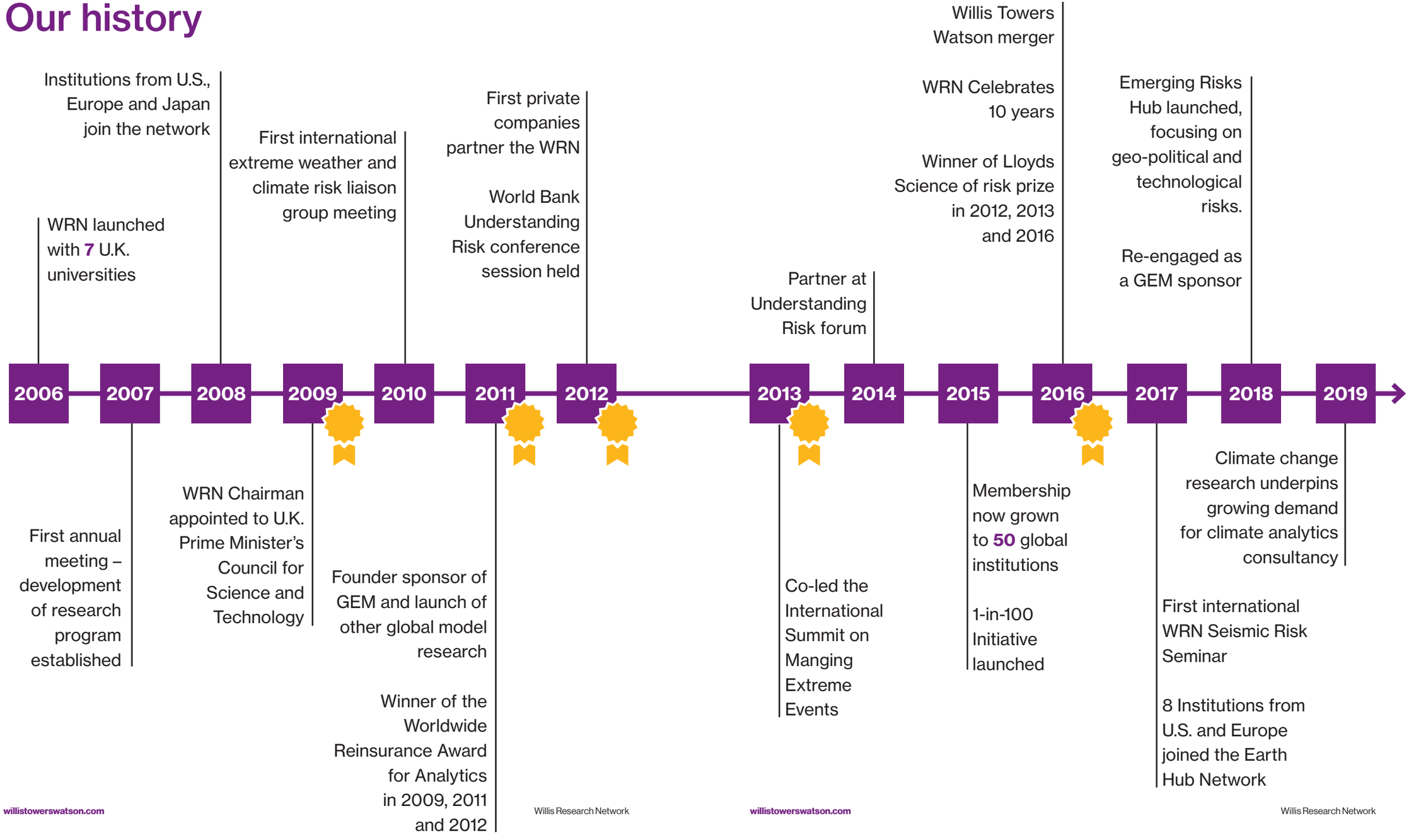
Our history



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Medium Range Hail and Tornado Forecasting, and Longer Term Trends

Using the environmental conditions

Large hail storms and tornadoes cause extreme damage in the U.S. and, while they can occur anywhere, focus is on Tornado Alley through the spring and early summer. Predicting the exact location and severity of extreme thunderstorms that can cause damaging hail and tornadoes is difficult, even at the short weather forecasting time scales of a few days. To get an idea of potential for extreme thunderstorms, we have to understand the atmospheric environment in general, and look for the characteristics that thunderstorms need to grow.

Climate model outputs

By analyzing the outputs of National Oceanic and Atmospheric Administration's Climate Forecast System version 2 model, our WRN partners at Columbia University can provide guidance on areas that may have an elevated risk of producing hail or tornadoes for the month ahead. So the system/the tool doesn't look for individual storms but identifies areas at risk. The research team has developed two indices summarising the conditions required for severe convective storms: the Hail Environment Index (HEI) and Tornado Environment Index (TEI).

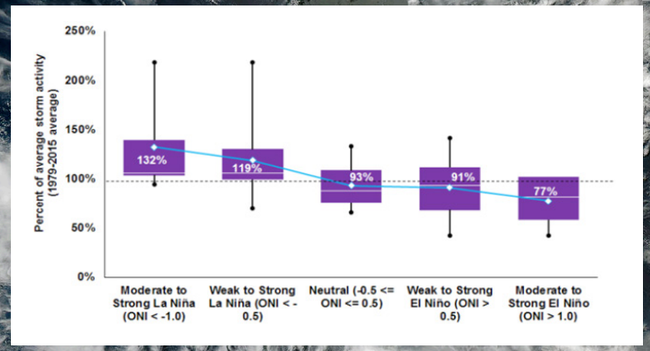
The indices are delivered each month to Willis Towers Watson colleagues in Willis Re and made available to view against exposures across the U.S. This can help in preparing for potential severe convective storm losses.

Further research on tornado outbreaks

The research partnership is now starting to look at clusters of tornadoes, known as outbreaks, and how these vary according to climate conditions and how they relate to the TEI. Clusters of tornadoes are likely to show greater correlation with major loss events, depending on the definition of such outbreaks. The damage from a maximum EF5 strength tornado is severe but local, so it is hypothesized that there may be a stronger relationship to a cluster of less severe tornadoes. This could give more utility to the TEI to the extent it can be calibrated for tornado outbreaks.

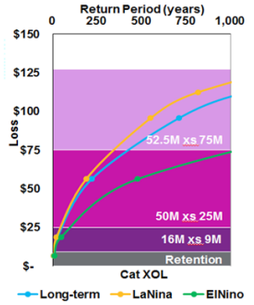
Columbia University

Columbia University in the City of New York is a leading global research university, with engineering and science facilities designed and equipped for next-generation research. The Columbia Initiative on Extreme Weather and Climate focuses on understanding the risks to human life and property from extreme weather events and on developing solutions to mitigate those risks. Dr. Micheal Tippett, Professor Adam Sobel, and Dr. Chiara Lepore have been working with the WRN to help us understand and better manage risks from climate extremes, with a focus on severe thunderstorm impacts.

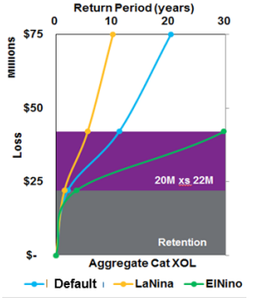


ENSO conditioned view of severe convective storm risk

Occurence XOL treaty



Aggregate XOL treaty



Cat XOL Layer	Exceedance probability		
	Default	La Niña	El Niño
$52.5M xs $75M	0.14% (1 in 705)	0.18% (1 in 547)	0.05% (1 in 1,910)
$50M xs $25M	**0.46% (1 in 216)**	**0.54% (1 in 184)**	**0.21% (1 in 474)**
$16M xs $9M	4.3% (1 in 23)	5.6% (1 in 18)	2.3% (1 in 43)
Retention	25% (1 in 4)	33% (1 in 3)	17% (1 in 6)

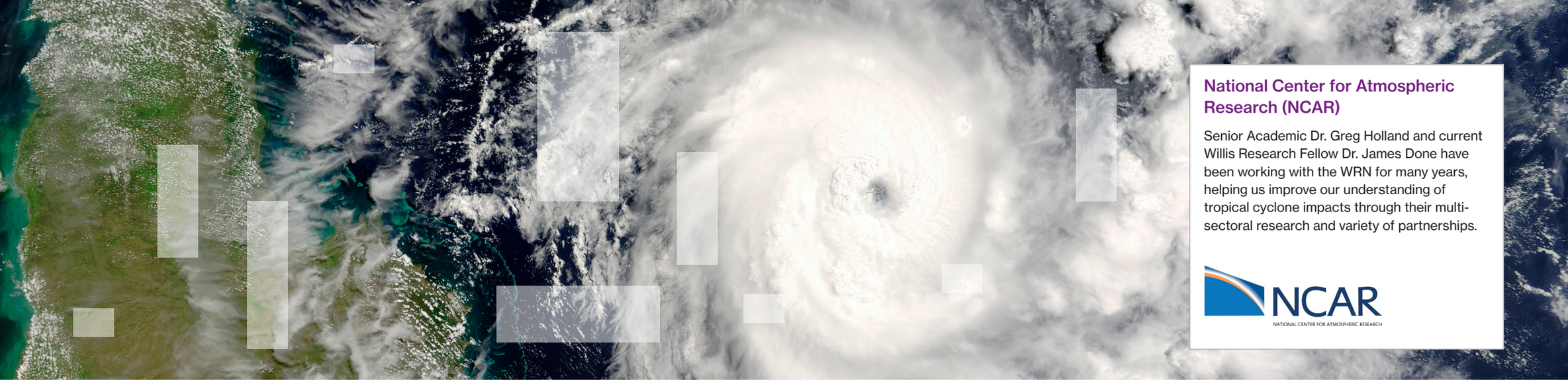
Aggregate Cat XOL Layer	Exceedance probability		
	Default	La Niña	El Niño
$20M xs $22M	**9% (1 in 11)**	**18% (1 in 6)**	**3% (1 in 30)**
Retention	48% (1 in 2.1)	67% (1 in 1.5)	28% (1 in 3.6)

Seasonal view of risk

The effects of the El Niño-Southern Oscillation (ENSO) on the risk of severe thunderstorms can be predicted several months in advance. This can help us take a seasonal view on whether a year-long reinsurance contract should be more or less exposed to severe hail and tornado damage. In particular, regional variability in increased or reduced severe convective storm frequency due to the ENSO phase can have a significant impact on regional and single state writers.

Application to portfolios

Given the promising results from the 'research generated by Columbia University, the Willis Re North America Catastrophe Analytics team has developed climate conditioned views of severe convective storm risk and portfolio loss estimates to various phases of ENSO. A climate conditioned view of risk can help companies understand, manage and mitigate the regional and year over year variability in severe convective storm risk to property portfolios.



National Center for Atmospheric Research (NCAR)

Senior Academic Dr. Greg Holland and current Willis Research Fellow Dr. James Done have been working with the WRN for many years, helping us improve our understanding of tropical cyclone impacts through their multi-sectoral research and variety of partnerships.

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Modelling Tropical Cyclone Landfalling Rates

Variable rates

Tropical cyclones are represented in great detail by catastrophe models. Different events are assigned a 'rate' of occurrence, based on stochastic simulations representing tens of thousands of years with storms. But these rates are typically based on limited historical records. We know that natural variations in the climate system such as ENSO and Atlantic Multidecadal Oscillation (AMO) can give rise to variability in the basin-wide activity (overall number of tropical cyclones that occur in a given basin). These variations can also control intensity and regional landfall frequency.

Reinsurance application

Over the years our Willis Re Catastrophe Analytics teams have developed methods to adjust the tropical cyclone rates, produced by industry catastrophe models, to represent these variations in terms of overall, basin-wide activity. Our latest work in the pipeline will expand the limited historical record using climate model simulations and examine the effects of climate variability, such as ENSO or the AMO, on landfall rates along different parts of the U.S. coastline. Our novel approach characterizes TC rates according to typical, reoccurring weather patterns over the North Atlantic. We know that seasonal forecasts have higher skill in forecasting these weather patterns than in forecasting the actual basin-wide activity. Our approach therefore emphasizes where we have the highest skill. Futhermore, each El Niño event is unique and so too is its impact on TC rates. Our approach captures these different 'flavors' of El Niño through the differing weather patterns. This aims to build on previous TC activity rate adjustments to give more detailed guidance relevant to the coastal impacts of hurricanes from wind, rain and storm surge.

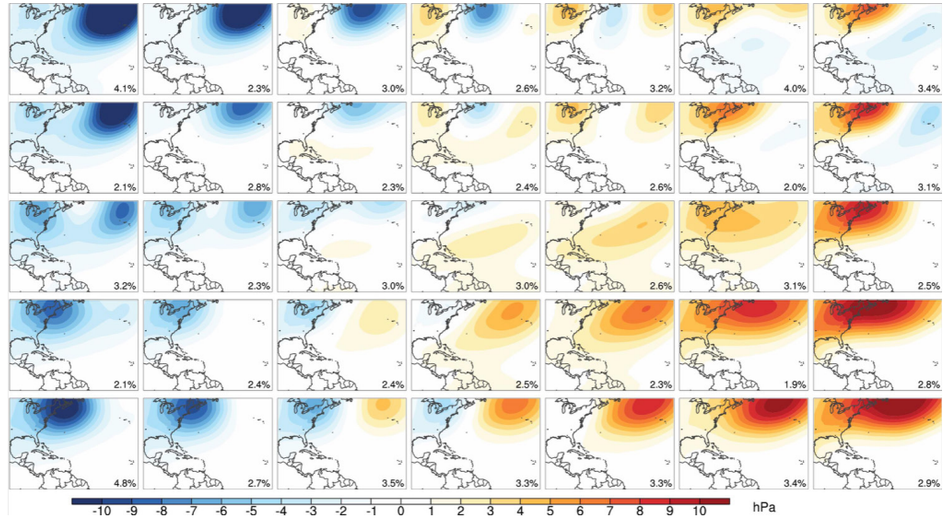


Figure 1: Typical daily Weather Types, shown here in sea-level pressure anomalies (hPa). Each Weather Type has a different likelihood of tropical cyclone genesis. The numbers in the bottom right of each panel are the average frequency of occurrence of each Weather Type over many years. Modes of climate variability, such as ENSO, modify these frequencies and therefore TC rates. (Figure courtesy of Abby Jaye, NCAR).

A Flood Model Evaluation Framework

Close collaboration

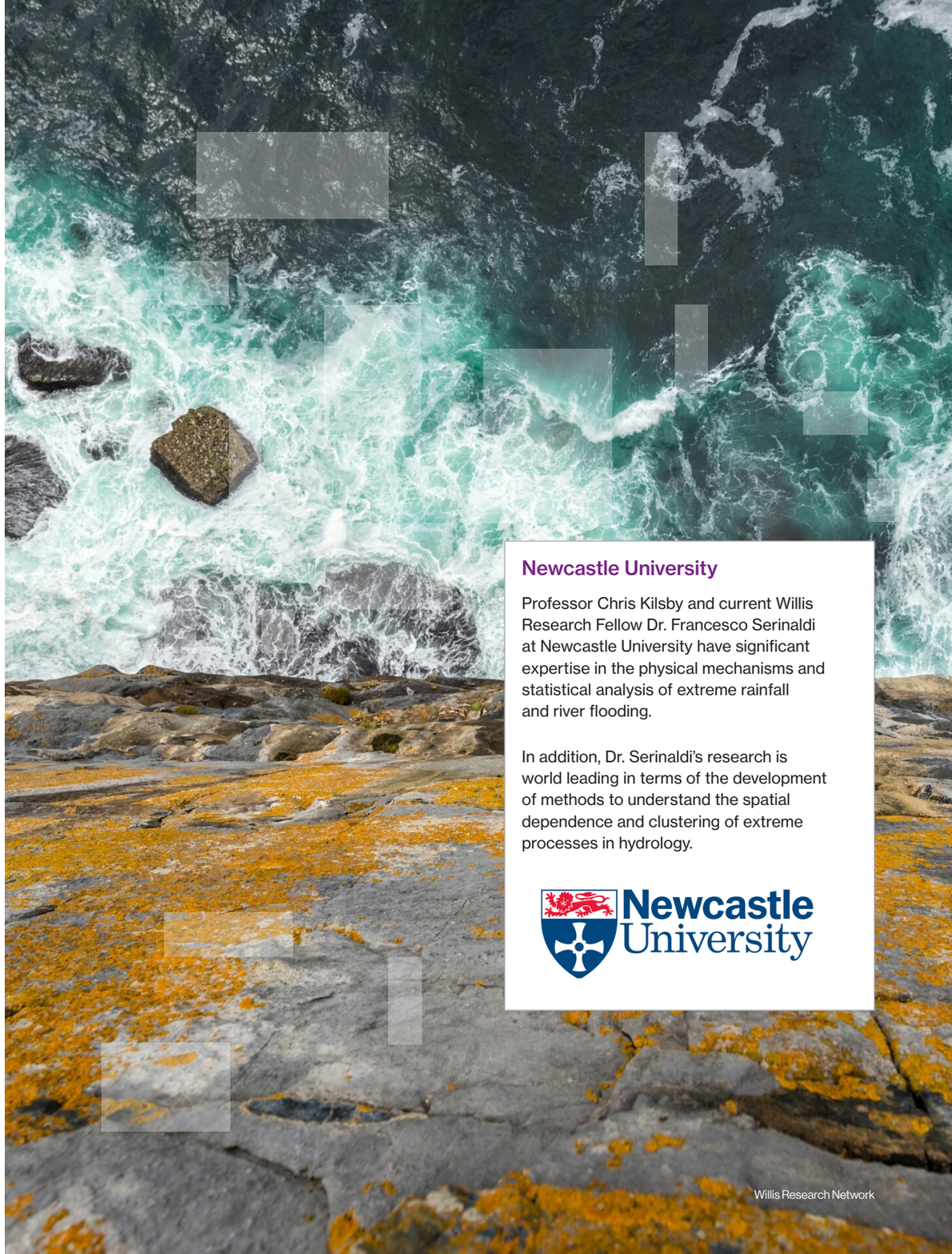
Our long term WRN partners at Newcastle University, Dr. Chris Kilsby and Dr. Francesco Serinaldi, have always worked closely with our Willis Re Catastrophe Analytics teams. This year, we've benefitted from a close collaboration with our Willis Re International team on inland flood model evaluation, as part of an ongoing effort to validate and justify industry catastrophe model outputs. This work is key to advising our clients on the relative pros and cons of using the various models available to the market, and how the different approaches that are taken may affect individual client portfolios.

Developing a framework for evaluating flood models

Building on some initial advice and guidance on a flood model evaluation project for one particular country last year, the current collaboration has helped the Willis Re team to develop key tests to decipher robustness of stochastic catalogues - a blueprint - for model evaluation going forward. This is based on peer-reviewed literature which relates to systematic evaluation frameworks, but tailored to the needs of the Willis Re Model Research and Evaluation team and reinsurance clients.

Metrics and statistics

It involves building a series of key observed statistics and a categorization scheme for model performance to produce quantitative standardized metrics. These metrics can be aggregated over different spatial and temporal scales and enable evaluation and cross-validation between models and locations. Further analysis with the Newcastle academic team has involved looking at European flood country correlations and comparing them to what is seen in the vendor model outputs to provide an independent assessment, and help to develop the Willis Re View of Catastrophe Risk for flood. The world-leading statistical expertise available through our WRN partnership with the Newcastle University upon Tyne remains a key part of our research portfolio, and continues to feed directly in to our client advisory services.



Newcastle University

Professor Chris Kilsby and current Willis Research Fellow Dr. Francesco Serinaldi at Newcastle University have significant expertise in the physical mechanisms and statistical analysis of extreme rainfall and river flooding.

In addition, Dr. Serinaldi's research is world leading in terms of the development of methods to understand the spatial dependence and clustering of extreme processes in hydrology.

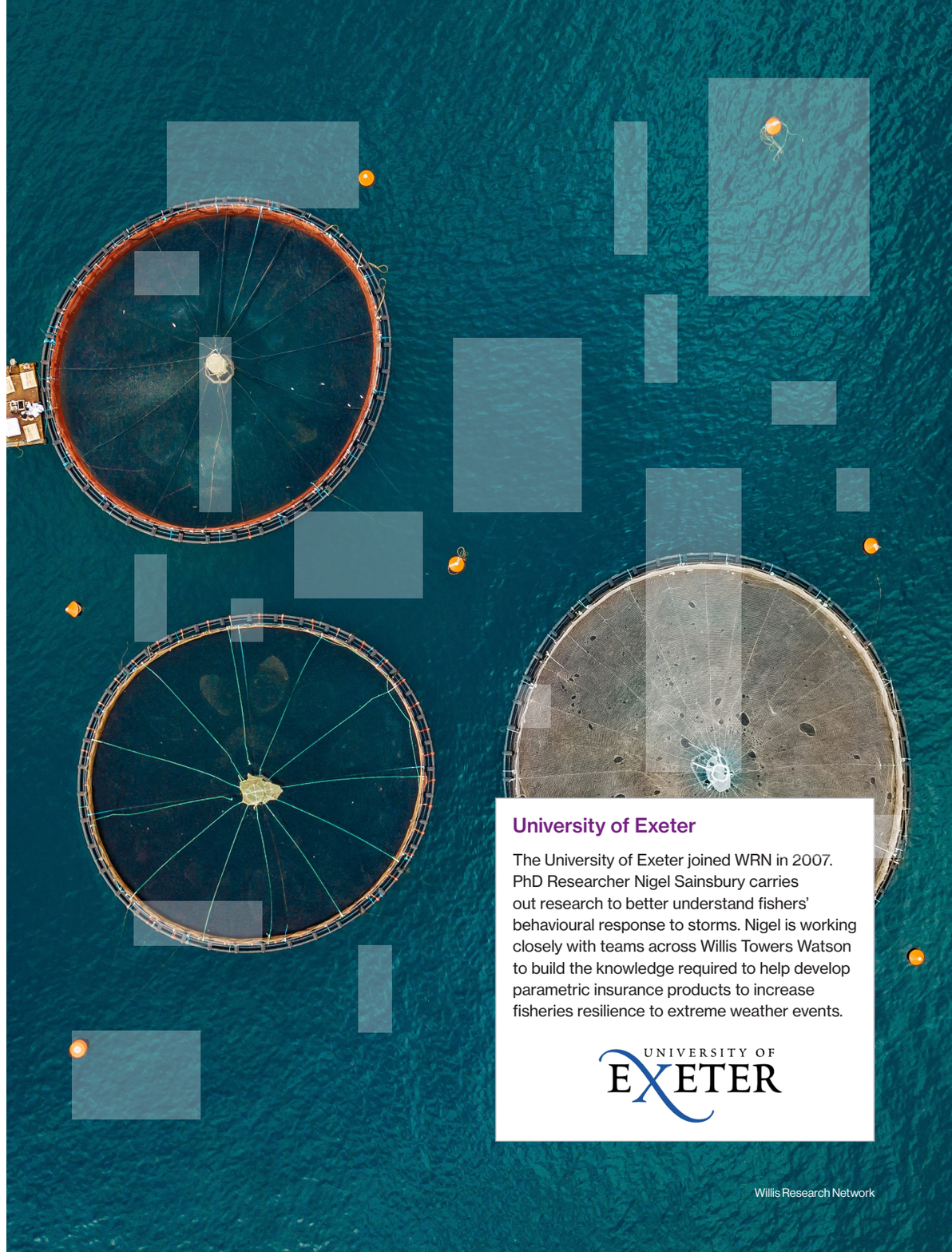
Newcastle University

Understanding the Impacts of Storminess on the Fishing Industry

The global fishing industry is an essential resource for food security, health, livelihoods and trade around the world. The impacts of storms on the behaviour of fishing fleets and aquaculture is an area that has received relatively little attention in terms of risk management. It is important to better understand the impact of storminess on fishing communities, especially in light of potential changes to the frequency and severity of extreme storms due to climate change. PhD research being undertaken by Nigel Sainsbury at the University of Exeter's Penryn campus, is tackling this very problem. His project is supported by Natural Environment Research Council, with added support from the WRN to supervise and guide the project towards the development of useful insurance tools, such as a method for modelling business interruption or loss of earnings for fishing fleets due to storms, or an index of damage potential for various types of fishing boats. This work is guided by Dan Fairweather, Director of Livestock, Aquaculture and Fisheries at Willis Towers Watson, with the aim of applying Nigel's findings to insurance applications and offering new products to the market, both in developed and developing countries.

Developing tools in data rich environments

Initially focussed on the U.K. where data on fishing behaviour and weather is relatively rich, this project will develop tools with transferable potential across the globe. The first output from this research was published earlier this year in Nature Climate Change as a paper entitled "Changing storminess and global capture fisheries". The paper provides an overview of this vital area of research and it is hoped that the findings from this project can be used to provide financial resilience to vulnerable fishing fleets when storms strike.



University of Exeter

The University of Exeter joined WRN in 2007. PhD Researcher Nigel Sainsbury carries out research to better understand fishers' behavioural response to storms. Nigel is working closely with teams across Willis Towers Watson to build the knowledge required to help develop parametric insurance products to increase fisheries resilience to extreme weather events.

UNIVERSITY OF EXETER

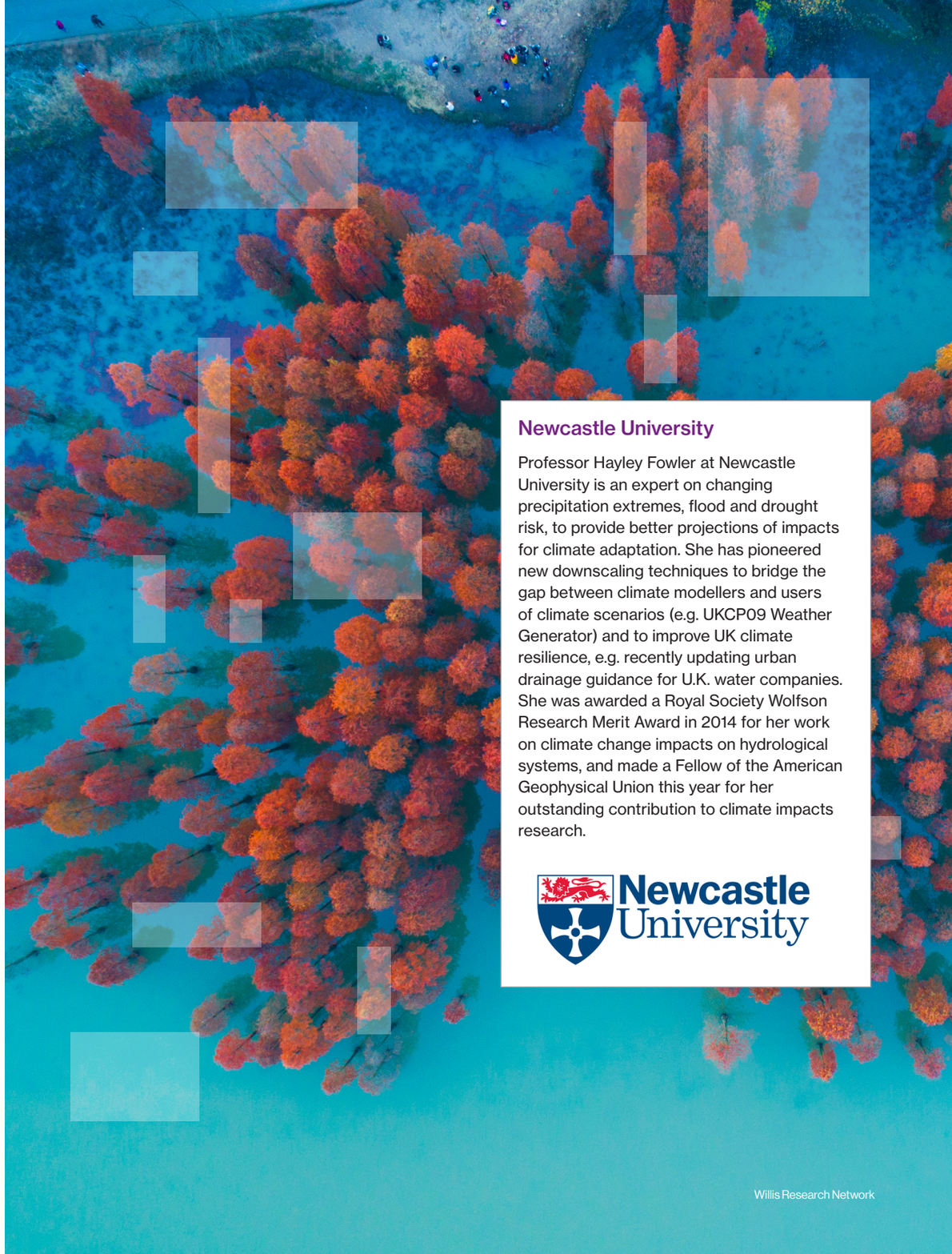
FUTURE-STORMS Collaboration

Successful bid for project funding

In August 2018, collaborators at the Newcastle University announced that they had been successful in a project bid focussed on the quantification of uncertainties and identification of drivers of future changes in weather extremes in the latest generations of climate models. Specifically, this project will examine the outputs from models that allow convection to be explicitly resolved - in most climate models convective storms (often developing into thunderstorms) are parameterised, due to the fact the spatial and temporal resolution required to represent them dynamically would be too demanding on super-computing time. These highly detailed climate models can start to answer some of the more subtle questions that the non-convection permitting models cannot. Understanding of how these models represent mesoscale convective systems, often leading to extreme weather impacts from perils such as large hail, tornadoes and flash flooding, may be improved by the project, while experiments using future climate projections can help us understand possible changes in extreme weather due to climate change.

Wider collaboration to develop tools for climate change risk assessment

This research in collaboration with the U.K. Met Office aims to improve the fundamental understanding of how weather extremes may change in the future, exploiting and building on the new convection-permitting projections from the U.K. Climate Projections 2018 (UKCP18) project. Via the WRN, Willis Towers Watson will sit on the external advisory committee for this collaboration, and aims to find ways to leverage the findings of the research. This will be achieved through the application of the new high resolution datasets from a weather generator output from the research, and through helping us develop new approaches to climate change impact studies for our clients. There is also opportunity to contribute to the next U.K. Climate Change Risk Assessment report published by the U.K. government.



Newcastle University

Professor Hayley Fowler at Newcastle University is an expert on changing precipitation extremes, flood and drought risk, to provide better projections of impacts for climate adaptation. She has pioneered new downscaling techniques to bridge the gap between climate modellers and users of climate scenarios (e.g. UKCP09 Weather Generator) and to improve UK climate resilience, e.g. recently updating urban drainage guidance for U.K. water companies. She was awarded a Royal Society Wolfson Research Merit Award in 2014 for her work on climate change impacts on hydrological systems, and made a Fellow of the American Geophysical Union this year for her outstanding contribution to climate impacts research.

Newcastle University

Middle East and North Africa Earthquake Model

State-of-the-art catastrophe risk modelling

Willis Re has developed its own view of catastrophe risk for all major perils and territories globally – i.e. the Willis Re View of Risk (WVoR). The Middle East and North Africa (MENA) Earthquake Model is part of this key framework to provide the most robust catastrophe risk quantification solutions in the region.

A consistent hazard and loss modelling methodology was employed across six countries in North Africa and ten countries in the Middle East.

Cross-country and correlated hazard event set with OpenQuake

The 10,000-year long earthquake event set provides a comprehensive (i.e. cross-country and correlated) view of seismic risk utilising latest academic studies and historical catalogues from our WRN partners. Willis Re leverages the state-of-the-art Global Earthquake Model (GEM) OpenQuake engine ensuring an up-to-date view of hazard and risk.

Vulnerability module developed with WRN partners

Our bespoke vulnerability module was developed in collaboration with University College London (UCL) via the WRN and using the GEM methodology.

Empirical fragility curves are derived from historical damage reports, thus more accurately reflecting actual loss estimates including secondary uncertainty. Typical construction typologies, building height, quality of construction and occupancy were defined for each country leveraging expertise from local scientists.

The Willis Re modeling platform also allows for explicit consideration of limits and deductibles, various policy conditions and reinsurance structures predominant in the MENA region.

High-resolution exposure

Exposure is disaggregated onto a variable resolution grid (VRG) with urban areas captured at the highest resolution. The VRG was developed using satellite imagery, night lights & land use data and the Willis Re database of industrial facilities.

Global Earthquake Model

OpenQuake-engine is an open and community-driven tool for seismic hazard and risk analysis.

GEMOQ
GLOBAL EARTHQUAKE MODEL OPENQUAKE
WORKING TOGETHER TO ASSESS RISK

UCL EPICentre

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UCL
EPICentre™

Destructive Megathrust Earthquakes in 3D

The planet's most powerful earthquakes occur along convergent plate boundaries, where one tectonic plate slides underneath another plate. The destructive power of such megathrust earthquakes, which are accompanied by widespread shaking and often large tsunamis, was last exemplified during the 2011 M 9.0 Tohoku, the 2010 M 8.8 Chile and the 2004 M 9.2 Sumatra-Andaman earthquakes (combined insured losses of $249 billion, Munich Re, 2015). An earthquake of similar magnitude could also occur in the Cascadia subduction zone, offshore of the Pacific Northwest, with potentially grave consequences for the metropolitan areas of Vancouver, Seattle and Portland, as during the last Cascadia megathrust earthquake that occurred in 1700. A.D., before the advent of instrumental seismology.

High-resolution Ground Motion Simulations

In order to reduce the large uncertainty around this tail risk, the WRN is funding a project with researchers from San Diego State University to simulate ground motions for a suite of plausible rupture scenarios on the Cascadia megathrust, based on a detailed three-dimensional representation of the seismic velocity structure in the Pacific Northwest.

A challenge to these simulations arises from the sheer size of the computational box required to accommodate the Cascadia fault zone (stretching 1,000 km from N to S) and the urban regions, along with the need to resolve the short wavelengths which are especially hazardous for buildings.

By taking advantage of recent performance optimizations and improvements in the uses of supercomputers, the researchers at San Diego State University were able to increase the surface resolution to better reflect the detail required for such an analysis, which has simply not been possible previously.

Improving Loss Estimations

The results from this pioneering project will help Willis Towers Watson provide realistic disaster scenario analyses as well as a valid comparison of the expected losses from this advanced physics-based realistic approach, compared to the more traditional methods. The study will provide Willis Towers Watson's clients with a higher confidence in tail risk assessment and help them in making more informed reinsurance purchase strategies. The shaking intensity footprints obtained from these simulations will be analyzed to identify those differences.

Preliminary results show that the 3D wave propagation simulations tend to predict stronger shaking levels in the deep basins, as they are able to capture the complicated interplay between the incoming wavefield and the heterogeneous Earth structure. Footprints from an ensemble of 3D simulations will be used to assess insured losses expected during the next M9 earthquake on the Cascadia megathrust.

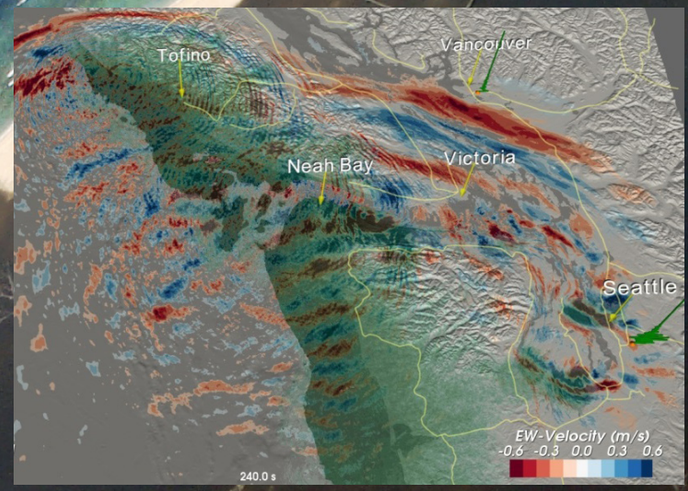


Figure Caption: Snapshot of the simulated wavefield during a M9 earthquake scenario rupturing off the coast of Oregon and propagating towards the north. Red and blue colors depict the ground shaking in the E-W direction, with landmarks depicted by yellow arrows and synthetic seismograms by green traces (i.e., what would be recorded by a seismograph). The green shading denotes the extent of nonlinear or plastic behavior of the soils in the model, affecting the ground shaking mostly near the coast, but also in the sediments below Seattle.

San Diego State University (SDSU)

San Diego State University (SDSU) has been an affiliate member of WRN since 2017. Kim Olsen and Daniel Roten at SDSU are among the primary developers of the Anelastic Wave Propagation (AWP) code used to generate physics-based ground motion predictions for future Cascadia megathrust earthquakes in the Pacific Northwest. The simulations are taking into account the three-dimensional structure of the sedimentary basins, the ocean water layer, realistic variation in the rupture pattern, and the amplification and nonlinear effects of the near-surface low-velocity layers.

SAN DIEGO STATE UNIVERSITY

Sequential Earthquake and Tsunami Fragility of Buildings

Currently, 8 out of the 10 most populous megacities in the world are vulnerable to severe earthquake damage, while 6 out of 10 are at risk of being severely affected by tsunami. To mitigate ground shaking and tsunami risks for coastal communities, reliable tools for assessing the effects of these hazards on coastal structures are needed.

Advanced numerical modelling of cascading events on structures

The EPICentre group at UCL is leading the field in tsunami vulnerability, and more recently on cascading earthquake and tsunami vulnerability.

For several years, the WRN has been investing in research to understand buildings' tsunami vulnerability and is now collaborating in a project with UCL EPICentre that aims to fill the gap in the fragility assessment of buildings in coastal areas, subjected to onshore flow from tsunami, preceded by earthquake ground shaking. The research has developed advanced structural analysis procedures, which have been used to simulate the response of various case-study buildings located in tsunami-prone countries, from Japan to Chile. This required accounting for the preceding ground shaking damage, leading to the derivation of combined earthquake and tsunami fragility curves.

Developing future tsunami building codes

Working with partners from the University of Hawaii, guidance on how to perform tsunami fragility assessment within the new ASCE7-16 is being developed. This also involves buildings located in USA Pacific Northwest, with exposure to the Cascadia Subduction Zone.

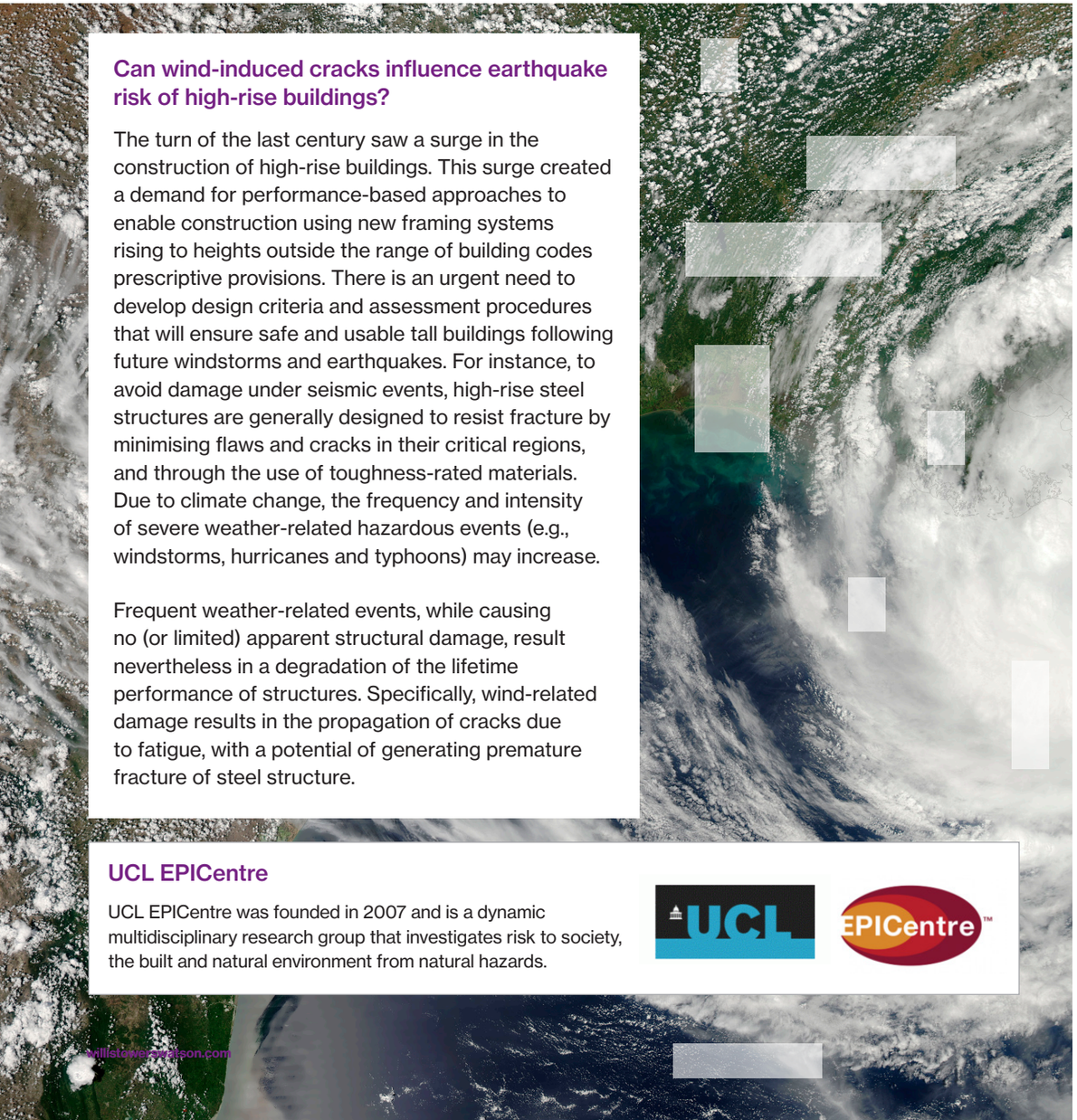
The project aims to further develop simplified methods for fragility and vulnerability evaluation of buildings subjected to earthquakes and tsunami, by defining a procedure for tsunami vulnerability assessment of buildings, and assessing the influence of preceding ground shaking to tsunami vulnerability of buildings.

This project will be instrumental for Willis Towers Watson in validating recently developed models that contain a tsunami component. Moreover, this will be paramount in the evaluation of tsunami impact as a secondary peril.

UCL EPICentre

UCL EPICentre was founded in 2007 and is a dynamic multidisciplinary research group that investigates risk to society, the built and natural environment from natural hazards.

Multi-Hazard Vulnerability Assessment of High-Rise Steel Structures



Can wind-induced cracks influence earthquake risk of high-rise buildings?

The turn of the last century saw a surge in the construction of high-rise buildings. This surge created a demand for performance-based approaches to enable construction using new framing systems rising to heights outside the range of building codes prescriptive provisions. There is an urgent need to develop design criteria and assessment procedures that will ensure safe and usable tall buildings following future windstorms and earthquakes. For instance, to avoid damage under seismic events, high-rise steel structures are generally designed to resist fracture by minimising flaws and cracks in their critical regions, and through the use of toughness-rated materials. Due to climate change, the frequency and intensity of severe weather-related hazardous events (e.g., windstorms, hurricanes and typhoons) may increase.

Frequent weather-related events, while causing no (or limited) apparent structural damage, result nevertheless in a degradation of the lifetime performance of structures. Specifically, wind-related damage results in the propagation of cracks due to fatigue, with a potential of generating premature fracture of steel structure.

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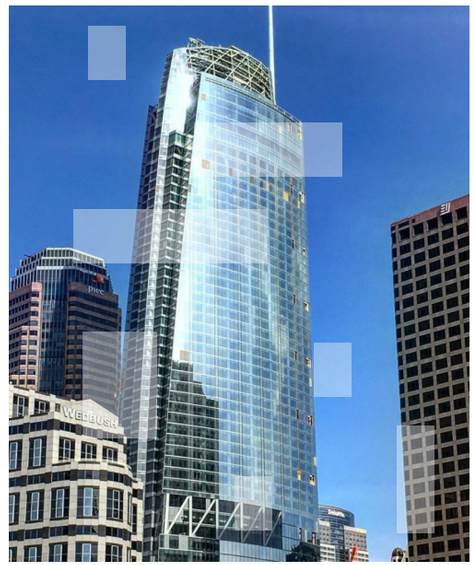
Investigating the effect of wind-induced damage on earthquake vulnerability

Wind-induced cracks may finally lead to fracture of critical structural components (e.g., columns and beam-column joints) and thus to catastrophic structural collapse during moderate-to-severe earthquakes. Unfortunately, the impact on structures of repeated windstorms followed by earthquakes is currently ignored when assessing structural safety. This may lead to a significant underestimation of the physical and consequent social vulnerabilities.

The WRN is supporting a project from the University College London (UCL) EPICentre to investigate, for the first time, the vulnerability of structures in the case of multiple – successive yet uncorrelated hazards, such as extreme windstorms and earthquakes. For this project, UCL-EPICentre is collaborating with the University of California, Davis (UCD) and Prof Amit Kanvinde's research lab, including worldwide-unique large-scale experimental facilities in structural engineering.

Better quantification of the earthquake risk

This project will explore the work done within the scientific and engineering community, and allow us to use those findings to inform our wind model validation work. Additionally, this will provide a better understanding of the potential for wind-induced fatigue crack growth in high-rise steel frames in different interested seismic zones. This will help better quantify the structural reliability, fracture risk and expected damage and loss of high-rise steel structures, in the case of wind-generated material degradation followed by earthquakes in the considered seismic regions. Projects like this can also help advanced performance-based design guidelines for steel tall buildings subjected to wind and earthquake.



Dr. Carmine Galasso and Biao Song at UCL-EPICentre are developing a multi-hazard risk assessment framework for high-rise steel structures, which combines the potential risks resulting from extreme weather conditions (i.e., extreme winds) and seismic events. Photo: Wilshire Grand / Korean Air Building.

Understanding and Quantifying Political Risk

The threat posed to businesses by political upheavals or government action, such as expropriation, trade embargo or political violence, are difficult risks to manage as the past is often a poor guide to the future.

Political risks can emerge rapidly in societies that have enjoyed stable business conditions for years, so that simple trend assessments or data analysis are inadequate in gauging the financial impact of political risk.

Political risk has increased significantly, now becoming a reoccurring and material cost of doing business. If risk levels remain elevated, companies will fall under increasing pressure from shareholders for greater levels of transparency around the losses actually incurred and the companies' ability to monitor, quantify and manage these risks as well as their strategy to mitigate them.

Our partnership with Oxford Analytica complements our internal expertise to provide superior advisory services to our clients.

Political risk expertise Global Risk Index

Oxford Analytica has a 1,400-strong contributor network, which comprises senior faculty in first-class universities, scholars in leading research institutes, and world-class industry and sector specialists.

That breadth of expertise allows it to find the right qualitative and quantitative experts to derive political risk assessments for over 165 countries. This network also supports client conversations, bespoke analysis and macro monitoring via The Oxford Analytica Daily Brief.

Political Risk Survey Report

Since 2017, Willis Towers Watson and Oxford Analytica have collaborated to publish an annual Political Risk Survey Report. It is based on a survey of senior executives at leading global firms (followed by in-depth interviews) across different industry sectors to determine their response to ongoing global political volatility.

Global Horizons

Oxford Analytica organises a yearly conference "Global Horizons" which gathers CEOs, policy-makers and government leaders, allowing them to engage with leading geopolitical experts to analyse the key global issues facing decision-makers in both the private and public sectors.

Report available at [https://www.willistowerswatson.com/en/insights/2018/09/political-risk-survey-report.](https://www.willistowerswatson.com/en/insights/2018/09/political-risk-survey-report)

Oxford Analytica

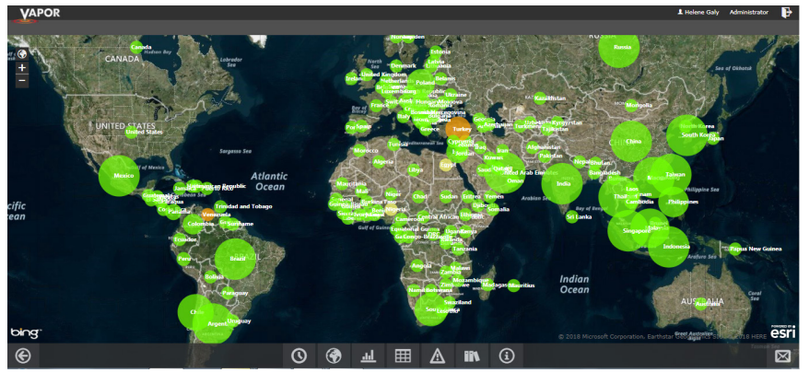
Oxford Analytica is a global analysis and advisory company drawing on an extensive global network of experts to advise clients on strategy and performance in complex markets. We have been working with Oxford Analytica since 2006.

For more information please visit their website http://www.oxan.com/

Value At Political Risk - VAPOR

VAPOR is a jointly created analytics platform that allows global companies to assess and compare the financial implications of exposure to a suite of political risks – in individual countries, regionally, or globally.

Harnessing the combined strength of Oxford Analytica's geopolitical analysis and the extensive analytics experience of the Willis Towers Watson team, VAPOR allows companies to assess alternative investment scenarios in an uncertain world. This is a useful tool that can support investment (including new country assessments) and risk management decisions, allowing political risk estimates to be incorporated into financial planning and enterprise risk management. Risk assessments are industry-specific, for six political risk perils in 165 countries. Risk ratings provided by Oxford Analytica are based on a 40-year track record of advising clients on political risk scenarios, and a rigorous research and risk modelling methodology.



Impact of Systemic Risks

Cambridge Global Risk Index

As the world's economy becomes more complex and interconnected, the potential impact and reach of individual events is amplified. How can we best approach, explore and communicate in a quantified manner such systemic risks to clients and communities?

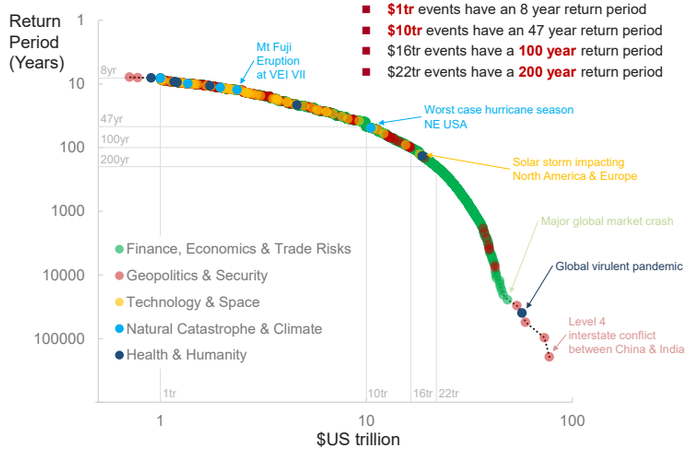
The Global Risk Index (GRI), developed by the University of Cambridge Centre for Risk Studies, has designed a scenario modelling framework and metrics (such as GDP@Risk) to assess 22 perils from their Taxonomy of Threats, in categories covering natural catastrophes, geopolitics, trade, technology and health. The index provides a consistent yet flexible platform with which to evaluate global exposure portfolios year on year to identify how business operations may be disrupted and how business plans be impacted.

The GRI also supports the Lloyd's 'Lloyd's 'City Risk Index ' website provides an open access interface to threat profiles for around 300 of the world's urban centres and approximately 50% of global GDP. Application programming interface (API) technology allows modelling components of GRI analytics to be incorporated into internal platforms and dashboards.

Scenarios for business management

Understanding the consequences of threats through the development of scenarios is a technique used extensively by the Centre for Risk Studies, which can bring in best-in-class research from a broad range of subject matter experts and encourage participation in structuring qualitative risk narratives. Many scenarios are published as monographs, covering such topics as human pandemic, solar storm and social unrest. Exceedance probability curves describing frequency and severity of loss can be constructed from events sets of scenarios of differing intensities across threat classes.

Global Catastrophe Exceedance Probability Curve



Assessing Corporate Resilience

Jointly with the Centre for Risk Studies, we have used their modelling frameworks to investigate corporate viability, risk management decision-making and preparedness at a range of scales from regional to international and across varied business sectors from oil and gas to manufacturing and distribution. External risk registers are matched to company-specific exposures by geography and activity to derive impact to the company balance sheet in terms of revenue and profitability shocks.

Emerging technology and cyber risk research

The Centre continues to monitor emerging risks and changes in the threat landscape. The modern knowledge economy is increasingly reliant on information technology, communication systems, and infrastructure service continuity. Exploring the emerging risk of disruption and catastrophic failure of these critical systems is a key theme of research at the Centre. Understanding cyber risk and the potential for massive failure of interconnected infrastructure systems requires a detailed technical appraisal of complex engineering interactions, domain-specific assessment of the threat, and a risk analysis framework.

The Cambridge Centre for Risk Studies has been playing a leading role in research into cyber catastrophe risk since its earliest publications in 2013. The Centre's approach includes developing an understanding of the cyber threat landscape resulting from different technological attack vectors, actors and motivations, and conceptualizing potential scenarios of loss. The framework provides a method of assessing the economic and social impact of future cyber-attacks. It also captures risk correlation structures and the potential for systemic cyber catastrophes to impact society, companies, and national governments.

This deep understanding of the cyber threat landscape supports our cyber advisory services, from assessment to quantification and protection.

University of Cambridge Judge Business School Centre for Risk Studies

The Centre for Risk Studies provides frameworks for identifying, assessing and managing the impacts of systemic threats. Their research programme focuses on catastrophes and how their impacts ripple across an increasingly connected world with effects on the international economy, financial markets, companies and local economies. To guide the research agenda and test their research outputs, the Centre engages with the business community, government policy makers, regulators and industry bodies.

We have been partnering since the start of the Cambridge Global Risk Index (formerly known as "Pandora") in 2016.

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About Willis Towers Watson

Willis Towers Watson (NASDAQ: WLTW) is a leading global advisory, broking and solutions company that helps clients around the world turn risk into a path for growth. With roots dating to 1828, Willis Towers Watson has over 40,000 employees serving more than 140 countries. We design and deliver solutions that manage risk, optimize benefits, cultivate talent, and expand the power of capital to protect and strengthen institutions and individuals. Our unique perspective allows us to see the critical intersections between talent, assets and ideas – the dynamic formula that drives business performance. Together, we unlock potential. Learn more at willistowerswatson.com.

About Willis Re

One of the world's leading reinsurance brokers, Willis Re is known for its world-class analytics capabilities, which it combines with its reinsurance expertise in a seamless, integrated offering that can help clients increase the value of their businesses. Willis Re serves the risk management and risk transfer needs of a diverse, global client base that includes all of the world's top insurance and reinsurance carriers as well as national catastrophe schemes in many countries around the world. The broker's global team of experts offers services and advice that can help clients make better reinsurance decisions and negotiate optimum terms. For more information, visit willisre.com.

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