Willis Research Network

Willis Towers Watson
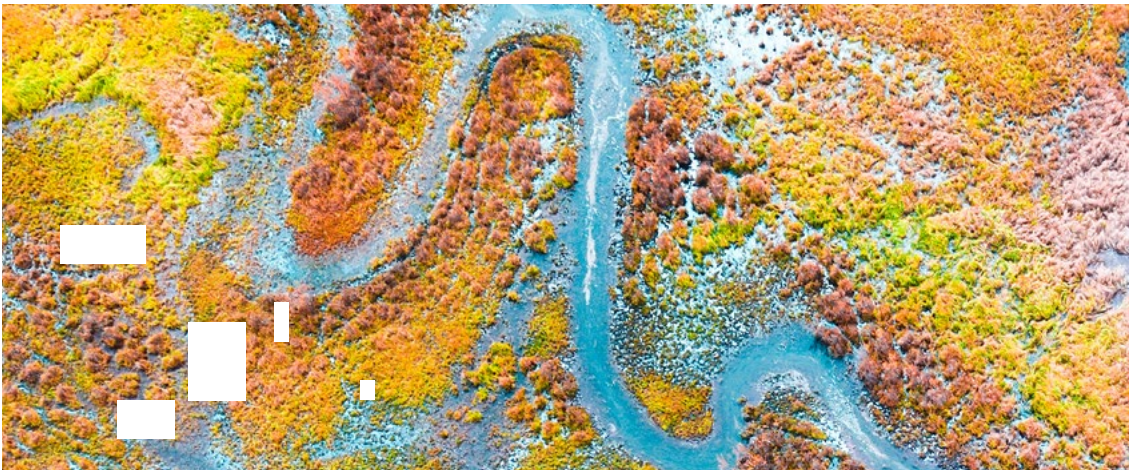
Willis Research Network Annual Review 2021

Science for Resilience

Table of contents

Foreword

The purpose of the Willis Research Network (WRN) is to help society better prepare and cope with the types of events we have all experienced in 2020. Since our formation in 2006, the Network has focussed on developing the science of resilience to support the management of extremes from natural, man-made and hybrid risks.

Despite the operational challenges of 2020, the following pages illustrate another remarkable year in scientific collaboration, real-world application and impact across our research themes and geographies, including North America, Europe and Asia Pacific. Long standing academic partners such as NCAR, Columbia University, NOAA SSL Oklahoma, San Diego State University, University of Exeter, University of Cambridge, Newcastle University, NU Singapore, Tohuku and UCL have been joined by partners from beyond the university sector including Cloud to Street, Mitiga Solutions, RUSI, Temblor and Metabiota. Over the last few years, our scope has continued to expand to encompass risks such as pandemic, cyber and political risk.

COVID-19 illustrates how we should all consider high-impact, low probability events within our core operations, planning and finances. Engineering and re/insurance risk management techniques, such as scenario development and stress testing, are now entering the mainstream. The WRN is at the heart of that integration, driven by our engagement with policy makers, regulators and market practitioners.

Structural reform is underway on how markets evaluate, disclose and manage contingent risks and liabilities. Until these risks are effectively accounted for, resilience cannot be sufficiently valued and incentivised. The tragic results will be additional lost lives, livelihoods and assets in the years and decades ahead. Through the WRN, and our related activities such as the Coalition for Climate Resilient Investment, we are working hard to support development of this expertise and its wider adoption across the public and private sector.

Looking ahead, we have a busy year driven by mobilisation in response to the Climate Emergency, the upcoming CoP26 meeting in Glasgow and the needs of Governments, regulators, investors and others. The role of the WRN is to fill in the gaps between high level roadmaps and the practical implementation of the methods, metrics and models to integrate these risks into mainstream valuations and management. In December 2020, we propelled this process with a WRN Challenge Fund competition to support financial sector climate stress testing methods and models.

A decade ago, in September 2011, the WRN co-hosted a three-day summit in Washington DC with the National Academy of Sciences on Managing Extreme Events. Bringing together leaders from science, finance and public agencies, it played a significant role in catalysing the resilience agenda in the U.S. and beyond in the following years. Assuming the COVID situation allows, we aim to hold a second meeting with the National Academy in 2021 to mark the ten-year anniversary and identify the themes and approaches to help us all manage the coming decade.

To underpin all this progress, the Network has also undergone significant internal growth and development this year to prepare for its future. Its success owes most to Hélène Galy, Managing Director, WRN and her growing team. Our thanks also to Carl Hess, Vickie Sefcik and fellow members of the WRN Steering Group, the wider Willis Towers Watson team and WRN members, who have driven our collective projects and programmes. A special thank you to our clients whose engagement and support enables us to maintain our global research programme as a client service and a public good.

> "Through the WRN, and our related activities such as the Coalition for Climate Resilient Investment, we are working hard to support development of expertise and provide wider adoption across the public and private sector."

Rowan Douglas, CBE
WRN Chairman
+44 (0)20 3124 8345
rowan.douglas@willistowerswatson.com

About us

The Willis Research Network (WRN) is an award-winning collaboration between science and the insurance, finance and risk management sector, going back to 2006. Our mission is to encourage and harness innovative research to improve our understanding of a wide range of risks, operationalize this research to support better risk solutions, help clients and society become more resilient and take advantage of growth opportunities.

Whilst the risk and insurance industries continue to evolve and improve at an astonishing rate, no individual institution has the resources or breadth of knowledge to single handedly answer all of the questions around the quantification and management of risk. This is where our long-term investment in research partnerships proves invaluable, bringing the latest science to our clients, and highlighting emerging risks before they make the headlines.

Harnessing more than 60 organizations across the world from science, academia, think tanks and the private sector, the WRN forms innovative partnerships to confront the full spectrum of risk challenge.

The WRN continues to build on the strength of its partnerships, delivering and incorporating solutions into models, methodologies and transactions that increase resilience and improve the market's understanding and coverage of risk.

The WRN is organized around seven research hubs, which drive a number of research programs and research projects, producing academic and business-focused research outputs.

Outputs include data, models, applications, peer-reviewed journal articles, financial instruments and conferences. Along with longer term research programs, we continue to identify projects with tangible outputs for our clients within shorter time-frame, enabling us to deliver solutions on demand.

We are proud to support early-career scientists, not only through funding, but also via internship and guidance in their studies. This reflects our wish to build long-lasting partnerships with academics at all stages of their careers.

Global partners, local expertise
We drive research by partners in science, academia, think tanks and the private sector, combining specialist expertise with state of the art knowledge across our global network.

Innovative, long-term partnerships
We form long-term, innovative partnerships with the research community.

Understanding of risk
Our partnerships identify risks, improve their understanding and quantification for the benefit of our clients and society.

Transmission mechanism
Our dedicated team brings best practice research and evidence into our client proposition: risk models, advice, thought-leadership, insights and events.

How it works

How do we select research projects? There are two main routes: business-driven requests and science-inspired topics. We aim for a good balance between risks on everyone's radar and emerging risks.

1 Identify a business need

2 Engage the right scientist

Link with internal resources

Deliver risk insights to better advise our clients

Link with internal resources

2 Identify a risk challenge

1 Horizon scanning by WRN team

Key research hubs

Earth Risks
Rosa Sobradelo, Head of Earth Risk Research
+44 (0)20 3124 7322, rosa.sobradelo@willistowerswatson.com

Weather and Climate Risks
Geoffrey Saville, Head of Weather and Climate Risk Research
+44 (0)20 3124 8858 geoffrey.saville@willistowerswatson.com

Flood Risks
Nalan Senol Cabi, Head of Flood Risk Research
+44 (0)20 3124 7336, nalan.cabi@willistowerswatson.com

People Risks
Hélène Galy, Head of People Risk Research
+44 (0)20 3124 8520, helene.galy@willistowerswatson.com

Technology Risks
Stuart Calam, Head of Technology Risk Research
+44 (0)20 3124 7590, stuart.calam@willistowerswatson.com

Emerging Risks
Lucy Stanbrough, Head of Emerging Risk Research
+44 (0)20 3124 8508, lucy.stanbrough@willistowerswatson.com

Exposure and Vulnerability Research
Simon Sølvsten, Head of Exposure and Vulnerability Research
+45 88 13 94 07, simon.solvsten@willistowerswatson.com

Hélène Galy, WRN Director
helene.galy@willistowerswatson.com

Stuart Calam, Program Director
stuart.calam@willistowerswatson.com

Setareh Mayel Afshar, Marketing Coordinator
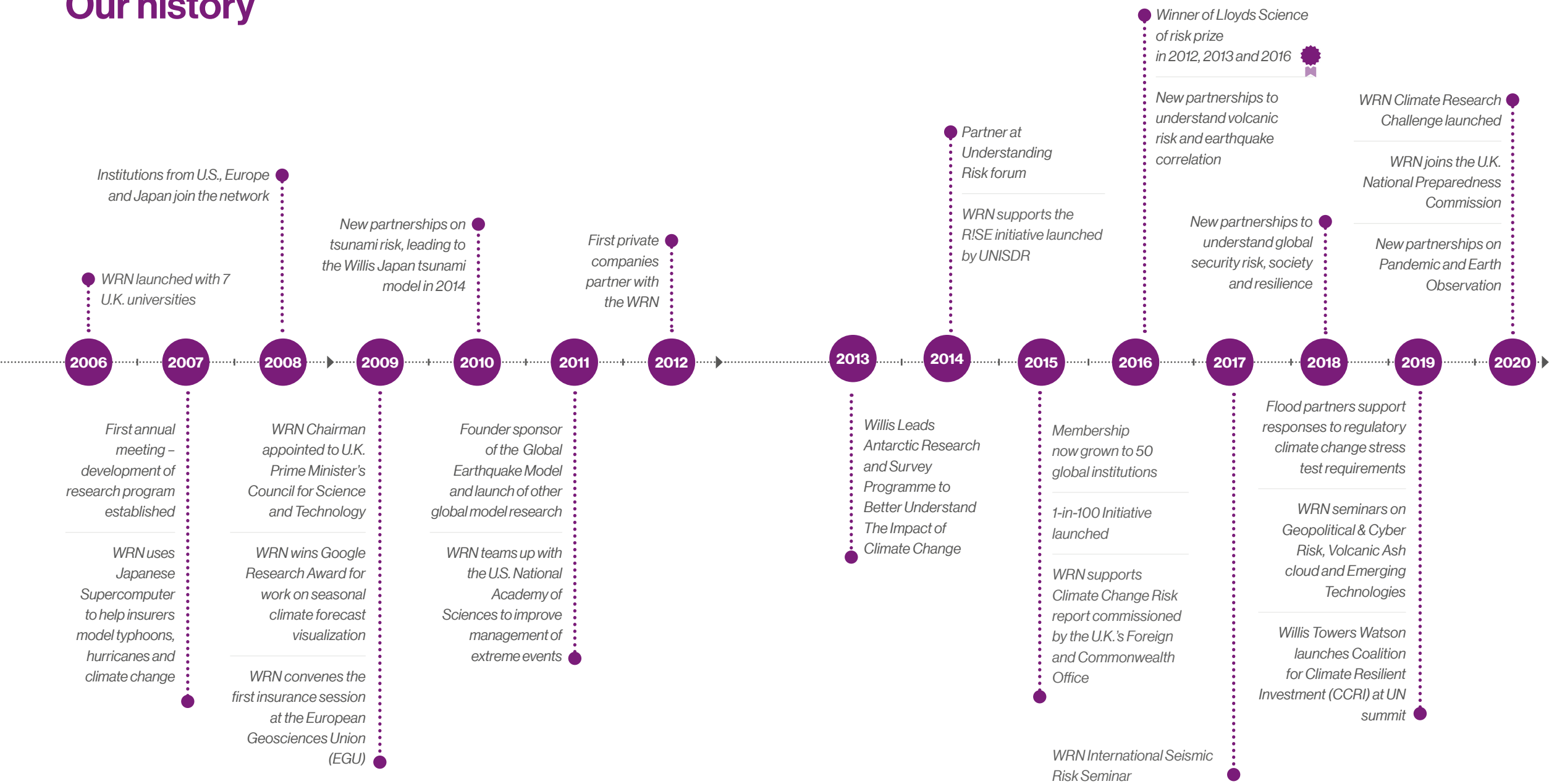setareh.mayelafshar@willistowerswatson.com

Willis Research Network partners over the years

Our history

Institutions from U.S., Europe and Japan join the network

WRN launched with 7 U.K. universities

New partnerships on tsunami risk, leading to the Willis Japan tsunami model in 2014

First private companies partner with the WRN

Partner at Understanding Risk forum

WRN supports the R!SE initiative launched by UNISDR

Winner of Lloyds Science of risk prize in 2012, 2013 and 2016

New partnerships to understand volcanic risk and earthquake correlation

New partnerships to understand global security risk, society and resilience

WRN Climate Research Challenge launched

WRN joins the U.K. National Preparedness Commission

New partnerships on Pandemic and Earth Observation

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

First annual meeting – development of research program established

WRN uses Japanese Supercomputer to help insurers model typhoons, hurricanes and climate change

WRN Chairman appointed to U.K. Prime Minister's Council for Science and Technology

WRN wins Google Research Award for work on seasonal climate forecast visualization

WRN convenes the first insurance session at the European Geosciences Union (EGU)

Founder sponsor of the Global Earthquake Model and launch of other global model research

WRN teams up with the U.S. National Academy of Sciences to improve management of extreme events

Willis Leads Antarctic Research and Survey Programme to Better Understand The Impact of Climate Change

Membership now grown to 50 global institutions

1-in-100 Initiative launched

WRN supports Climate Change Risk report commissioned by the U.K.'s Foreign and Commonwealth Office

WRN International Seismic Risk Seminar

Flood partners support responses to regulatory climate change stress test requirements

WRN seminars on Geopolitical & Cyber Risk, Volcanic Ash cloud and Emerging Technologies

Willis Towers Watson launches Coalition for Climate Resilient Investment (CCRI) at UN summit

Weather and Climate

Weather and Climate

A re-invigorated emphasis on climate risk research.

Looking back through the year of WRN research, and indeed the projects that our academic partners and Willis Towers Watson business teams have collaborated on over last few years, we've seen a clear broadening of the remit of the Weather and Climate hub, and much more overlap between the different disciplines. As themes like this year's COVID-19 pandemic, and the looming threat of climate change, filter across multiple disciplines we see their impacts draw attention from a wide range of Willis Towers Watson clients. The questions that form our research projects subsequently have more users, and wider applicability across industries. Even when one Willis Towers Watson team designs the detail of a project to focus on their specific questions, we are finding that outputs are applicable in other parts of the business. This is a key benefit of the kind of innovation that the WRN brings. Through supporting underpinning science and development of tools, data and models, we provide robust and credible building blocks for products and services across industries, which can lay foundations for new regulations and improve financial resilience.

To make advances in our understanding of risks associated with wickedly complex problems like pandemics and climate change, we require a concerted, collaborative and multidisciplinary approach. We must encourage knowledge sharing across institutional, sectoral and industrial boundaries. The WRN is a facility for academic and industrial partnerships to grow through mutual benefits from new research, and the new analytical questions raised by industries, paying more attention to climate risks, will call on that capacity more than ever. At the end of last year, the WRN convened a climate risk workshop, inviting WRN members old and new, to discuss the challenges and new research opportunities that connect to the impacts of climate change. We discussed both the impacts that we are already experiencing and those that we are yet to face, as temperatures warm across the globe, and the frequency and severity of damaging weather events and extremes of climate are likely to change. We are aware of the need to go beyond physical climate risk modelling, to explore socio-economic impacts of different future pathways based on projections of how quickly we can reduce our CO_2 emissions.

As we've added to our climate change related research over the last year in this review, we intend to continue to expand this theme of research to help our clients, and the academic community, better understand climate risks. We will be conducting our directly funded research on a range of topics for our Willis Towers Watson business teams, as well as continuing to leverage our network and position in the financial sector through international partnerships such as the SOFF project (Systematic Observations Financing Facility) led by the World Meteorological Organisation, which aims to set in place a financing structure to enhance the existing weather observing network, thus building better infrastructure for assessing weather and climate risks across all sectors. This is one of many projects that our Willis Towers Watson colleagues are supporting, a suite of wider public/private partnerships that will promote financial stability in the face of climate change.

While regulatory pressures are driving much of the desire to address climate risk, many companies are charting their own course to a zero carbon operating model through improved ESG practices. Climate change indeed spans all aspects of a holistic Environmental, Social and Governance framework; an observation increasingly recognised across commercial sectors which traditionally viewed climate risk as a purely environmental issue. Climate risk is becoming embedded in strategic business planning. The individual strategies which will emerge will need to

be justified and implemented using credible and robust evidence from the scientific community and risk management industry. As we explore new research avenues in physical climate risk, we are listening to our clients and guiding industries using our research partnerships and internal expertise.

It's an exciting time for the WRN, and with the right combination of Willis Towers Watson talent and academic endeavour, we can provide data and tools, and design frameworks and metrics to deliver advice on the material risks related to climate change. It's an exciting time for climate science too, and while its core stems from physics and Earth system science, to truly understand the risks associated with climate change and how our society will mitigate and adapt to the worst effects it may bring, a broad and multidisciplinary approach is required; an approach that the WRN is ideally positioned to pursue.

> " This deep integration of the worlds of finance and public science is unearthing new scientific discoveries, and producing knowledge in a way that has far reaching impact. In this era of changing climate risk the WRN is more important than ever. "

Dr. James M. Done
Willis Research Network Senior Academic Fellow, National Center for Atmospheric Research, US

> " Our mutual interactions under the Willis Research Network have been remarkably productive, from the generation of ideas through to research that is both academically stimulating and societally useful. "

Geoffrey Saville
Head of Weather and Climate Risk research

Downscaling climate change impacts on Atlantic tropical cyclone landfall rates

Current and future hurricane hazard rates in specific locations cannot be accurately estimated directly from the historical record of hurricane landfalls alone. This is for two main reasons: Firstly, hurricanes are relatively rare, and the observed frequency in a particular location is impacted by sampling error; and secondly, in a changing climate, long-term averages of the historical record are biased estimates of current and future hazard rates. The sampling issue can be addressed by generating large numbers of synthetic storms whose statistics match those of the observed record. However, a purely statistical approach based on the historical record ignores the impact of a changing climate.

The Columbia University Hazard model (CHAZ) generates large numbers of synthetic storms conditional on specified large-scale climate features. With this approach, we can compute climate-dependent hazard rates which incorporate the current understanding of how hurricane genesis, track, and intensity (maximum wind speed) depend on climate.

The WRN and Willis Re have been supporting this work through 2020, and to date, CHAZ-generated North Atlantic synthetic storms have been used to estimate storm intensity (as described by maximum wind speed) return-period curves for two climate periods:

historical 1950-2006 and near-future (2006-2040). Large-scale climate features for the two periods come from CMIP5 models. CHAZ also incorporates uncertainty as to whether the overall global storm frequency will increase or decrease by using two genesis indices: one based on column relative humidity (CRH) and one based on saturation deficit (SD) (Figure A). The CRH case shows a modest increase in frequency, while the SD case shows a decrease. These initial results will underpin the development of our Willis Re View of Risk for North America, concerning climate change impacts on tropical cyclones frequency and severity.
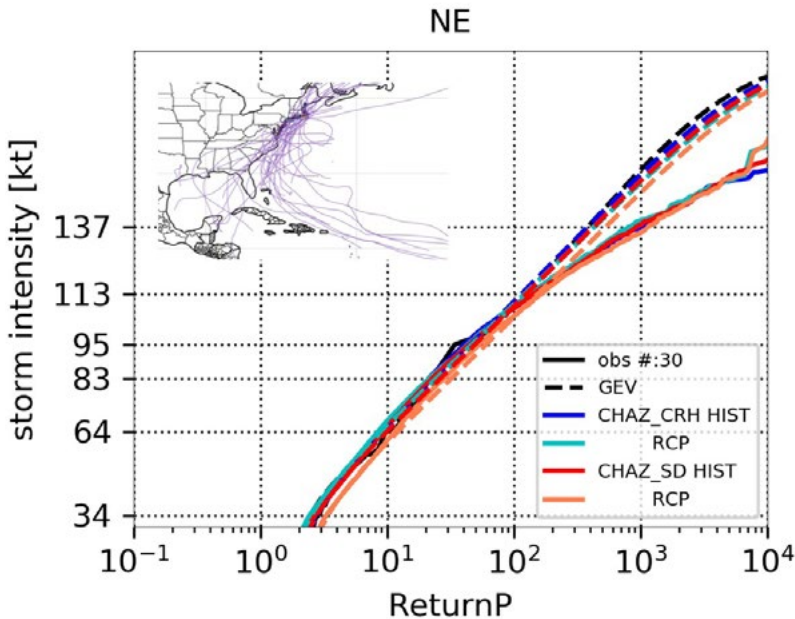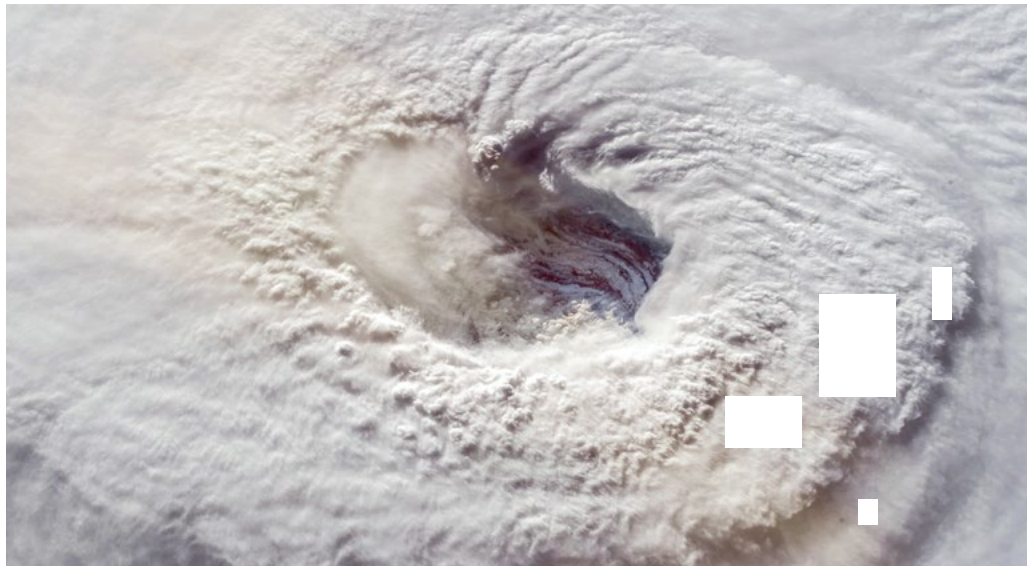

Figure A: The current (obs.) and CHAZ-projected return level of hurricane landfall with intensity along the U.S. Northeastern coastline (from Virginia to New York). The dashed lines are the estimated return period using generalized extreme value theory. The inserted small panel shows tracks of the storms in the historical record impacting the area.

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

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.

Projecting changes in severe thunderstorm frequency

In previous research with our partners at Columbia University, we used broad scale atmospheric variables ('ingredients") which relate to the occurrence of severe convective storms (SCS) to diagnose the historical record and to make seasonal predictions. Now they are analyzing the same quantities in the latest generation of climate change projections (CMIP6). This work is quantifying the expected future changes in SCS activity and providing an indication of whether recent changes in SCS activity are due to climate change or natural variability, and helping us understand risk associated with damaging hail storms and tornados both in current climate, and in a warmer future.

To date, the work has focused on the U.S. where SCS activity is high and where there is a long record of historical data. Over the contiguous U.S. (CONUS), annual averages of convective available potential energy (CAPE), an index which helps us determine whether conditions are favorable for storm formation, and convective inhibition (CIN), which indicates the opposite, are both projected to nearly double by the end of the century (Fig. A, top left panel). On the other hand, annual averages of vertical wind shear (shear and helicity) show no increase (Fig. A, bottom panel). To see the impact of these changes on shorter time scales relevant for storms, high-frequency SCS proxies (functions of the above ingredients) for storm occurrence are computed, and they show increases of 20%—50% by the end of the century (Fig. B, right panel). The same quantities have been computed globally as well. The SCS ingredients display a complex response to increasing atmospheric CO_2 concentration, which varies by model, region, and variable, with moisture dependent variables (i.e., CAPE and CIN) displaying robust and significant widespread increases, and shear-related quantities (i.e. Shear and Helicity) much less robust signals (Figure B). Climate change impacts on natural catastrophes are a core research focus of the Willis Research Network. We anticipate the conclusions from this study to help us better understand and quantify the impacts of climate change on severe thunderstorm risk.
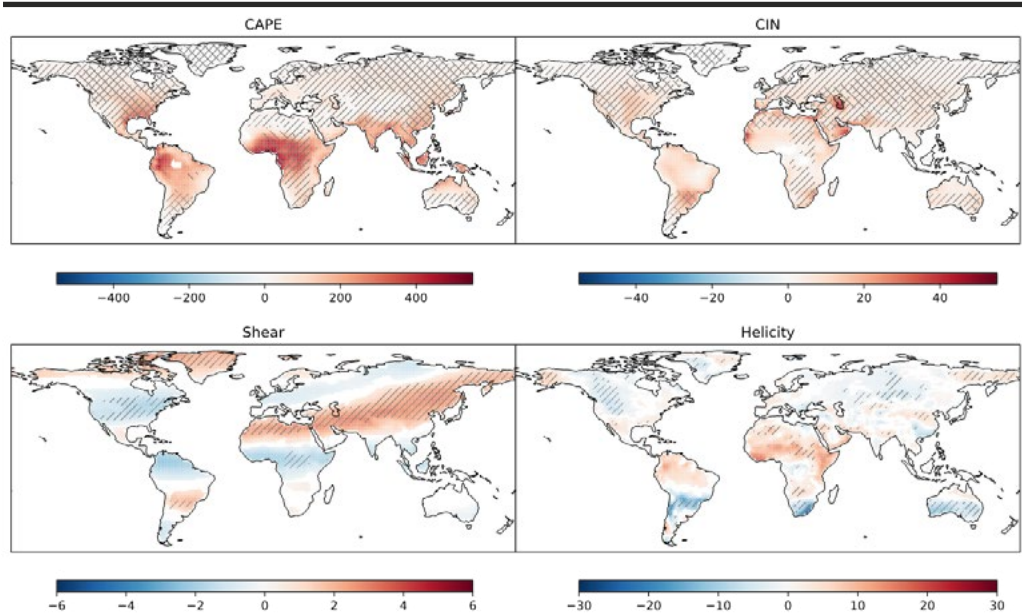

Figure A: Changes in annual averages of severe weather ingredients: CAPE (J/Kg), CIN (J/Kg), Shear (m/s), and Helicity (m²/s²) projected by 7 CMIP6 models. Projected changes use SSP5.85 and are computed as the difference between the 2050-2100 and 1980-2010 periods. Changes are only plotted where more than 66% of the models agree on the sign of change. The backslash and forward slash indicate significant and robust changes, respectively, while hatching indicates both significant and robust changes.
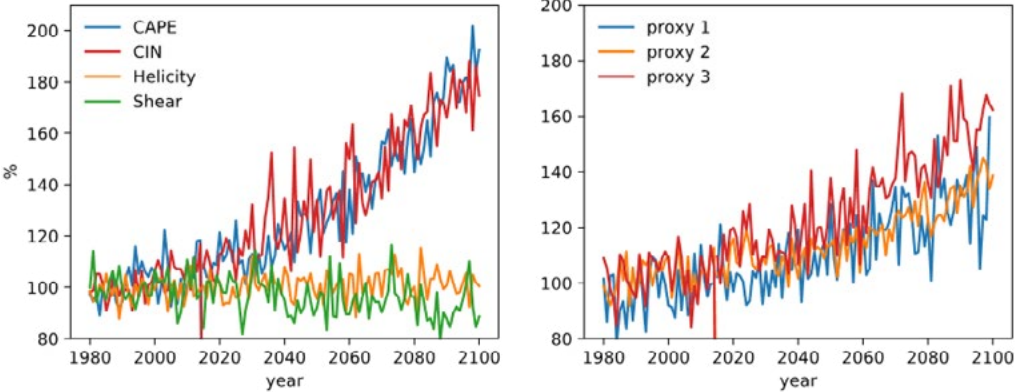

Figure B: CONUS-wide yearly average values for convective environments (on the left, CAPE, CIN, Helicity, Shear) and yearly count of exceedance for three SCS proxies (proxy 1 is CAPExSRH2 > 3.6x106, proxy 2 is CAPExS061.67>25000, proxy 3 is the Supercell Composite Parameter, a function of CAPE, Helicity, Shear, and CIN). Changes are in percent relative to the 1980-2010 average.

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Quantification of potential climate change impacts on tropical cyclones

Our WRN relationship with the National Center for Atmospheric Research (NCAR) has run for over a decade. This long term collaboration has helped us learn how to better guide NCAR into producing research outputs that can be used in supporting our clients and developing our view of risk, and it also allowed our partners at NCAR to gain first hand insights into the (re)insurance industry. A large portion of our recent research, led by Dr. James Done, over the last couple of years has been focussed on developing a new approach to representing the wind field of tropical cyclones over ground. This has led to the development of the 'WRN Global Tropical Cyclone Wind Footprint' *Catalogue* covering all ocean basins where tropical cyclones (TC) occur, and adding detail to the representation of maximum winds during a storms passage. Such research output offers a sophisticated alternative view to what is available in the industry or from the scientific community. Version 1 was released in early 2020, and since then, the team has made makes key improvements to the representation of wind field asymmetries, and to urban and coastal effects, leading to an improved Version 2 (see Figure A as an example for Hurricane Irma from 2017).

The work described above has been presented and discussed through previous WRN events and articles, but recent application of the methodology has focussed on addressing climate change. The WRN and Willis Re International's team aimed to develop a set of climate change-informed wind footprint scenarios. These scenarios were generated to enable sensitivity testing of TC wind losses to climate change, and essentially create an alternative view on key historical storms, to provide a stress test for TCs that are stronger, larger, faster/slower, or a combination of those, in a warmer world. Having full control of the methodology behind these footprints allows us to make appropriate changes to storm parameters, and provide a view of risk which is indicative of what a storm might look like in a warmer world, or show the impacts that climate change has already had on recent tropical cyclone losses.

Being able to visualise the different possible storms that may affect us in the present or future, is an important academic achievement but it is also a significant capability for the scientific-focused/analytical communities of our industry. Our main goal with this work was to demonstrate further applications of such deterministic scenarios into our business world, and we have identified three main areas of potential usage:

- Model completeness – evaluation
- Excess of loss reinsurance – structuring
- Regulatory environment – compliance

To test the model completeness, we look at a climate change scenario and evaluate whether such events ('storms of the future') are already included into the model's stochastic catalogue or not. This was done through an evaluation of a severity distribution provided by the vendor for the storm in question and establishing whether the scenarios fit well within that distribution, or whether they sit on the fringes of that catalogue of events.

Stress testing is also important in structuring excess of loss reinsurance, as reinsurance can bear a disproportionate share of a loss from an extreme scenario. Before catastrophe models, such deterministic scenarios were playing a structural role in this area. Now, these are mainly used for testing and making sure a given structure offers enough vertical limit and protection.

The NCAR/WRN scenarios can also help with addressing specific regulatory stress tests (e.g. EIOPA), explore capital adequacy and stress-test reinsurance recoveries to validate net estimates in a capital model. In addition, the storms of the future may be able to demonstrate robustness of risk framework and assist in maintaining regulatory compliance

Up to this point, the work has only accounted for the wind hazard, but there are other perils from tropical cyclones that are driving losses, including coastal flooding from storm surge, heavy rainfall inland, demand surge and many others. And
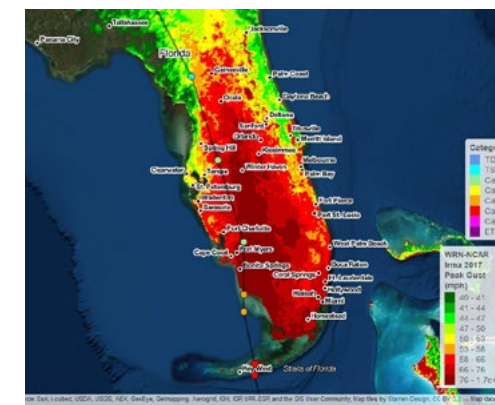

Figure A - WRN/NCAR wind footprint for Hurricane Irma which occured in 2017.

so, we are planning to expand our footprinting technique to incorporate a view on flooding, by modelling rainfall within a tropical cyclone using a method developed by Prof. Kerry Emanuel at Massachusetts Institute of Technology. This will be combined with our current view on wind risk to ultimately create a more holistic view of tropical cyclone related hazard. In the end, these efforts will further support our client interactions touching on the tropical cyclone topic and help us to develop new services.

National Center for Atmospheric Research (NCAR)

The National Center for Atmospheric Research (NCAR) Is based in Boulder, Colorado and one of the leading research institutions in the US. The WRN has been collaborating with staff at NCAR's Mesoscale and Microscale Meteorology lab for well over a decade, which has the mission to advance the understanding of the large and small scale aspects of weather and climate, and to apply this knowledge to benefit society. Willis Research Network Senior Fellow Dr. James Done, and Emeritus Director Dr. Greg Holland have been delivering research and applications throughout our partnership, helping us improve our understanding of tropical cyclone impacts through their multi-sectoral research and variety of wider academic partnerships.

How do fishers assess and manage the risks related to extreme storms?
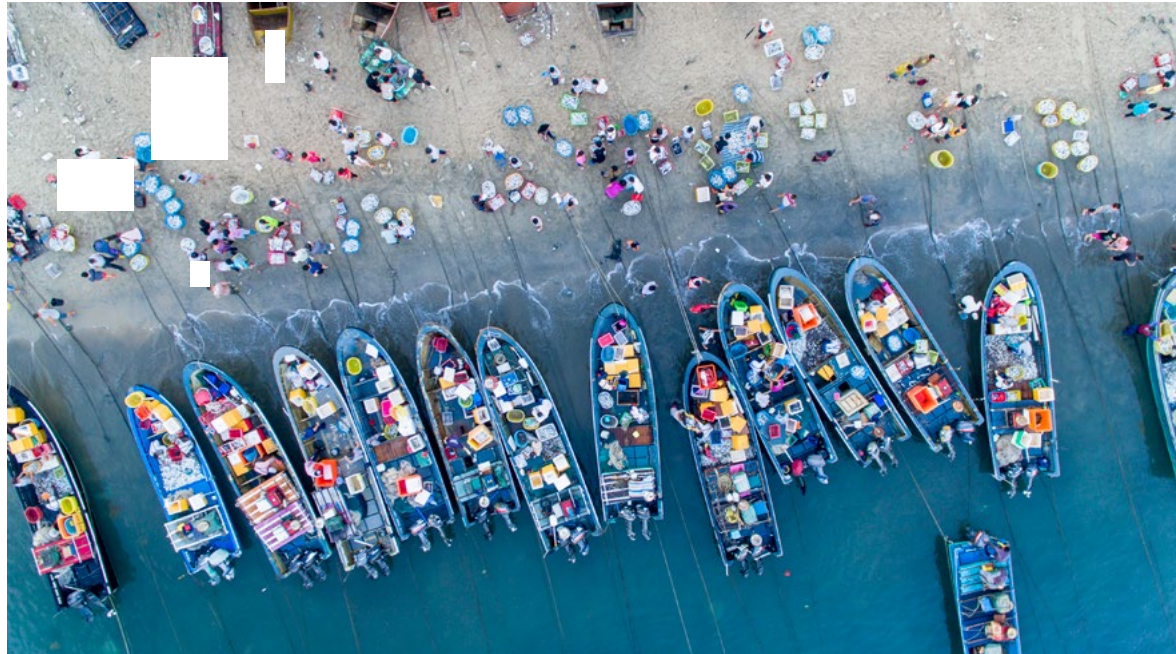
The global fishing industry is an essential resource for food security, health, livelihoods and trade around the world. Although there is growing evidence that global storminess will alter in a changing climate, the risk posed by changing storminess to fisheries has received relatively little attention in terms of risk management. Dr. Nigel Sainsbury has spent the last four years investigating fishers' behavioural response to storms and the implications for the vulnerability of fishing fleets and their adaptation to changing storminess. Funded by NERC at the University of Exeter, Nigel collaborated with a multi-sectoral and multidisciplinary raft of supervisors including experts from Cefas, the Met Office and Willis Towers Watson's Bloodstock, Estates, Livestock & Aquaculture Practice via the WRN.

Nigel's work focused on the UK's fisheries. He carried out social fieldwork with skippers in Cornwall to explore the factors that affect how fishers trade off the physical risks and economic rewards of being at sea and to assess the extent to which fishers expertly manage weather-related risks. Using datasets from the Met Office and the Marine Management Organisations, Nigel also identified how wind speed and wave height affects landings of the U.K. fishing fleet when skippers choose to go to sea. These studies revealed that fishing methods, boat size and design, economic need, and social processes affect the way that skippers trade off risk and reward. Skippers were found to use digital weather forecasts and their expertise to predict the physical risk they would face based on wind, wave, and tidal conditions, and to choose whether, when and where to fish based on their spatial assessment of risk. Nigel's results suggest that through their fishing trip decisions, skippers choose their level of vulnerability to physical and economic risk. From an insurance perspective, this work can inform appropriate setting of trigger thresholds in parametric products for business interruption caused by storms, and it implies that these triggers should vary by fishery, depending on economic need, fishing methods and fishing boat size and design.

University of Exeter

Having recently completed his PhD studies at the University of Exeter, Nigel Sainsbury is an environmental social scientist and geographer with particular interests in risk, including climate change vulnerability and adaptation, social-ecological systems, sustainable development, and conservation. He ran a NERC-funded research program exploring the role of human behaviour in climate vulnerability using fisheries and storms as a case study. During his project, he worked closely with Cefas, the Met Office, and Willis Towers Watson (via the WRN) to achieve direct policy and business impact. Nigel is now exploring risks to Pacific Salmon in British Columbia through a postdoctoral fellowship at Simon Fraser University in Canada.

Wind vulnerability

Despite considerable progress since the 1980s in the development of loss estimation tools for a variety of wind conditions (tropical and extratropical cyclones), loss estimates still reflect high uncertainties and disparities that can undermine their credibility. In particular, only a few studies deal with best-practice methodologies for wind physical vulnerability modeling, and existing approaches often lack appropriate guidance for their selection, rating and use. These concerns emphasized the need for a rational, integrated and comprehensive compendium of existing wind-related fragility (likelihood of building-level damage as a function of hazard intensity) and vulnerability (likelihood of loss as a function of hazard intensity) models to be used in practical probabilistic wind risk assessments.

WRN is supporting scientific research carried out by PhD candidate Biao Song and Dr. Carmine Galasso at University College London (UCL) who are investigating and documenting wind vulnerability across different parts of the world.

Following the approach developed by the Global Earthquake Model (GEM) project, this partnership has produced

1. a comprehensive review of state-of-the-art approaches to wind vulnerability assessment, including empirical and engineering-based methods;

2. a detailed analysis of the main factors affecting the reliability of empirical fragility and vulnerability relationships for wind, with a focus on data sources, building classification, statistical techniques for data collection/fitting, and damage scales/loss metrics;

3. a novel model taxonomy for wind fragility and vulnerability relationships;

4. a preliminary compendium of existing wind fragility and vulnerability models for buildings in a variety of geographic regions, based on the proposed model taxonomy.

This project is creating one of the most complete catalogue of wind loss models to date, with hundreds of highly heterogeneous vulnerability relationships.

This framework can serve as a reference against which damage curves from catastrophe risk models can be evaluated for various regions and construction types (Figure A). This initiative can benefit (re)insurance companies interested in wind loss assessment as well as various decision-makers (e.g., governmental agencies) committed to disaster risk reduction in wind-prone region.

This work is part of a wider project on earthquake vulnerability aimed at understanding if/how wind-induced damage makes high rise buildings more vulnerable to damage from small earthquakes. See article "Multi-Hazard Vulnerability Assessment of High-Rise Steel Structures" in the 2019 Brochure's Earth Section for further details.
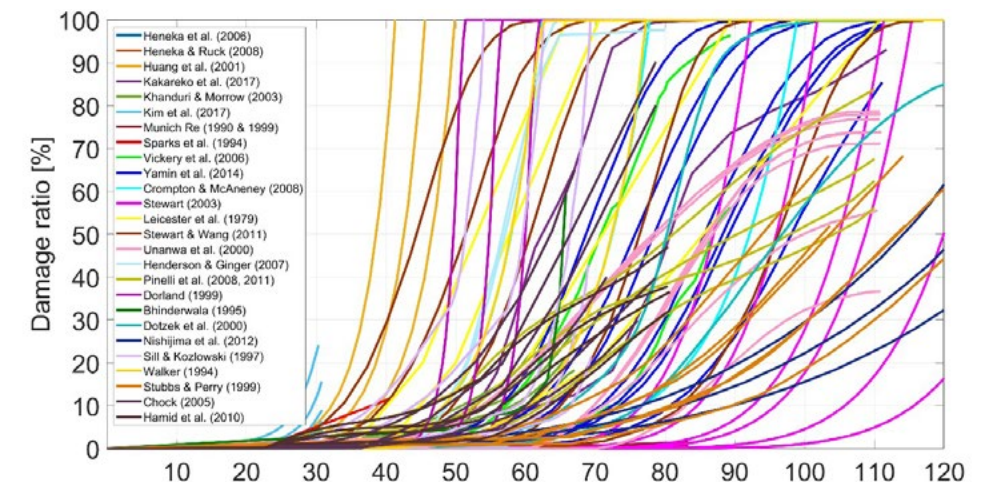

Figure A: Comparison of vulnerability curves for various types of occupancy from the scientific literature against 3-second gust wind speed at 10-meter elevation using open terrain conditions for wind speed conversion. Curves for all regions are shown.

UCL EPICentre

EPICentre at UCL is a multidisciplinary research group that investigates risk to society and infrastructure from earthquakes and other natural hazards. Our collaboration with UCL is currently looking at developing a novel, robust, unified framework for assessing the vulnerability of critical urban infrastructure to the combined effects of earthquake ground shaking, tsunamis and induced soil liquefaction. The research is not only looking at these cascading hazards but is also taking into account the effect of infrastructure interdependence across various systems and how this affects the infrastructure's ability to provide its services.
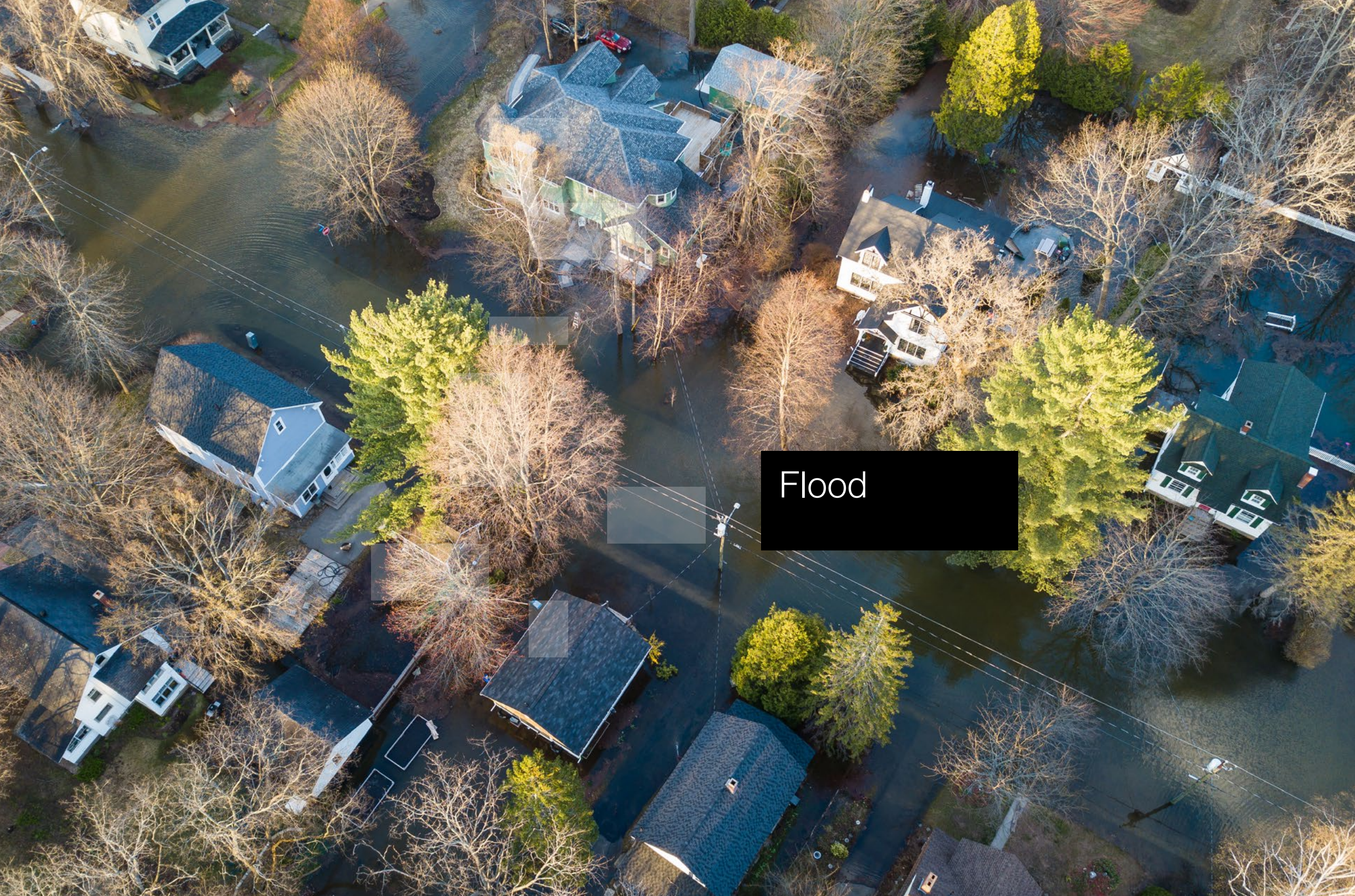
Flood

Flood

Rising Levels of Flood Risk

Flood risk has been under the spotlight many times this year. In the midst of the COVID-19 crisis, Europe suffered multiple flash floods, causing widespread damages to Italy, France[1] and Spain[2]. Deadly floods and landslides in Japan[3] put additional strain on government's emergency responders and the insurance market. Coastal floods after the devastating earthquake in Turkey[4] and Greece this year, highlighted the need to be prepared for the combined impact of disasters.

With Cloud to Street as our newest partner in our Willis Research Network Flood Hub and with Newcastle University and National University of Singapore as our existing long-term partners, we have many projects to tackle the challenges that our world is facing now and provide much needed practical solutions and guidance to the re/insurance industry to address these challenges.

WRN fellows Prof. Chris Kilsby and Dr. Francesco Serinaldi of Newcastle University worked closely with Willis Towers Watson when the Bank of England, Prudential Regulation Authority (PRA) requested the U.K. insurance companies to disclose the impact of climate change on their portfolios based on specific scenarios set last year. This year, together with Newcastle University, Willis Towers Watson is exploring how to calculate

material impact of climate change on flood risk across other European countries and further generalize the methodology to provide a view with an insight of probabilistic outcomes.

Climate change impacts flood risk in various ways. Changes in intensity and frequency of extreme weather events might result in significant shifts in the view of flood risk. How these changes affect losses and portfolio risk profiles are the two main questions the industry is trying to answer. Therefore, right now, understanding these changes, quantifying them, finding sensible and credible adjustments to existing tools and providing representative stress test scenarios are the industry's priorities.

WRN fellows Prof. Shie-Yui Liong and Dr. Srivatsan V. Raghavan of National University of Singapore are working closely with Willis Re to identify the climate change impacts on rainfall and drought distributions in Southeast Asia. We are exploring how to incorporate the insights from climate projection models into realistic scenarios for portfolio sensitivity analysis.

Impact of climate change on flood risk is not just on the agenda of the insurance industry. The U.K. Government also made a significant commitment to tackle the challenges related to flood risk. The Government released a policy paper[5] on the national flood and coastal erosion risk management strategy last summer. The strategy provides a framework for operational and decision-making purposes in the short-term as well as goals for the nation over the next 10 to 30 years. It indeed marks a serious commitment from the Government to make sure the U.K. is more resilient to major weather events associated with climate change.

Willis Towers Watson's response[6] to the Committee's inquiry, again stressed the importance of collaboration between the academia, insurance industry and Government to reduce the risks and levels of damage through improving access to flood risk mitigation measures. This expands on the need to leverage insurance solutions, integrate climate considerations into mainstream finance and ensure a risk first approach.

We will continue to collaborate with our partners and affiliates to provide guidance and insights to the re/insurance industry and governments to set the standards for practical solutions.

Nalan Senol Cabi
Head of Flood Risk research

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[2] http://floodlist.com/europe/spain-floods-malaga-november-2020
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[4] http://floodlist.com/asia/greece-turkey-earthquake-tsunami-october-2020
[5] https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2
[6] https://committees.parliament.uk/writtenevidence/5066/pdf/

Quantifying the climate change impact on flooding: scenario approach

Flooding is being recognised as one of the most serious threats the world is facing. Managing such risk is a major challenge for risk managers across the industry and society at large, and it is generally expected that for the U.K., flood risk will become ever more severe as the impact of climate change unfolds.

Insurance companies are therefore becoming increasingly interested in understanding and mitigating this evolving threat. Especially with the need to strategically respond to an evolving risk management framework in light of regulatory demands, such as the Prudential Regulation Authority, insurance companies need to be able to stress test the impact of climate change on their portfolios. The Willis Re analytics team, under the guidance of our longstanding collaborator Professor Chris Kilsby at Newcastle University, have developed solutions that allow insurance companies to quantify the climate resilience of their portfolios by considering different influences on the frequency, severity and duration of extreme flood events.

The U.K. Climate Projections of 2018 (UKCP18) use cutting-edge climate science to project future flood risk in the U.K.. The projections show an overall shift towards warmer, wetter winters and hotter, drier summers, with the possibility of more intense localized rainfall events. This shows a significant increase in winter precipitation from the 1981 - 2000 baseline over southern and central England and along the coastal regions in the north, as highlighted for the 2060 - 2079 period under Representative Concentration Pathway (RCP) 8.5 in Figure A.

Using this framework, we have developed a deterministic climate change scenario framework, as summarised in Figure B. A flood footprint of interest is generated using present time precipitation and HEC-HMS/HEC-RAS models, and a current loss is subsequently estimated using present day client specific exposure and claims data derived vulnerability functions. The corresponding future loss is estimated using hazard projection outputs from UKCP18 at both 25 km and 2.2 km spatial resolution.

This flexible approach, repeatable for other projections and regions, leverages the latest science and most up to date data to provide flood scenario estimates for current and future climates. Such endeavors allow for stress testing client portfolios, which can be used to inform on treaty structure limits, respond to regulators and assess model completeness.

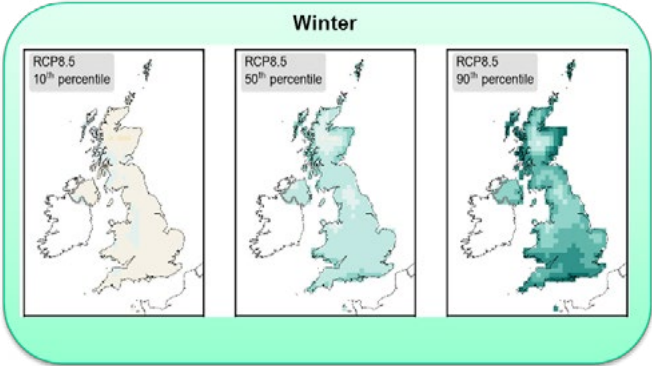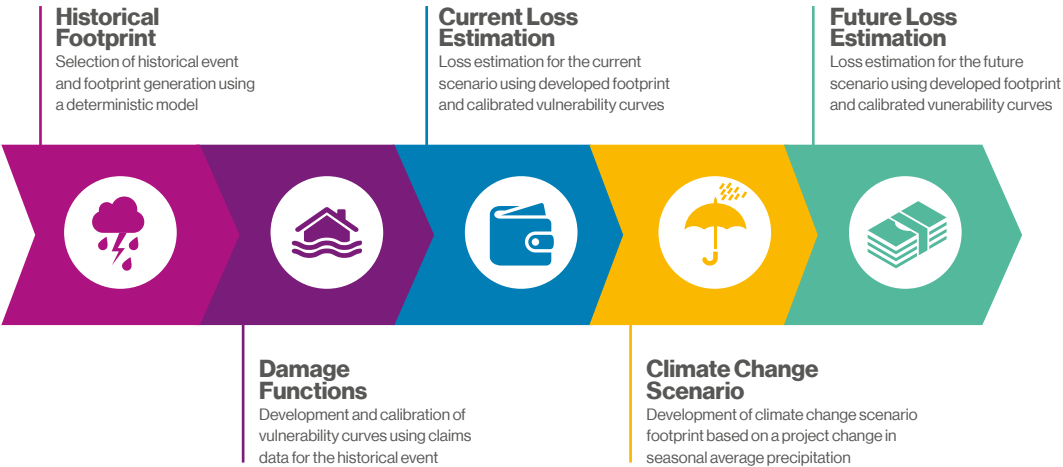Figure A - Spatial pattern of projected winter precipitation change in the U.K. (RCP 8.5)

Figure B - Climate Change flood scenario framework

Historical Footprint
Selection of historical event and footprint generation using a deterministic model

Current Loss Estimation
Loss estimation for the current scenario using developed footprint and calibrated vulnerability curves

Future Loss Estimation
Loss estimation for the future scenario using developed footprint and calibrated vunerability curves

Damage Functions
Development and calibration of vulnerability curves using claims data for the historical event

Climate Change Scenario
Development of climate change scenario footprint based on a project change in seasonal average precipitation

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.

Providing a view of risk in emerging markets

Filling the gaps in model coverage in Asia

Willis Towers Watson has been working with National University of Singapore (NUS) Tropical Marine Science Institute (TMSI) since the devastating floods in Jakarta, Indonesia in 2007. Many of our clients suffered large losses from this event which was unmodeled. Much of Jakarta is at high risk from flood and much of the insured losses in 2007 came from industrial risks in the northern area. The response of many companies was to move their large manufacturing and processing facilities out of the main city and into Industrial estates in neighboring areas. However this was a slow and complex process. Insurance companies had an immediate need to assess their risk in Jakarta and then consequently in newly developing areas elsewhere in Indonesia.

TMSI has significant experience in developing hydrological and hydraulic models for evaluating flood risk in South East Asia, particularly in Indonesia. Flood simulations rely heavily on high quality digital elevation models (DEM). TMSI has well-established links to the data providers in the region, utilizing satellite data (e.g. SRTM and Sentinel-2 multispectral imagery) to derive a high-resolution DEM using artificial neural networks. This NUS research improved the accuracy of SRTM DEM significantly to allow better flood risk modeling in the key areas.

TMSI outputs for Jakarta have been integrated into Willis Towers Watson models for the region and are deriving real benefits in helping clients understand and manage their risks. This has provided a precise re-run of the 2007 event – which is still used by many insurance companies as a benchmark, and a series of updates which extended the spatial coverage into new and developing areas to allow insurers to keep up-to-date with their changing exposure. This has culminated in TMSI research that is enhancing the newly launched Willis Re Indonesia Flood Model, which is highly detailed and fully probabilistic, and provides a broad and extensive capability to Willis Towers Watson clients, fully utilizing the work from TMSI.

Flood hazard affects all territories in South East Asia. In the wake of extreme flooding in Thailand in 2011, a significant proportion of heavy and high-tech industry was relocated from Thailand to the Hanoi and Ho Chi Minh regions in Vietnam. As a consequence, Willis Towers Watson clients needed detailed assessment of the flood risk to the industrial estates with increased exposures. TMSI were able to utilize their technical expertise to help Willis Towers Watson assess their clients' risk in these areas as accumulations increased.

TMSI specializes in climate science and has extensive experience, particularly in dynamical downscaling global climate models for local application, in conjunction with other leading academic and government institutions, both in the WRN and externally. By utilizing a multi-disciplinary combination of climate science and flood expertise, TMSI and WRN are exploring the influences of climate change on extreme flood and rainfall distributions that could form the basis of scenarios and future event sets.

National University of Singapore

The Tropical Marine Science Institute (TMSI) in NUS is a center of excellence for research, development and consultancy in tropical marine science as well as environmental science. With its multi-disciplinary research laboratories and active international links, it handles projects relevant to Marine Biology, Marine Mammals, Climate Change, Water Resources, Shallow-water acoustics; Underwater technologies and Physical Oceanography. Through active collaboration with academic, government and industrial sectors, TMSI plays a strong role in promoting integrated marine science, in R&D, and as well as to establish itself as a regional and international education and training center. https://emid.nus.edu.sg/aboutus.jsp

The Climate and Water Research cluster at TMSI specializes in climate research and has extensive experience, particularly, in high-resolution dynamical downscaling of global climate models at a range of spatial scales – from regional (10-20 km) to local (urban) (400 m – 2 km), that are applicable for a suite of impact studies.

How remote sensing technology is becoming the key component of analysing flood risk

This year Cloud to Street became an Associate member of the WRN. We are delighted to welcome Cloud to Street into our Flood Hub.

Cloud to Street is a global flood-mapping and monitoring platform designed for governments, humanitarian organizations and insurers in low data environments to effectively respond and prepare for disasters. Originally founded with seed funding from Google in 2014, Cloud to Street's technology combines high-resolution satellite imagery, cloud computing, machine learning, and community intelligence to monitor floods in near real-time and analyse flood risk remotely around the globe. Since its founding, Cloud to Street has worked with governments and global insurers in almost 20 countries to provide the tools and analytics they need to both respond faster and reduce risk to disasters over long-term.

For the past two years Willis Re, the reinsurance broking arm of Willis Towers Watson, has worked with Cloud to Street to expand insurance coverage in Indonesia. Currently Willis Towers Watson is collaborating with Cloud to Street to provide the best available remote sensing based parametric solution for flood risk in Morocco.

The insurance gap in the developing world, where 90% of economic losses from disasters remain uninsured, puts economically vulnerable households at greater risk and slows recovery efforts following disasters. Cloud to Street's service offerings rely almost exclusively on remotely sensed data, which makes it affordable and easily deployable in the developing world for almost all types of flooding. Most flood maps rely on long histories of local stream and rainfall equipment, which are expensive and difficult to maintain. Flood models use input this data and then run complex flood simulations. High resolution elevation data is required to accurately simulate flooding but is often unavailable for the developing world.

Cloud to Street leverages global satellites imagery, high capacity cloud computing, advanced remote sensing and AI algorithms and community input in order to create decision quality flood analytics and predictions anywhere in the world. The mission of the company is to fill the current massive flood information gap in the developing world. Filling this information gap required developing a new type of flood science, which was finally enabled by an exponential increase in earth observing satellites and the availability of high parallelised cloud computing.

The resulting methods are designed to be built and executed remotely, dynamic and updated locally through the cloud so that computing equipment required would be affordable to install and maintain.

This new technology enables Cloud to Street to develop The Global Flood Map Database, the world's largest database of flood maps, which will be released to the public in the coming years.

With their research focused agenda and a mission to provide cutting-edge technology to the most vulnerable countries in the world, Cloud to Street fits right in the Network where academic and industry collaborations are cherished. Technology sharing is encouraged for a better world for everyone.

Cloud to Street

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Earth

Earth
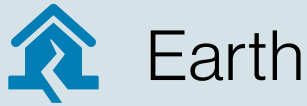
Terra Firma, a year of significant achievements

All around the world the intersection of growing populations with exposure to natural hazards calls for a constant improvement of the understanding of those hazards and their impact on societies, as well as the identification of strategies to reduce vulnerability and increase resilience.

In the Earth Hub we focus mainly on the study of natural hazards that have their origin in the "terra firma", aka Solid Earth, the earth beneath our feet. Since forming the WRN we have been collaborating with internationally renowned scientists in seismic, tsunami and volcanic risk to get a state of the art understanding of the potential losses from these catastrophes, so that our clients can make informed business decisions.

But the dynamics of the earth interior with external forces and the interconnectivity of the Earth structure makes climate change an area of relevance for the Earth Hub too. The potential risks of carbon capture and underground storage (CCS) pose a potential threat to water contamination and seismicity increase. Mining activities and the tailings dams are other areas of study we turned to in recent months as a result of climate change.

With the help of our WRN partners we try to understand the potential interaction among hazards, such as the dynamics between earthquakes and tsunamis, and the vulnerability of corresponding infrastructures. Taking advantage of working with the best scientists in each field, we create multiperil research projects for regions with large, active faults, and major subduction zones responsible for some of the world's biggest earthquakes. The aim is to increase the understanding of their joint potential for destruction, as a basis for more reliable forecasting.

In this brochure we illustrate the most relevant achievements of the past year.

Rosa Sobradelo
Head of Earth Risk research

Harbour Waves

Since 2009, the WRN and Willis Re have worked in partnership with Tohoku University and the International Research Institute of Disaster Science (IRIDeS) in Japan to improve the understanding and quantitative assessment of tsunami risk in Japan and other target areas in the world. IRIDeS have also been studying and identifying tsunami-prone regions and it has been particularly relevant for areas where new evidence indicates a higher risk than previously believed.

Tsunami is a Japanese word which translates to 'Harbour Wave'. A tsunami generally occurs when gigantic waves are created not only due to earthquakes but also other causes such as landslides and volcanic eruptions under the

sea. The recent tsunami events in Indonesia highlighted the potential severity of non-seismic induced tsunamis or 'silent tsunamis' leading to a new research direction (Figure A). Silent tsunamis are difficult to predict and not accounted for in any tsunami warning system.

Such tsunamis are not well considered in the insurance industry and the inclusion of such events may be considered for a portfolio stress-test. The IRIDeS study shows generation mechanisms of two silent tsunamis that occurred in Indonesia in 2018, and by numerical simulation, it demonstrates underrated risk of silent tsunamis, as shown in Figures B and C.
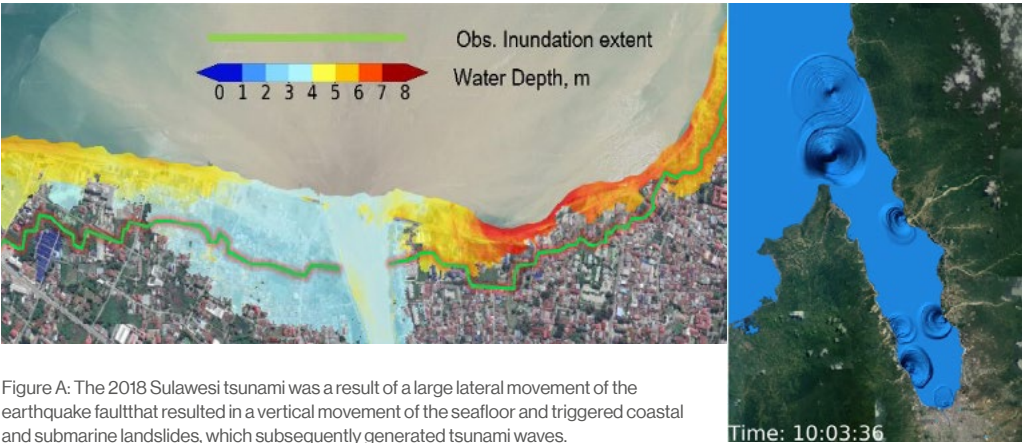

Figure A: The 2018 Sulawesi tsunami was a result of a large lateral movement of the earthquake fault that resulted in a vertical movement of the seafloor and triggered coastal and submarine landslides, which subsequently generated tsunami waves.

Figure B: The 2018 Sunda Strait tsunami was caused by the collapse of a volcano flank. Due to the non-seismic origins of the tsunami, there was no natural warning sign (e.g. ground shaking).

As we approach the 10 year anniversary of the 2011 Tohoku event , the IRIDeS research focus continues on the assessment of tsunami counter measures in Japan, in particular the multi-layered counter measures in the Tohoku region. The

WRN continues to monitor these scientific and pioneering advances to ensure our View of Risk in those associated regions with insurance exposure are as accurate and up to date as scientifically possible.
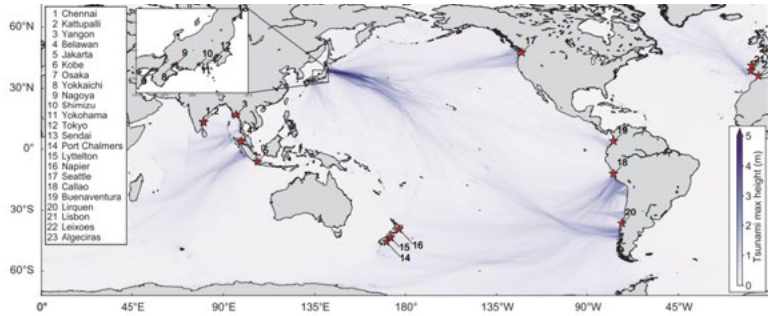

Figure C: Distribution of simulated maximum tsunami from 300 historical scenarios over expected damaged ports. Port damage criteria is determined from the 2011 Japan tsunami data.

Tohoku University

Tohoku University joined the WRN in 2009. It founded the International Research Institute of Disaster Science (IRIDeS) after having experienced the catastrophic disaster in 2011. The IRIDeS conducts world-leading research on natural disaster science and disaster mitigation, and aims to become a world centre for the study of the disasters and disaster mitigation.

Tsunami fragility of buildings

Tsunami have contributed to 250,000 deaths between 1994 and 2013. Statistically, they are the deadliest natural hazard, with an average of 79 deaths for every 1,000 people affected, compared to four deaths per 1,000 for other natural hazards. Past tsunamis have caused widespread damage and economic losses, with a direct loss of U.S. $211 billion being estimated for the 2011 Tohoku event alone. The WRN has invested in research to understand buildings vulnerability to tsunami for several years and UCL EPI Centre is leading the research in the field of tsunami physical modeling and vulnerability.

To mitigate tsunami risks for coastal communities, reliable tools for assessing the effects of tsunami on coastal structures are needed. One of our projects with UCL aims to fill the gap in the fragility assessment of buildings and critical infrastructure (e.g. schools and hospitals). Essential structural analysis procedures have been used to evaluate the response of various case-study buildings in Japan, Chile, U.S., Sri Lanka and Indonesia. Often this required accounting for the preceding ground shaking damage, leading to combined earthquake and tsunami fragility curves. The small impact of the ground motion on tsunami fragility is caused

Photo of Palu beach area after the 2018 Sulawesi Earthquake and Tsunami, Indonesia. (Source: EEFIT and T.Rossetto)

Masjid Apung Mosque in Palu, Indonesia, currently subjected to inundation due to coastal settlement from the 2018 Sulawesi Earthquake and Tsunami. (Source: EEFIT and T.Rossetto)

by the fundamentally different response of the structure to the two perils. This means that the fragility of seismically designed structures can be approximated by assessing the earthquake and tsunami response separately. These findings are reflected in the new guidance on how to perform tsunami fragility assessment that is included within the revised version of ASCE7 Standard to be published in 2022.

This project is helping Willis Towers Watson validate recently developed models with a tsunami component, or evaluate tsunami impact as a secondary peril.

UCL EPICentre

EPICentre at UCL is a multidisciplinary research group that investigates risk to society and infrastructure from earthquakes and other natural hazards. Our collaboration with UCL is currently looking at developing a novel, robust, unified framework for assessing the vulnerability of critical urban infrastructure to the combined effects of earthquake ground shaking, tsunamis and induced soil liquefaction. The research is not only looking at these cascading hazards but is also taking into account the effect of infrastructure interdependence across various systems and how this affects the infrastructure's ability to provide its services.

Seismic resilience of telecommunication networks

The importance of a resilient telecommunication network was highlighted during the COVID-19 lockdowns when many relied on internet connectivity to continue working from home. Network robustness is even more critical in a post-disaster scenario to support emergency and response management, and to restore other critical lifelines. Despite the importance of telecommunication networks, the assessment of their seismic resilience is currently underrepresented compared to other critical lifelines.

Investigating the impact of liquefaction on buried telecommunications infrastructure

Telecommunication networks cover large geographical areas and in many parts of the world are underground. They can be damaged by seismic events leading to service disruption and potentially causing business interruption over vast areas.

In particular, buried linear structures like pipelines and cables are susceptible to damage from liquefaction-induced settlements. The WRN is supporting a project at UCL that looks to improve liquefaction-induced settlement prediction and investigate the vulnerability of the telecommunication network to this hazard. For this project, Christchurch in New Zealand is being used as a case study, in collaboration with the New Zealand centre of research excellence QuakeCoRE and Chorus Ltd, a major New Zealand network provider (Figures A and B).

Figure B: Liquefaction manifestation observed inside a telecommunication Utility hole. (Photo courtesy of Rob Ruiter, Chorus Ltd.)

This collaboration has showed that the telecommunication network is a fast-changing infrastructure (Figure C). In Christchurch many components , observed to be very vulnerable during previous earthquakes, have become obsolete. The 'need for speed' for internet has pushed the replacement of the older copper network to the more resilient fibre ones. Data collected on the field shows that the new system is less susceptible to liquefaction damages, but business interruptions may still occur due to soil differential settlements and cracks on joint components.

A key to understanding the risk to these networks is the development of better models for settlement prediction. Scientific and engineering work to evaluate liquefaction potential and soil settlement has been compared with geotechnical measurements in Christchurch and has shown limitations. This project is proposing a new methodological framework to better quantify liquefaction occurrence and soil settlement by combining empirical and numerical methodologies, and introducing new settlement relationships. This research aims to reduce uncertainties and advance the loss estimation of critical lifelines.

Figure A: Liquefaction in the aftermath of the February 2011 Event in Christchurch. (Photo courtesy of Royce Liu, University of Canterbury.)

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EPICentre at UCL is a multidisciplinary research group that investigates risk to society and infrastructure from earthquakes and other natural hazards. Our collaboration with UCL is currently looking at developing a novel, robust, unified frameworks for assessing the vulnerability of buildings and critical urban infrastructure to the combined effects of earthquake ground shaking (including sequences), tsunamis, and induced soil liquefaction as well as strong wind. The research is not only looking at these cascading hazards but is also taking into account the effect of infrastructure interdependence across various systems and how this affects the infrastructure's ability to provide its services.

Do earthquakes interact with each other, and how do we account for it?

Recent events such as the 2008 Mw 8.0 in Wenchuan (China) and the 2019 Mw 6.4 – 7.1 in Ridgecrest (USA) suggest that there are at least three modes of earthquake interaction:

1. long- term repeated occurrence of large earthquakes on specific fault segments, which is in contrast with the common assumption of random occurrence of earthquakes;

2. interaction between adjacent faults, which may delay or promote the occurrence of other earthquakes on nearby faults;

3. short-term spatial and temporal clustering of foreshocks and aftershocks.

Is it possible to take advantage of these interactions to improve probabilistic seismic hazard forecasts and risk models? The WRN and UCL are currently tackling this question, providing scientifically-proven and industry-oriented solutions for (re) insurance clients.

The aim is to enable stakeholders to have a more accurate and refined view of the risk by fully including the time-dependency in their risk calculations. Decision-

making will take into account the dynamic nature of risk, which varies over time due to the intrinsic nature of earthquake risk.

The proposed methodology will be incorporated into new models developed at Willis Towers Watson and can be used to validate current models, which are starting to incorporate time-dependency assumptions.
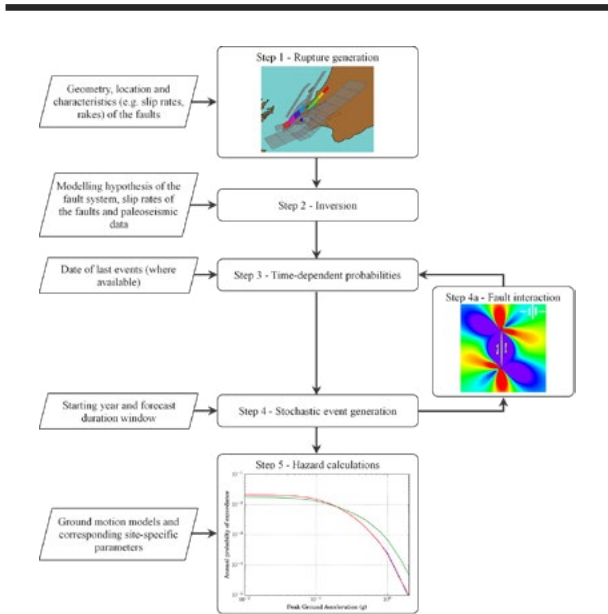

Figure A: Schematic representation of the hazard module of the proposed framework.

How will this be done?

A unified hazard and risk modeling framework, developed by PhD candidate Salvatore Iacoletti, Dr. Gemma Cremen and Dr. Carmine Galasso at UCL, incorporates the latest scientific advancements in earthquake interaction (Figure A). On the hazard side, it includes more realistic, time-dependent occurrences of major earthquakes and interactions between adjacent faults, promising more accurate hazard and risk estimates. A case study for Wellington (New Zealand) has been used to test the hazard module's capabilities and limitations.

Ongoing Improvements

UCL and WRN are developing a versatile and flexible methodology to incorporate aftershocks (often neglected in risk models) in the stochastic event set. On the vulnerability side, aftershocks can be more damaging than the mainshock (e.g., 2010 Canterbury, New Zealand) due to physical damage accumulation to building infrastructures. For this reason, the proposed time-dependent risk module will use state-dependent fragility relationships of structures subjected to ground-motion sequences (e.g. mainshock-aftershock or

triggered earthquakes), to develop vector-valued vulnerability relationships that account for the damaging effect of two ground-motion records.

The unified framework resulting from this long-standing collaboration will provide state-of-art solutions for clients in the (re)insurance and earthquake risk- modeling industries.
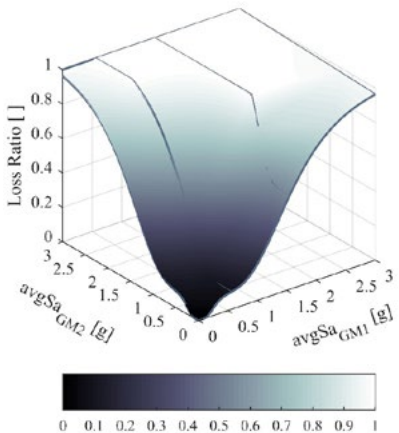

Figure B: Example of vulnerability surface for a reinforced concrete pre-code frame.

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Earthquake risk in realtime for Japan

The 2011 M 9.0 Tohoku-Oki earthquake was a cruel reminder that no advanced nation faces a higher seismic risk than Japan, with the possible exception of far-smaller Taiwan. The subduction-of the Pacific Plate beneath northern Honshua-long the Japan Trench—which slipped up to 80m in about 120 seconds during the M 9.0shock—and the subduction of the Philippine Sea Plate beneath southern Honshu along the Nankai Trough, are the principal drivers of its outsized earthquake hazard. But Japan also has its own San Andreas-like 'transform' fault,the Median Tectonic Line, that extends from southern Hon-shu through Kyushuand ruptured in the 1995 M 6.9 Kobe shock at its northern end, and the 2016 M7.0 Kumamoto shock at its southern end.

A series of blind thrust faults also underly the Japan Sea coastline.

The WRN has been collaborating with Dr Ross S. Stein, at Temblor, Inc., and Prof Shinji Toda, at IRIDeS, Tohoku University, to better understand the earthquake risk in this region. In early 2020, the Temblor team identified a mild swarm of M≥5 shocks ranging from the Greater Tokyo area, and extending up the Tohoku coastline, at the beginning of April (Figure A). With the prior Tohoku and Kumamoto shocks, along with this newly observed mild swarm, they built a new forecast using their state of the art tool Realtime Risk, which was taken into consideration to inform Willis Re View of Risk in the region, as shown below in Figure B.
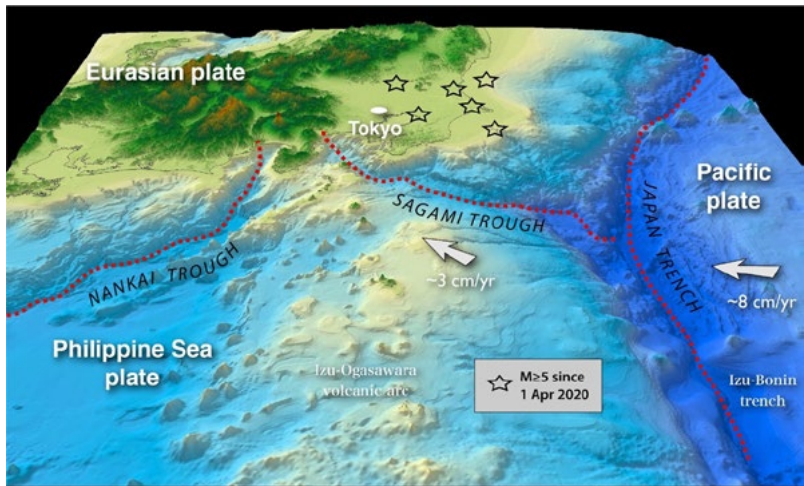

Figure A: Greater Tokyo's 38 million residents live near a plate tectonic 'triple junction' (the intersection of the dashed red lines) where three plates meet, and so is subject to large earthquakes from the east along the Japan Trench, as struck in 2011, taking 22,000 lives, and large earthquakes from the south along the Sagami Trough, as struck in 1923, taking 90,000 lives.
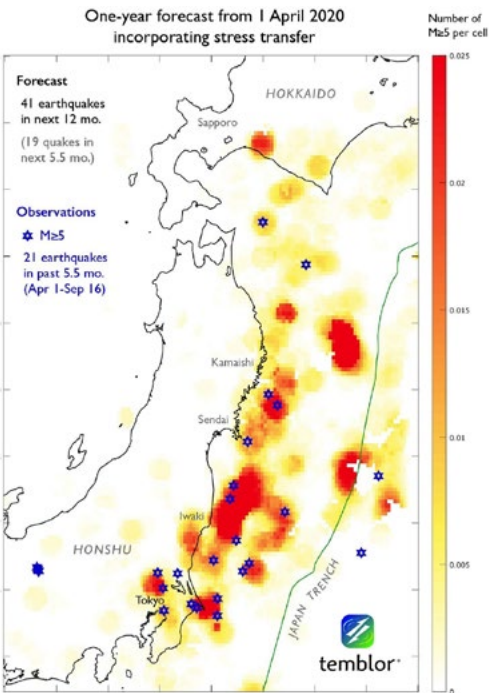

Figure B: Realtime Risk earthquake forecast for Honshu and southern Hokkaido for the period 1 April 2020 - 31 March 2021. The observed quakes that have struck since the forecast was issued are shown as blue stars.

The red-orange areas have the highest expected quake rates. The forecast is for earthquakes of all sizes, but in Figure B it shows the M≥5 forecast, because it shows a large sample of observations to compare with the Realtime Risk forecast. We are now midway through the forecast, and we can see that the observed quakes generally locate in regions of high expected occurrence rate, and the total number of M≥5 quakes half-way through the forecast period is about half of what Temblor forecasted for the full year. So, thus far, the forecast is faring very well. The WRN continues to monitor the evolution of these to ensure our view or risk can include the most credible, latest scientific developments.
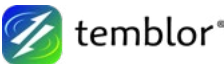
Temblor, Inc.

Temblor is a Silicon Valley tech company providing personal, immediate, and credible sources of seismic risk understanding ad solutions. The Temblor seismic risk app and Temblor Earthquake News are accessed by 100,000 people a month worldwide, and their enterprise projects for insurance and financial clients has given them an understanding of key unmet needs. Temblor's CEO Ross Stein, CTO Volkan Sevilgen, and collaborator Shinji Toda from IRIDeS of Tohoku University, are the world pioneers in Coulomb stress transfer, and will lead this effort.

2019 Ridgecrest: can earthquakes cause a chain reaction?

The 2019 M6.4 and M-7.1 Ridgecrest earthquakes were largely unforeseen. Unusually, the larger quake followed 34 hours after the smaller one. Fortunately, both occurred in the remote southern California desert which caused no deaths, only modest damage, and almost no insurance consequences.

But the Ridgecrest ruptures could have far reaching effects because the Garlock Fault, which links the Ridgecrest faults with the San Andreas Fault, appears to have been brought significantly closer to failure. So, can anything new be forseen? That is the question that WRN and Temblor sought to answer in a study published in July in the prestigious Bulletin of the Seismological Society of America (Toda and Stein, 2020). The WRN continues to work with Dr. Ross S. Stein, and Prof. Shinji Toda to fully understand the risk in the area and any potential implications this could have from a re/insurance perspective.

Setting the stage for Ridgecrest

In the 150 years prior to the 2019 Ridgecrest quakes, four M -7.0+ shocks struck up to 90 miles away. Toda and Stein found that these quakes added stress to the newly discovered Paxton Ranch and the Salt Wells Valley Faults that would rupture in 2019. The increase in stress was about 3% of the stress released during the 2019 earthquakes, which means that the four past M -7.0+ events did not cause the Ridgecrest earthquakes, but they nevertheless promoted it.

Figure B highlights areas that are stressed (red-yellow) as a result of the M -7.0+ events. Plotting M -4.0+ quakes since 1900 on this map shows that most lie in the red-yellow regions — areas stressed as a result of these four larger quakes: these four large events affected not only the Ridgecrest rupture, but also the broad pattern of Southern California seismicity.

However the Garlock Fault hasn't otherwise budged. That does not mean it won't: large progressive ruptures separated by months to years are not uncommon; the North Anatolian Fault in Turkey has had many since 1939.
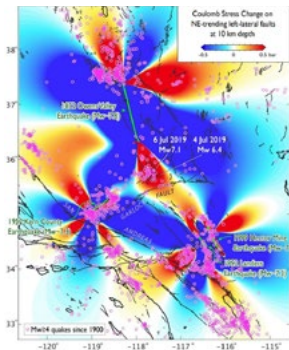
Figure B: Stresses imparted by the largest earthquakes known to have struck within 90 miles (150 kilometer-skm) of the Ridgecrest epicenters. Areas of increased stress are shown in red-yellow. Stress "shadows" are in blue. M-4.0+ earthquakes from 1 Jan 1900 – 4 Jul 2019 (USGS ANSS catalog) are not a complete catalog, but the pattern is similar if plotted since 1970, which would be complete.

Could the Garlock Fault cause a San Andreas quake?

Since 2019, a shallow portion of the Garlock has slipped slowly, a process known as 'creep', probably as a result of the stress imparted by the Ridgecrest earthquakes, or due to the ground shaking.

Toda and Stein concluded that if a Garlock Fault ruptured within about 30 miles (45 kilometers) of its junction with the San Andreas Fault, it would raise the probability by factor of 150 for a San Andreas rupture extending to the southeast, on the so-called 'Mojave section'. They estimate the net chance of a large San Andreas earthquake in the next 12 months to be 1.15%, or 1 chance in 87. Whilst the chances are slim, this probability is 3.5 - 5.0 times higher than the annual chance of a large San Andreas earthquake in the 'UCERF3' benchmark model for California (Field et al., 2014; Field et al., 2015) (Figure D). That means a View of Risk based on UCERF3 might need adjustment to reflect the slight increase in the probability, together with further research to continue informing our view of risk.
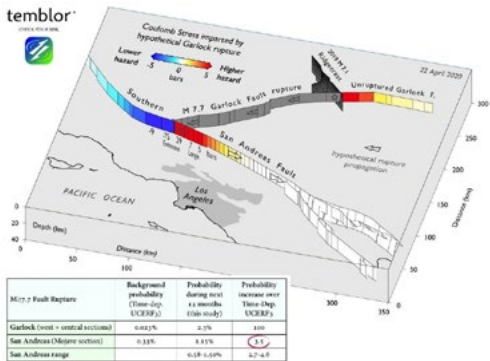
Figure D: The Garlock Fault links the remote 2019 Ridgecrest rupture to the San Andreas, with densely populated greater Los Angeles nearby. Temblor finds tha the Garlock is now about 100 times more likely to rupture in a large quake than it was prior to the Ridgecrest events. If it did so, and if the rupture came within 30 miles (45 kilometers) of the San Andreas, there is a 50/50 chance that the Mojave (red) section of the San Andreas would follow suit.

Temblor, Inc.

Temblor is a Silicon Valley tech company providing personal, immediate, and credible sources of seismic risk solutions. Their free mobile and web app and daily blog have gained 900,000 users worldwide in under 16 months, and their enterprise projects for insurance and financial clients has given them an understanding of key unmet needs. Temblor's CEO Ross Stein, CTO Volkan Sevilgen, and collaborator Shinji Toda from IRIDeS of Tohoku University, are the world pioneers in Coulomb stress transfer.

Quantifying the tail risk from very large earthquakes.

It is critical for the financial health of earthquake insurance companies to ensure that premiums accurately reflect expected losses in a catastrophic event. The insurance industry conventionally relies on regression of empirical ground motion recordings (Ground Motion Prediction Equations, or GMPEs) from historical earthquakes to estimate insured losses. However, GMPEs produce large uncertainty and potential bias in estimated ground motions, and include major gaps in data in the near field and for large-magnitude events. The use of wave propagation simulations carried out in a state-of-the-art 3D earth model may help refine the expected range of ground motions and loss estimates associated to very large earthquakes.

The WRN has been collaborating with Prof. Kim Olsen and Dr. Daniel Roten from San Diego State University to develop 3D velocity and rupture models for M8.7 - 9.6 subduction earthquake scenarios. This has been successfully done for the Cascadia region in the Pacific Northwest, and is now being developed along the South American west coast, to generate ground motion footprints for Chile and Peru.

The west coast of South America has experienced frequent M 8 - 9+ megathrust earthquakes, including the largest historical event of 1960 (M9.5) and the 2010 (M8.8) Maule earthquake. The region includes large insurance exposure at population centers such as Santiago, Chile and Lima, Peru. The aim is to provide more accurate levels of ground motions and enable refined loss estimates for large, damaging earthquake scenarios as compared to GMPE-based estimates. This will allow better evaluation of tail risk as a more robust replacement of GMPEs.

The current efforts in the collaboration are concentrated on assembling an accurate 3D earth model for the south American west coast region. This is done with a combination of a series of geophysical and geotechnical features, including geometry of the subducting slab, mantle and crustal velocities, and sedimentary basin parameters. The model is validated against recorded strong ground motions, such as from the 2010 M8.8 Maule, Chile, earthquake, before generating accurate footprints of scenario ground motion (Figure A).
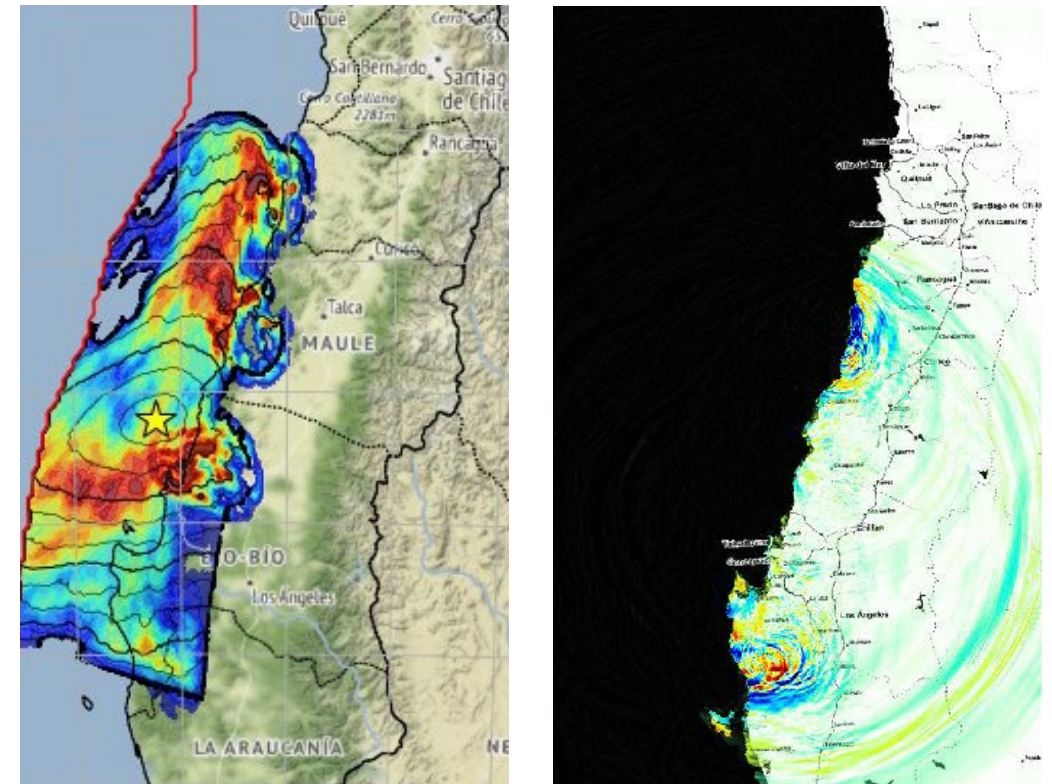

Figure A: Simulation of the 2010 M8.8 Maule, Chile, earthquake, to validate the 3D earth model for generation of footprints for large scenario earthquakes. (left) Compoundsource model for the Maule event, generated by combining background slip with high stressdrop subevents. The star depicts the epicenter, the color shading is the slip distribution (red largest), and the contours show the rupture initiation times. (right) Snapshot of 3D wave propagation.

San Diego State University

San Diego State University (SDSU) has been a member of WRN since 2017. Prof. Kim Olsen and Dr. 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.

Better earthquake modelling for (re)insurance decision-making

Earthquakes are outside human control and can have catastrophic consequences for our society. Initiatives such as the Global Earthquake Model (GEM) are helping to better understand, quantify and manage this risk with the ultimate aim of building a world more resilient to earthquakes. Willis Towers Watson, through the WRN, was one of the founding members and continues to be a proud supporter. Nowadays, GEM is a world leader in earthquake science and has developed a global, fully probabilistic, earthquake hazard and risk models that are continuously updated.

We use GEM datasets to enhance loss assessment and apply their probabilistic models for novel and rapid loss estimation. These solutions can be fundamental in assisting clients in several risk management areas such as regulatory requirements, alternative views of catastrophe risk to develop robust loss estimation and capital needs definition, contribution to technical discussions during (re)insurance placement, and understanding of unmodelled risk and the sound determination of loss size and frequency of events. Below are some examples of Willis Towers Watson applications.
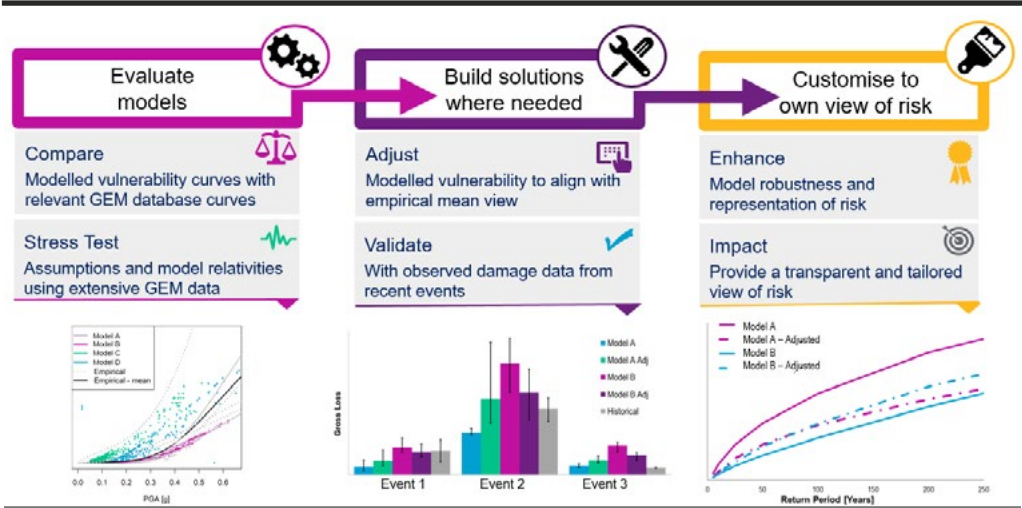
Enhancing loss assessment using GEM exposure and vulnerability databases

The GEM vulnerability and global exposure models are extensively used by Willis Towers Watson to develop the Willis Re View of Catastrophe Risk worldwide. GEM exposure data is used to refine the view of risk and support robust, technical broking arguments in the reinsurance placement, particularly in regions and for portfolios with 'unknown' construction typology or other primary modifiers. The GEM vulnerability database is key in the comprehensive approach towards risk quantification developed at Willis Re (depicted below), allowing us to create a customised view of risk suitable to individual portfolios, and underpinned by a transparent and scientifically robust methodology, that supports reinsurance placement and improves our confidence in defining capital needs.

Figure A. Leveraging GEM vulnerability database in loss modelling: a comprehensive approach towards risk quantification.
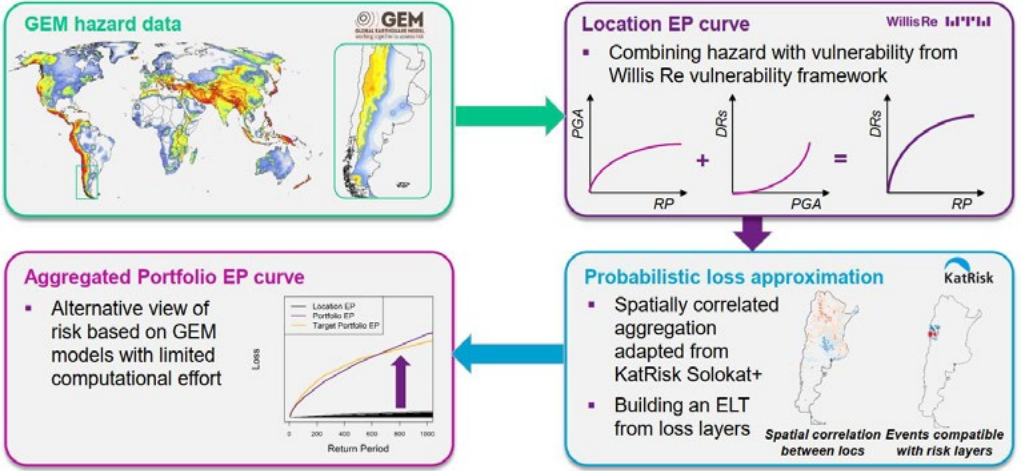
Figure B. Innovative portfolio modelling for reinsurance decision-making: rapid conversion of GEM model outputs to portfolio Exceedance Probability (EP) curves.

Leveraging GEM model for probabilistic loss estimation

The continuously updated GEM global mosaic of 30 risk models can help decision making in various ways. The development of stochastic event sets from GEM models allow calibration of existing models for use in decisions around reinsurance. Fully probabilistic models developed with the OpenQuake engine from GEM, such as the Middle East and North Africa earthquake model from Willis Re, enabled the definition and calibration of a parametric cover with minimal basis risk; a very relevant risk transfer solution, particularly for emerging markets.

Willis Re has been developing an exposure driven, reproducible and robust method to rapidly produce alternatives to vendor views of risk, without the need to run a computationally expensive, fully probabilistic, risk model.

The innovative solution is expected to provide much needed support for reinsurance placement and in defining capital requirements in unmodelled territories or areas with outdated vendor offering. Leveraging GEM outputs in business decision- making through a number of applications can significantly improve capital management and control earnings volatility.

The low computational effort of our bespoke methodology, leverages the latest science by GEM, and is at the forefront of the innovative Willis Re service offering available to its clients.

GEM
GLOBAL EARTHQUAKE MODEL
working together to assess risk

Global Earthquake Model (GEM) Foundation
Initiated by the OECD's Global Science Forum, GEM was formed in 2009 as a non-profit foundation in Pavia, Italy, funded through a public-private sponsorship with the vision to create a world that is resilient to earthquakes. GEM's mission is to become one of the world's most complete sources of risk resources and a globally accepted standard for earthquake risk assessment. Learn more at http://www.globalquakemodel.org.
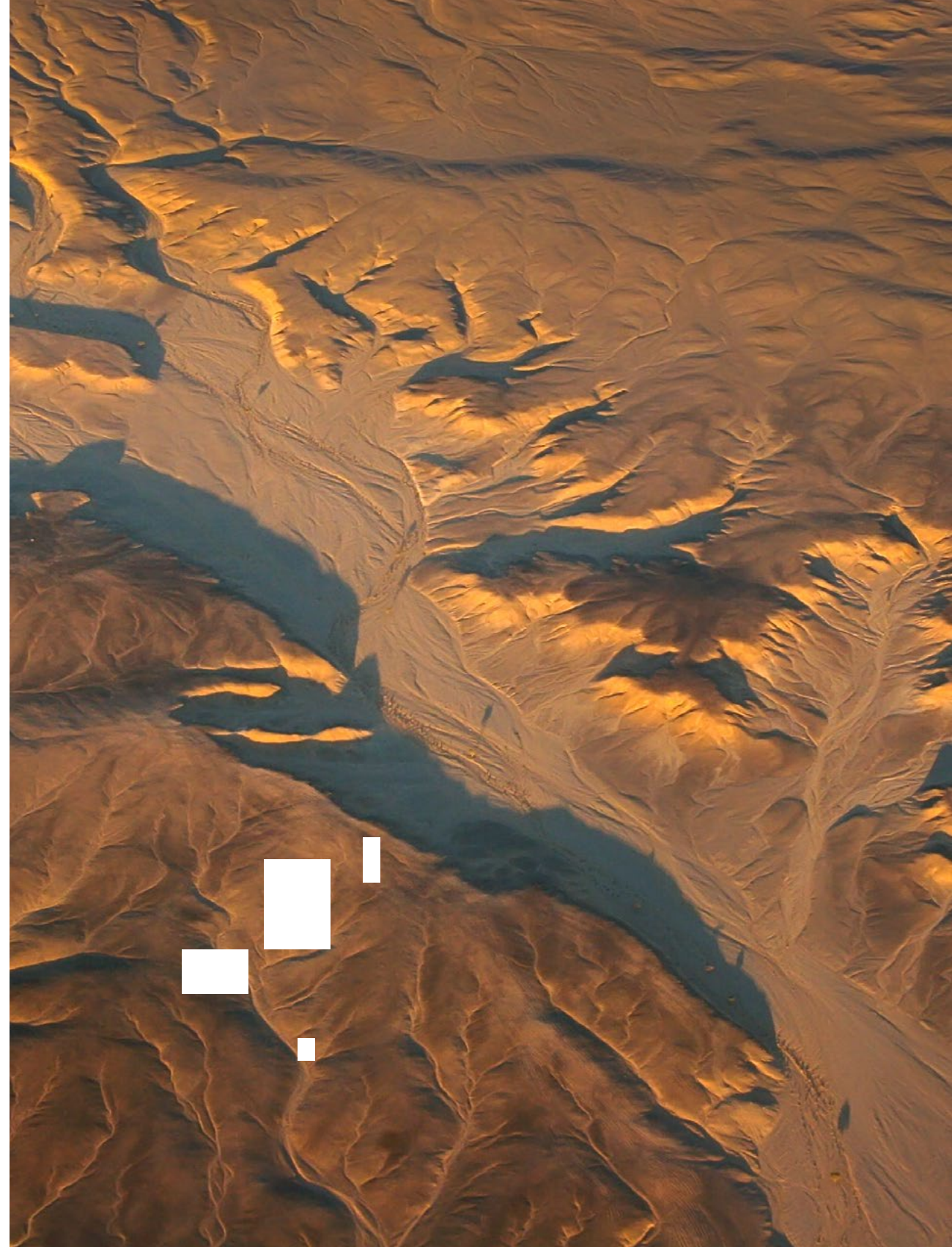
People

People

The coronavirus pandemic has reminded us of the ultimate people risk (infectious diseases unknowingly transmitted from people to other people) and of our profound biological vulnerability, even in high-tech societies. In fact, one can argue that "progress" (e.g. urbanisation, democratisation of travel) has increased our vulnerability to such outbreaks.

In May 2020, the World Economic Forum unveiled The Great Reset, its proposal to rebuild the economy sustainably following the COVID-19 pandemic. The pandemic has indeed forced a reset of mindsets and priorities, with for example the realisation that "key workers" are not the highest paid, but rather those who keep the real economy going: nurses, doctors, teachers, retail assistants...

As economies are rebuilt in 2021, with hopes of a return to a "new normal" thanks to vaccination programmes, shaken and debt-ridden societies may face political upheaval. In most cases, a rethink of the social contract will be on the cards, with a number of wide-ranging ethical questions: what is the acceptable trade-off between lives and livelihoods? How much of our personal freedoms are we prepared to give up for public health demands? How can we prioritise both economic and environmental objectives?

The concept of societal resilience and building forwards is at the centre of these challenging questions. Our longing for the stability of a "new normal" is understandable, but maybe this change of mindset needs to be more radical, and accept the advent of the "never normal"?

The pandemic has sorely tested the resilience of our societies, with many useful lessons to be learned as the world is finally taking the climate crisis more seriously: delaying action is costly and exacerbates inequalities; natural science is essential to inform policy, but decisions made by politicians require weaving this information with social sciences and ethics, with communication of decision making a crucial 'last mile' step that can make or break acceptance.

Our research themes will continue to focus on:

- Decision-making in the face of uncertainty, and communication of risk;

- Societal resilience in partnership with the Royal United Services Institute, and now the American Enterprise Institute, with a special focus on resilience to hybrid aggression (including cyber): the grayzone ; and

- Understanding of emergence patterns for infectious diseases, with the acceptance that the next pandemic could be very different from this one.

> "The global pandemic has put increased focus on how organisations manage people risk and thrown into sharp relief how people risk underpins all other corporate risks. Defining people risk as both risk to people (i.e., a company's "duty of care") and risk to an organisation from people factors (i.e.,talent attraction and retention, total cost of reward, etc.) , it is apparent organisations will be judged by the way they have managed their human capital during the pandemic and many will take a reputation hit impacting their ability to attract future talent and recover. Those that have consciously and empathetically managed their people risk and maintain this focus will recover faster and be more resilient in the future."

Crispin Marriott
Client Relationship Director,
Willis Towers Watson

We also continue to invest in research on political violence and terrorism, which have an undeniable impact on people and the economy. These human-induced hazards can be difficult to predict or model, and our long-term partnership with Oxford Analytica has allowed us to move from a qualitative approach to a more transparent quantitative approach to political risk, without denying the uncertainty that such modeling entails. Understanding the complex relationship between geopolitical drivers of risk remains a key focus of research, supporting our advisory services to clients. The impact of rising climate change regulation, investor sentiment, activism or litigation is one example amongst others of the impact of people decisions on business. Our links with the Thinking Ahead Institute will multiply the insights and the impact of our work in this space to enhance the resilience of our clients.

Hélène Galy
WRN Director, Head of People Risk research

Industry focus: towards a net zero and more resilient aviation sector

Developing multi-partner projects for a specific industry shows our continuous effort to use research and innovation to identify and understand threats and inform business decision making. Here we provide highlights of work underway across three WRN partners focussed on supporting the aviation sector.

State-of-the-art volcanic ash cloud modeling for air traffic management

A year after the unprecedented travel disruption caused by the 2010 Icelandic eruption, EUROCONTROL, the intergovernmental organization for air-traffic management, released EVITA, a visualization tool for the volcanic-ash advisories. Unfortunately this tool remains basic, not intended to provide operational support to an airline during a volcanic eruption, nor is it a reliable tool for designing risk-transfer financial instruments, due to its low spatial resolution, no impact analysis, lack of validation and uncertainty quantification.

To fill this gap, WRN has partnered with Mitiga Solutions, an offshoot of the Barcelona Supercomputing Center (BSC), a leading institution for the development of computer applications for science and engineering, and leaders in modeling dispersal of small particles in the atmosphere.

With more than 1,500 potentially active volcanoes globally, and an average about 10 - 20 volcanoes erupting (on land) at any given time, volcanic ash in the atmosphere remains a serious threat to global aviation. Volcanic ash particles can be transported over large distances by wind before settling on the ground. In addition to volcanic ash, sandstorms and mineral dust are also key hazards for airlines, which affect flight safety, aircraft routes, infrastructure and engine lifetime.

Mitiga Solutions has developed models and online platforms to help aviation stakeholders reduce the impact of volcanic ash, mineral dust, sea salt and other atmospheric hazards. They combine global high-resolution weather data, flight plan configuration and routes, and engine dose to aerosol contaminant intake, with impact calculation or engine tools, for safer and more efficient air asset management.

These analytical tools can be used at each stage of an aircraft's operation and in ongoing emergencies, or prior to an event for early warning and for efficient management during an emerge test and enhance preparedness. Such advances in modeling are expected to help airlines and associated organizations to mitigate their exposure, re-route planes, minimise delays and cancellations.

VIEWS is a tool for operational planning, integrating volcano/fire ash/dust storm forecasts updated every 15min with real time data from the VAACs, airlines and engine Original Equipment Manufacturers

eDOSE is an engine dose exposure assessment tool, used for safety and maintenance planning. Predictions on the impact of airborne contaminants in real time and from historic data, allow predictive maintenance analysis and optimized time-on-wing.

Mitiga Solutions

Mitiga Solutions is an offshoot of the Barcelona Supercomputing Center which specialises in high-performance computing. It is certified by Eurocontrol, and Mitiga Fall3d is the dispersion model currently in use by the Darwin and Buenos Aires Volcanic Ash Advisory Centers. The Barcelona Supercomputing Center is also the official provider for the sand and dust storm warnings of the World Meteorological Organization. Learn more at: mitigasolutions.com

Unlike traditional reports provided by the Volcanic Ash Advisory Centers (VAACs) offering the aerospace community static, 2-D information at six-hour intervals, MITIGA's modeling offers a 3-D view of the present disruption at specific altitudes and is updated as information becomes available. This collaboration gives Willis Towers Watson the opportunity to bring airlines, airports and associated organizations in both the public and private sectors closer to state of the art tools, which predict and mitigate the impact of natural hazards to air traffic management and aviation operations.

Operational efficiencies towards a carbon neutral aviation sector

With regards to climate change, the aviation sector is facing pressures from regulators, consumers, environmental activities, and the UN's International Civil Aviation Organisation (ICAO), via CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation).

In 2018, domestic and international flights emitted 2.4% of global energy-related CO_2 emissions. Although there is progress with bio-fuels, aircraft redesign and fleet overhaul, there is a risk that these changes will come too late to meet the CORSIA aims.

Our collaboration with Professor Ian Poll (Cranfield University) highlights the potential for operational efficiencies to save up to 30% of fuel, through a mix of measures, which would require increased collaboration within the sector: increasing the load factor for passengers and cargo; better route planning (e.g., avoiding the use of long-range aircrafts for short haul destinations) and optimising air traffic management to reduce stacking before landing.

We are also supporting the Air Transportation Systems Laboratory at UCL, where Professor Andreas Schafer and his team are using a world leading model of the aviation ecosystem (Aviation Integrated Model, AIM) to support aircraft manufacturers, airlines, airports and governments in their decisions to optimise the aviation industry, not least to adopt less carbon-intensive technology and strategies.

Global Airport threat analysis and risk indexing

Airports face a unique set of challenges in their central role in keeping customers safe, airlines operating and trade moving. Many large organizations depend on these hubs for their business, transporting their products for international sale, obtaining supplies of goods in complex and time-dependent supply chains, and moving staff and personnel around the world to facilitate their business activities. Managing the airport risk landscape effectively requires a holistic view of the risk landscape and the collective expertise of the sector to help drive resilience.

Our Airport Risk Community (ARC) is working with the Centre for Risk Studies at the University of Cambridge Judge Business School to develop an annual index of possible disruptors for over 110 international airports, covering current trends and emerging threats that they face. The Centre is a long-term WRN partner and world leader in developing frameworks for recognising, assessing and managing the impacts of systemic threats.

This study takes a focused look at the range of disruptive threats that airports face as a result of global trends – geopolitical, technology, environmental, social and governance – and how prepared they are to responding. The research

includes a selection of airports (with a spread over passenger traffic, cargo, and geography) and the potential impacts from severe disruptor threats over the next 3 to 5 years. The Willis Towers Watson Cambridge Airport risk index could be used for benchmarking and understanding key risk drivers and vulnerabilities, and support informed decision making about building resilience and support key business growth. It will be launched early 2021.

> We are pleased that our Airport Risk Community is bringing industry stakeholders together in a spirit of collaboration, sharing knowledge, insights and developing solutions for evolving risk trends.

Darren Porter,
Managing Director,
Aerospace, Willis Towers Watson
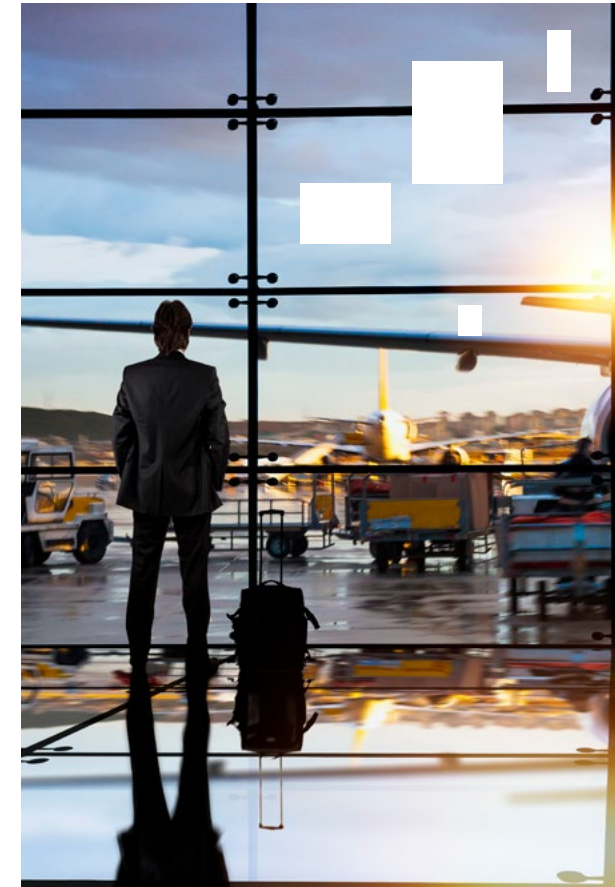
University of Cambridge

The Centre for Risk Studies is a multidisciplinary center of excellence for the study of the management of economic and societal risks. The Centre's focus is in the analysis, assessment, and mitigation of global vulnerabilities for the advancement of political, business and individual decision makers. CCRS is part of the Cambridge Judge Business School. The group provides frameworks for identifying and assessing the impact of systematic threads, using their threat taxonomy, and are very well connected to the insurance industry, government and the World Bank.

Pandemic models are evolving quickly; pandemic insurance needs to as well
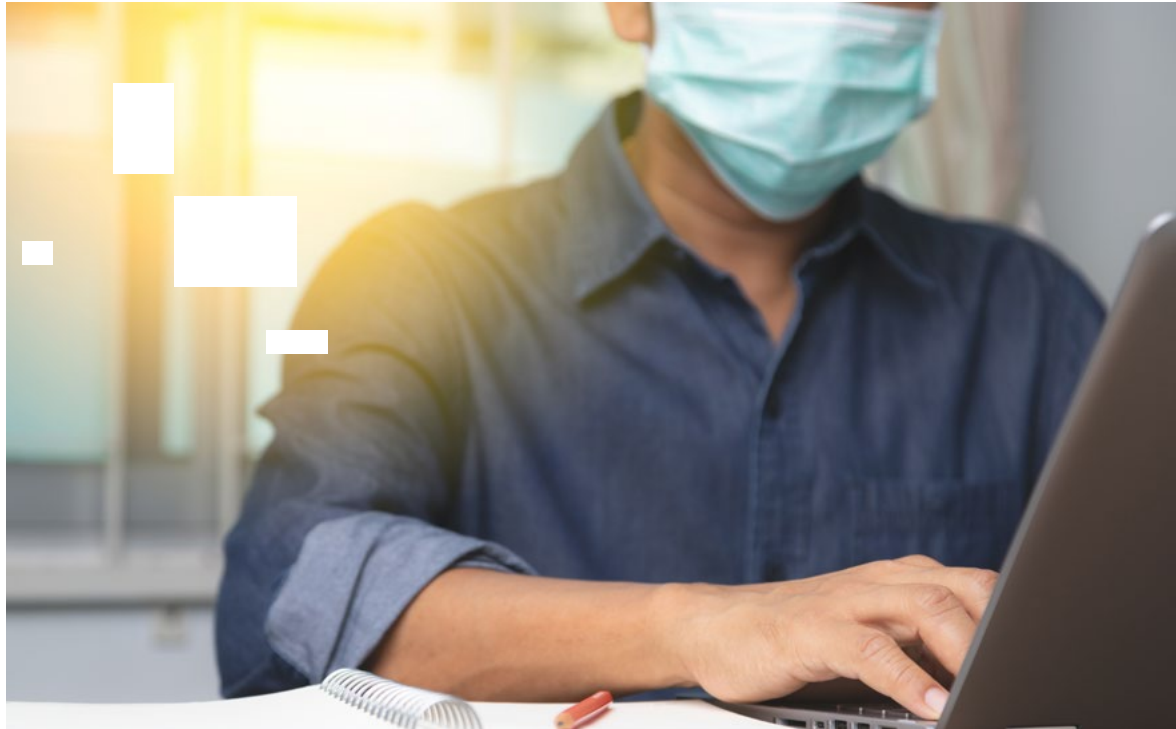
Organizations face no shortage of risks, yet pandemic modeling hold unique challenges compared to other perils. The SARS-CoV-2 pandemic (COVID-19) has shone the brightest of lights on the global need for improved understanding of and preparedness for communicable disease risk. It will take time and resources to build an infectious disease risk model. (Re)insurers will have to be more innovative in their pandemic coverage and exposure management. The next pandemic is unlikely to look like this one, which makes building industry knowledge and capabilities increasingly important to harness the current momentum.

Assumptions

Natural catastrophe risk models have revolutionised the property/casualty (P&C) (re)insurance business over the past 30 years. They have allowed more efficient deployment of capital by providing a rigorous way of estimating potential losses, better quantifying tail risk and increasing trust in the probabilities assigned to natural disaster events and the damage and losses they produce.

All of these models have been developed from common foundational assumptions: an event happens and produces impacts on a known (although somewhat uncertain) exposure (property or other fixed asset), which has a known (although, again, somewhat uncertain) vulnerability to the consequences (hazard) of the originating event. Using an intricate mix of physics (through natural science and engineering lenses) and statistics, such models produce insurance loss estimates that are, generally, robust and defensible.

As new systemic and non-natural risks have emerged, establishing the potential future loss range of perils, such as terrorism and cyber, has required the introduction of social science disciplines (and greater levels of uncertainty), but did not greatly disrupt the established logic of the cat model; the components and controls remained familiar.

Not so infectious disease models. First introduced to the insurance sector to capture the excess mortality from global pandemics in the life insurance business, they began as a combination of stochastic elements of natural catastrophe models with a well-established form of epidemiological model, the Susceptible – Infectious – Recovered compartmental model (and its many and varied siblings).

Unknowns

From a traditional cat modeling perspective, there remains a lot of unknowns. For example, the two components of "hazard" – location and intensity – were both poorly understood, due to a very sparse and poorly documented experiential history, and only a rudimentary understanding of the zoonotic viruses that are the dominant cause of epidemics and pandemics.

The model architecture required was more Gaudí than Brutalism. There is no fixed exposure or vulnerability; both are dynamic and feed back directly into the model in its next time step. Exposure and vulnerability are not controlled by engineering equations, they are assumed from the impacts of political decisions, human behaviour, travel webs and social networks.

The Sars-CoV-2 virus has brought epidemiological modeling to our living rooms (many doubling as home offices, which is where we hosted our joint webinar 'Pandemics under the microscope' from in October 2020). Previously obscure epidemiological modelers have become household names and the concepts of reproduction numbers, non-pharmaceutical control measures and even herd immunity have become all too familiar. COVID-19 is by far the best-documented pandemic ever, but even after many months of live information being available to calibrate forward-looking models of case-counts and mortality, inconsistencies and uncertainties abound.

Epidemic forecasting, by nature, is a tall order. In some cases, these model inconsistencies are due to different assumptions that necessarily change

> **Substantial challenges remain in quantifying public policy and behavioural elements that shape the nature of risk; these too need to be mapped out as they evolve over time and then linked to biological and epidemiological modeling frameworks**

Simon Young
Senior Director, Climate and Resilience Hub, Willis Towers Watson

as new information becomes available. Another reason model outputs may not reflect future outcomes is that there is a feedback loop dynamic which affect reality. If a model predicts a dire outcome, it may in fact prompt decision-makers and even the general public to change their behaviours, thereby changing the final outcome.

Further challenges are found in the conversion of pandemic model outputs to the short-term economic impacts of interest to P&C (re) insurers. The literature on the economic impacts of pandemics is extremely sparse (although this will change) and dominated by economic simulations that sit on top of epidemic simulations, rather than empirical data. The consequences of government policy responses (like lockdown) and sociological dynamics (fear, social distancing) are generally not economic outputs from models but input assumptions driving the direction of the reproduction number and, ultimately, the outcome of the epidemiological event.

As one moves from modeling a single event to the full probabilistic modeling familiar to the (re)insurance industry, additional challenges must be addressed.

We think near misses are frequent in real life and must be captured via counter factuals in the modeling domain. Two coronaviruses with very similar characteristics emerging in very similar locations can lead to very different global outcomes, at the whim of individual actions – by patient zero, a head of state or many people in between – impossible to fully capture stochastically. Substantial challenges remain in quantifying public policy and behavioural elements that shape the nature of risk; these too need to be mapped out as they evolve over time and then linked to biological and epidemiological modeling frameworks.

Lessons to learn

Not withstanding these challenges, progress is being made, and COVID-19 learnings will help. That said, the temptation to model to the last big event has to be closely managed - the next pandemic will most certainly be different in character as compared to the present event.

There have been significant advances in our understanding of the nature and spatial distribution of zoonotic viruses that pose the greatest risk of spilling into human populations and igniting pandemics. Improvements in bio surveillance have also shed new light on the rate of spillover, which is critical to characterising high-frequency events, as well as the tail.

There are also continuing advances in modeling methodology, ranging from the incorporation of socio-political factors to capturing population movements. And there is still work to be done. The assumptions required to construct a probabilistic pandemic model are hugely influential on outcomes. These assumptions must be based on expert judgments that are art as much as science and vary from modeler to modeler. The use of structured expert judgment to quantify and constrain uncertainties in such assumptions – and thus in model outcomes – is an area of development that carries promise from successful deployment in other contexts. Alongside other innovations,

the refinement of structured expert judgement techniques will help to build a level of trust in pandemic models that follows approaches found in natural catastrophe models.

Despite the present and future scientific and modeling advances, the full benefits will not be realised if there is a failure among decision makers to effectively use data and analytical tools as part of their decision-making process, whether it be to inform preparedness or guide response activities. This topic arose repeatedly in our October webinar, stating models provide a unique opportunity to demonstrate the value of preparedness and early action, and provide a sandbox in which to think about necessary decisions and potential pathways in advance, with time rather than on the fly under stress. After all, pandemics are not a health problem, they are a societal challenge; and effectively responding requires a wide range of capabilities.

In the context of the global (re)insurance market, it must be recognised that while modeling infectious disease risk is challenging and will take time and resources to build the level of trust found in nat cat models, there are already pathways to gain an understanding of the risk. This present understanding is sufficient to support tangible innovation – policy experiments, insurance structures, refinements to preparedness and mitigation strategies – within both public and private sectors.

Ultimately, further innovation will be necessary (and is entirely within our grasp) if we hope to better manage the financial and social consequences of future epidemics and pandemics.

Supporting business decisions

In 2021, we will continue to explore ways to leverage Metabiota's epidemiological data analytics capabilities to improve understanding of pandemic risk, build better pandemic risk models, and support mitigation and risk transfer decision making for increased resilience.

Our partnership will also look to support the global community across both public and private sectors manage the next pandemic in a more informed and pre-planned way once the current crisis has passed its peak. In the private sector, we will continue to assist our clients as they improve their structural resilience to pandemics and navigate human resources, insurance business and investment issues more effectively.

METABIOTA

Metabiota
Metabiota identify infectious disease risks, minimize the effects of outbreaks and contain the economic impact of epidemics. Their modeling platform generates real-world outbreak scenarios from global reference and customer data. For more information please visit their website: https://www.metabiota.com/

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. 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.

WRN's partnership with Oxford Analytica complements our internal expertise to provide superior advisory services to our clients.

Political 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.

In partnership with Willis Towers Watson, Oxford Analytica has for the past decade prepared a Political Risk Index, covering political stability in a set of key emerging markets several times per year.


A recent edition is available here:
Political Risk Index - Summer 2020

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.

Political Risk Survey Report 2017

Political Risk Survey Report 2018

Political Risk Survey Report 2019
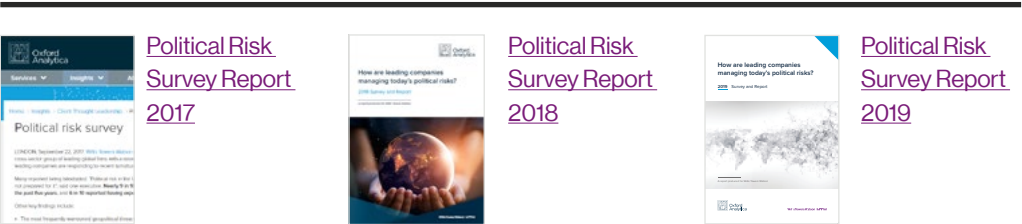
Value At Political Risk - VAPOR

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 (Figure A) 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 modeling methodology.
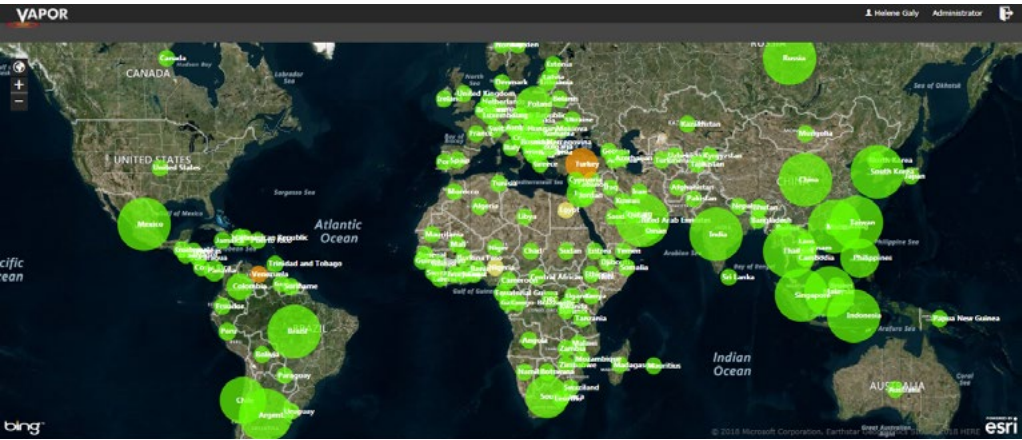

Figure A: VAPOR map view, allowing clients to spot risk driver areas for a global portfolio, for a given political risk type, and with a time horizon of 1 to 10 years.

Political Risk scenarios for strategic planning and risk management stress testing

COVID-19 has been a key factor in political risk, putting a strain on governments around the world and leaving a legacy of debt behind. For many of the emerging market countries covered in our Political Risk Index, the pandemic is proving to be an economic challenge as well as a health crisis. In July 2020, Kristalina Georgieva, IMF Managing Director, said that $2.5 trillion will be needed to help emerging market countries through this crisis. Most cannot issue local currency debt internationally and many rely on income from remittances and tourism, both of which collapsed in the second quarter of 2020.

Through our partnership with Oxford Analytica we have provided political risk scenarios to be used for corporate strategic planning and risk

management stress-testing. These scenarios which have been shared with our clients are driven by political reactions to COVID-19. Such political reactions may transform the world of international commerce as lastingly as the coronavirus itself.

Some of this scenario analysis is publicly available. For instance, scenarios for the politics of economic recovery in Europe were used to develop a report and webinar on European Politics after COVID-19.

The report is available below:

European Politics after COVID-19

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. Willis Towers Watson have been working with Oxford Analytica since 2006. For more information please visit their website.

Resilience to hostile activities of the grayzone

The year 2020 has been like no other in recent memory, with countries around the world brought to a halt by the advance of COVID-19 and a resulting economic downturn bringing new dimensions to existing tensions. 2020 has also offered a rapidly escalating confrontation – carried out in the commercial domain – between China and the United States; growing Western concern over subversive Chinese business practices in their countries; and a U.S. election marred by concerns about foreign interference. All demonstrate a changing global climate, where countries seek to strengthen their position and weaken their adversaries through non-military means.

Before the U.S. election on 03 November, polls showed a large percentage of American voters were concerned about the integrity of the election process and indeed the validity of the outcome. The U.S. government accused Russia, China and Iran of trying to interfere with the election. The growing confrontation between the United States and China also focuses on business practices, and features punishment by each side of the other side's companies. In Europe, governments and the European Commission are trying to establish to what extent Chinese takeovers of cutting-edge companies represent a national security threat and how to respond.

To increase awareness of these issues, and their immediate effect on a wide range of companies, the WRN completed its second year as a partner of RUSI's Modern Deterrence programme, which investigates how societies can tackle new national security threats without closing themselves off from globalised markets. The programme provides a platform and research hub for governments, the private sector and civic organisations to explore risks and vulnerabilities of resilient societies. This partnership directly supports Willis Towers Watson's Geopolitical Risk initiative and Cyber proposition, putting Willis Towers Watson in a leading position for client advisory work.

Understanding vulnerabilities of Globalization

The programme influences thinking in governments and the private sector on the crucial issue of how to improve industry, government and civil society resilience against hostile activities. During the second year, focus has been on subversive economics, a practice which sees foreign countries target their rivals through their private sectors.

> "The world is seeing increasing competition between Western countries on one hand and China, Russia and Iran on the other. The private sector is a frequent target of aggressive actions that include cyber attacks, unfair competition by state-supported companies from rival countries, or as targets threats from foreign governments. This all means that geopolitics poses an immediate concern to companies. Willis Towers Watson's expertise in identifying and analysing emerging risks made it an ideal partner for us. After two years of enormously productive collaboration with the WRN at RUSI, I look forward to building on our work and findings."

Elisabeth Braw
Visiting Fellow, American Enterprise Institute

The following tangible outcomes from this research programme are integrated into our client advisory services:

- Sharing best practices from leading countries including the Baltic countries, Norway, Switzerland and Singapore
- Bringing together strategists and practitioners from government, armed forces and civil society (private sector and the public) to discuss and promote practical measures
- National security courses for emerging leaders
- Incentivising companies to play a stronger role in national security
- Total defence exercises
- Resilience training and exercises in local communities
- Training government officials to counter disinformation
- Crisis response
- Resilience against supply chain disruptions
- Improving resilience of sectors critical to national security, including telecom and financial services
- Thought-leadership publications and conferences to influence policy and private sector

Modern Deterrence at RUSI ended in October 2020, but the work is being continued at the American Enterprise Institute in Washington.

Technology

Technology

Understanding the digital acceleration

Amongst the many significant impacts of COVID-19, the acceleration of digital transformation has led to a notable change in the Technology risk landscape. The virtualization of work, the wide adoption of telemedicine and remote learning have had a deep and prominent influence on organizations and societies response to these unprecedented challenges. In just a few months' time, years' worth of innovation and progress have helped create organizational resilience and opportunity and have given heightened awareness of the central role Technology will now play across the business landscape. A report by McKinsey suggests COVID-19 has pushed companies over the technology tipping point and executives now recognize technology's strategic importance as a critical component of the business, not just a source of cost efficiencies.

One of the key questions we will face over the coming years is how many of these changes are long term and how many will change again. Technology is by its very nature iterative and innovative. The Future of Work and the impact on job roles is an area which will see increased focus in 2021. The 2020 World Economic Forum Future of Jobs report suggested technology-driven job creation is still expected to outpace job destruction over the next five years. 85 million jobs may be displaced by a shift in the division of labour between humans and machines, while 97 million new roles may emerge that are more adapted to that new division. Up-skilling and reskilling people will be key and easing the transition of workers into more sustainable

job opportunities is going to be a real challenge. Through access to information we have the means to do that in unprecedented numbers but in many subjects the burden of communication still sits with the reader and until we reach a societal maturity in making this information accessible discussions on trust in technology will continue to be frustrated by a lack of basic understanding.

Of course, increased technology use raises new questions and opens up areas of risk in an area the Insurance industry was already battling with. Cyber Security remains a sleeping giant of the Insurance world. Cyber risk is not simply a technology risk: it often comes down to people risks. People represent the largest source of data breach claims. Cyber claims data shows that employee negligence or malicious acts account for two-thirds of cyber breaches. This drives a lot of the security behaviour that we see and suggests that some of the main areas we need to look at are not necessarily technical areas - it's human behaviour and simple best practice. A lot of the work needs to be done upstream, to help our understanding on how to adopt a better cyber hygiene and reduce cyber risk through smart business decisions and a strategic view on resilience.

The Cyber market is still very relatively small and has huge scope for growth. Last year we had around $2.5b premium which is 0.03% of the global insurance market. Prices are low and risks are high. Insurers don't like insuring what they don't under-

> " The pandemic has been a disaster, but there is also a silver lining: companies and societies found new, digital, ways to collaborate, work, learn, and stay healthy. This profound societal transformation is rife with new opportunities, and poses new risks, for thriving in the post-pandemic era. "

Dr George Zarkadakis
Digital Lead, Willis Towers Watson

stand and can't quantify so leveraging academic partnerships for increased understanding and learning in this field can support significant improvements. With that in mind, 2020 saw the first cyber insurance programme to exceed $1 billion and the breadth of coverage continues to expand. Cyber losses among businesses targeted in the past year have risen nearly six-fold but, encouragingly, this years Hiscox Cyber Readiness Report identified a marked improvement in cyber security readiness with the numbers achieving 'expert' status nearly doubling – from 10% to 18%. And while losses increased, the proportion of businesses targeted fell from 61% to 39% suggesting some sectors are starting to get things right.

Our technology risk themes in the Willis Research Network continue to explore the gaps in our areas of understanding alongside specialist areas of

research that help drive tailored conversations. Our partnerships across institutions including The Wharton Mack Institute, University of Oxford, University of Southern Denmark and Loughborough University allow us to provide tangible insights to develop our view of risk and support our client proposition aimed at assessment, quantification and protection against cyber risks. We continue to look at areas as diverse as Boardroom attitudes to Cyber, Deep Fake Technologies, Artificial Intelligence and Technology in supporting Loss Prevention. I hope you enjoy more information on a selection of projects currently underway.

Stuart Calam
Programme Director and Head of Technology research

Understanding the startup landscape using knowledge spaces

As insurance becomes increasingly digital, the issues of Artificial Intelligence (AI) adoption become increasingly sector wide. The digital transformation is partly driven by new players, including start-ups, that transform incumbents' business models. This community of start-ups and incumbents form an entrepreneurial ecosystem where cross-fertilizations, symbiosis, and competition amidst collaboration, constantly occur.

But what are the places where new combinations of knowledge relevant to the AI transformation in insurance are likely to happen? Loughborough University and the WRN are collaborating as part of the TECHNGI programme to describe some of these issues from a Knowledge Space perspective. Knowledge spaces are essentially network maps that illustrate connections to more and less related knowledge fields.

Knowledge spaces can show us which related technologies drive which kinds of innovation in the insurance sector. Here we utilize a dataset derived from the Crunchbase database of start-ups and investors[1]. Full details on the methodology can be found in an in-depth report produced by the research team.

Four questions are being used to explore the landscape:

- What does the InsurTech start-up landscape look like in terms of related and unrelated variety in technologies?

- What are the specific knowledge fields and technologies that relate to developments in AI and what other fields are these related most closely to?

- What is the geographical distribution of distinct knowledge fields in InsurTech start-ups and financial centres?

- What are the types of start-ups that are currently being funded, and by which kinds of funding stakeholders?

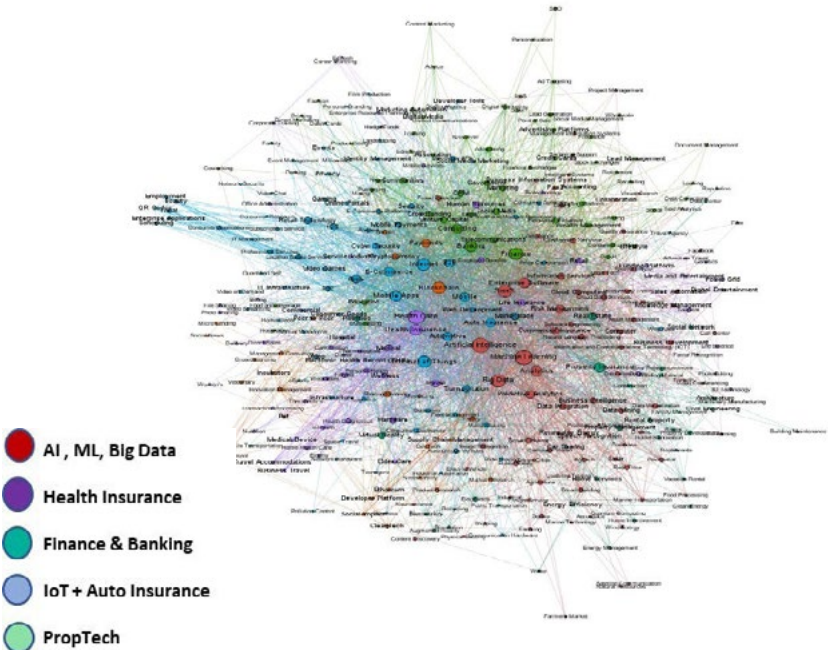The role of Start-ups in the Insurance Knowledge Space

The landscape

Mapping the knowledge similarities between individual start-ups reveal their position in the technological knowledge space (Figure A). This allows stakeholders to identify the strength, location, and ties within this industry of relevant start-up enterprises. Such knowledge spaces can also then be used to identify gaps, for example between investors and local skills, providing better information of the insurance ecosystem that will allow stakeholders to make better decisions and start-ups, investors and policy makers to target their resources.

At first glance it can be difficult to see patterns and relevant insights, but by asking the right questions you can start to zoom-in and isolate. For instance the colour coding shows five technological specializations comprising of distinctive knowledge nodes (Figure A).

Figure A: The knowledge space

- AI , ML, Big Data
- Health Insurance
- Finance & Banking
- IoT + Auto Insurance
- PropTech

[1]CrunchBase website https://support.crunchbase.com/hc/en-us/articles/360009616013-Where-does-Crunchbase-get-their-data

These specialisations can then be identified within particular regions. We can tabulate the number of active firms within specific knowledge fields and aggregate these for different metropolitan regions. By correcting size effects, one can then identify the particular specializations of specific metropolitan regions/ financial centres. The results are presented in the star in Figure B. What is clear is that the larger financial centres (such as London) are very diversified and have all the technologies present to a certain degree while others, perhaps less self-evident cities (Tel Aviv, Sao Paulo, Seattle, Austin) come out as specialized centres.

Figure B: Star Graph indicating specializations in particular financial centres
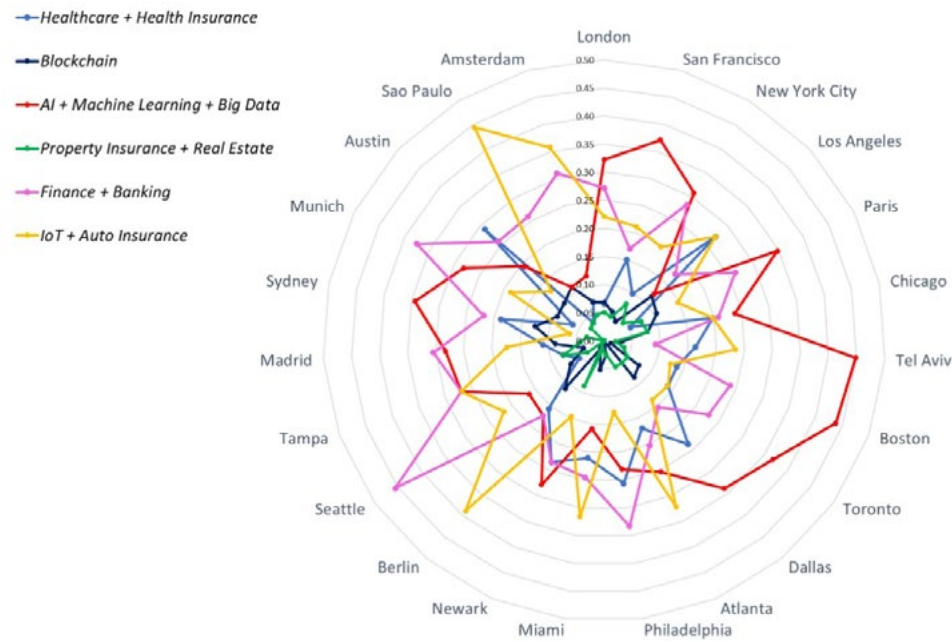
Note: the star edges are the 23 cities that were most prominent in the dataset

Digital transformation

There are four key findings from the work so far:

1. **A maturing scene:** The digital transformation has already entered the maturing stage in the diffusion of innovation. Fewer start-ups are entering the scene in recent years compared to three or four years back. This has resulted in clear geographical patterns where distinctive types of start-ups are found. New start-ups are slightly stronger in the U.S. than in Europe, with Tel Aviv standing out as an exception to this pattern with a continuing vibrant start-up population.

2. **Geography matters:** These geographical patterns correspond to theories of regional specialization and sector coalescence, as elaborated in evolutionary economic geography. The U.S. metropolitan areas have a significant population of InsurTech start-ups that follow a polycentric structure, while in Europe, it is London that dominates the scene. Although secondary centres in the EU do add up to a significant critical mass, its geography is much less spiky than in the U.S..

3. **Key linkages:** There are six distinctive modules in InsurTech relating to HealthTech, Blockchain; AI and Machine learning; PropTech, Finance and Banking, the Internet of Things, and Auto Insurance. Within this 'backbone' of technologies three related "AI-type" categories play a major role. Categories of Artificial Intelligence, Machine learning and Big Data were found to be strongly related key nodes in the network.

Within this network, there are limited direct linkages in the knowledge space with categories designated with the financial sector and the core AI segment of the AI cluster. Most linkages are intermediated through "software as a service" (SaaS) which seems to act as a bridge between "AI" and "Finance" . The role of SaaS indicates there might be some kind of "platformization", where third party software platforms offer AI solutions to the financial sector in a modular kind of way.

4. **Patterns in finance:** With respect to investors and the role of accelerators, the most important finding was that of accelerators being the key "glue" in the investment pattern dataset. Accelerators could play in important role in the strategic coupling of AI startups with the established insurance sector. We also found some evidence that investors in London have a stronger propensity to invest in the Blockchain and PropTech modules, and less in the Healthcare and Auto insurance sectors. San Francisco by way of example sees a somewhat reversal of that pattern.

Lessons for policy makers

While the research hasn't intended to generate lessons for policy makers, there are five learnings that could be used to shape future funding calls and directions for policy evaluations:

- **A shift from 'Industries' view to 'knowledge space' view.**
  The research suggests that policy makers should consider shifting focus from 'Industries', specifically InsurTech, to knowledge space and skillsets that are transferable between industries. There is clear momentum in the geographic areas highlighted in the study that can be further developed as centres of excellence.

- **The role of incubators and accelerators**
  The change program is significant for InsurTech start-ups to scale ups. These institutions signal the market about start-up potential. The evidence shows that being part of incubator programmes appears to streamline access to funding. Particularly the public sector can explore new bespoke incubators programmes in collaboration with Venture Capitalists that specialised in key areas of the identified knowledge space (not necessarily 'InsurTech'). These would allow risk to be shared with the private sector stake holders (investors, founders, incumbents).

- **Closing the Knowledge space gap between investors and companies.**
  Policy makers need to understand the gap between investors' location and expertise versus the InsurTech

- **Cross-industries knowledge flow.**
  In order to expand and stimulate a specific industry, such as InsurTech, governments should encourage and support cross-industry knowledge flow, allowing opportunities for companies that provide technological solutions in one industry to find opportunities in other industries. This cross-industry approach can expand the business proposition, increase streams of revenue for the tech companies, develop new stream-line channels and expand innovation opportunities for incumbents.

- **Globalisation power - Local strength.**
  Each knowledge space should be benchmarked with other InsurTech strong clusters in other places in the world. To keep those clusters at a competitive advantage, there are three elements that will require inflows: maintaining and developing the skills and stimulating the local knowledge space; securing and encouraging funding opportunities and providing network opportunities within the industry and across industries.

Future direction

TECHNGI is running until late 2021, and this research stream is currently exploring the following areas:

- Improving the knowledge space analysis by using more sophisticated near real time datasets, and expanding the research beyond insurance to understand whether AI has a transformative effect on the composition and division of labour between service industries.

- Exploring the relevance of incubators in tying together different start-ups, especially where incubators may have links to funding.

- Deepening the mappings into hotspots of activity to explore strategic links.

Loughborough University

School of Business and Economics, Loughborough University

Loughborough University is proud of its long history as an institution of further and higher education. Thanks to the vision of its founding father, Dr. Herbert Schofield, it has been able to grow and develop into one of the country's top universities. Today it is one of the country's leading universities, with a reputation for excellence in teaching and research, strong links with business and industry and unrivalled sporting achievement. Research is at the very heart of the school, which is committed to leading the way in advancing knowledge across the full range of business disciplines. The research centres and interest groups provide clusters of expertise recognized internationally for the quality of their research.

Cybersecurity as strategic asset

Despite devastating cyberattacks on companies like Honda, Garmin, Travelex, Facebook, or Marriott, many of the world's largest companies remain unprepared for cyberattack. With the latest wave of cyberattacks exploiting the current coronavirus pandemic, the danger of cyberattack is greater than ever before. Although executives acknowledge cybersecurity as an important part of their IT planning process, many seem to misunderstand the strategic character of cyberattack, both as a severe threat to earnings and operations, and as an opportunity.

Manuel Hepfer, PhD student from the University of Oxford, studied what has been called the most devastating cyberattack in history: the NotPetya attack of 2017 that infected more than 80 global companies. Within minutes, the cyberattack paralyzed every aspect of company operations, including interoffice communications, access to documents, access to customer data, and all operational and manufacturing systems – causing economic damages exceeding $10 billion. In his research, Manuel gained unprecedented access to three global companies that suffered from the NotPetya cyberattack and conducted extensive interviews with chief executives, chief financial officers, and other C-suite executives.

His research showed that the sudden reality of the cyberattack served as a "wake-up call" for executives, forcing them to jettison false beliefs about cyberthreats and cybersecurity. Executives who lived through a serious cyberattack experience a change of mindset, by which they come to view cybersecurity as strategic rather than operational, and as an opportunity rather than an expense associated with IT risk management. After the cyberattack, executives started to recognize cybersecurity as a top-level strategic priority, and that cybersecurity strategy provides a basis for noticing and capturing new strategic opportunities that arise uniquely in the environment of cybersecurity threats and responses.

Manuel's research provides a model for evaluating and improving cybersecurity resilience, and for leveraging cybersecurity strategy to detect and capture strategic opportunities. The crucial finding in the research is that resilience to cyberattack requires capabilities in all four elements of the model, given in Figure A: Protecting the Business, Broadening Awareness, Managing Consequences, and Responding and Recovering.

In the research, Manuel asked executives to reflect on their experiences with the NotPetya attack and asked for a piece of advice they would give to someone else who has not experienced a serious cyberattack. Here is what they said, arranged under the four elements of the model.
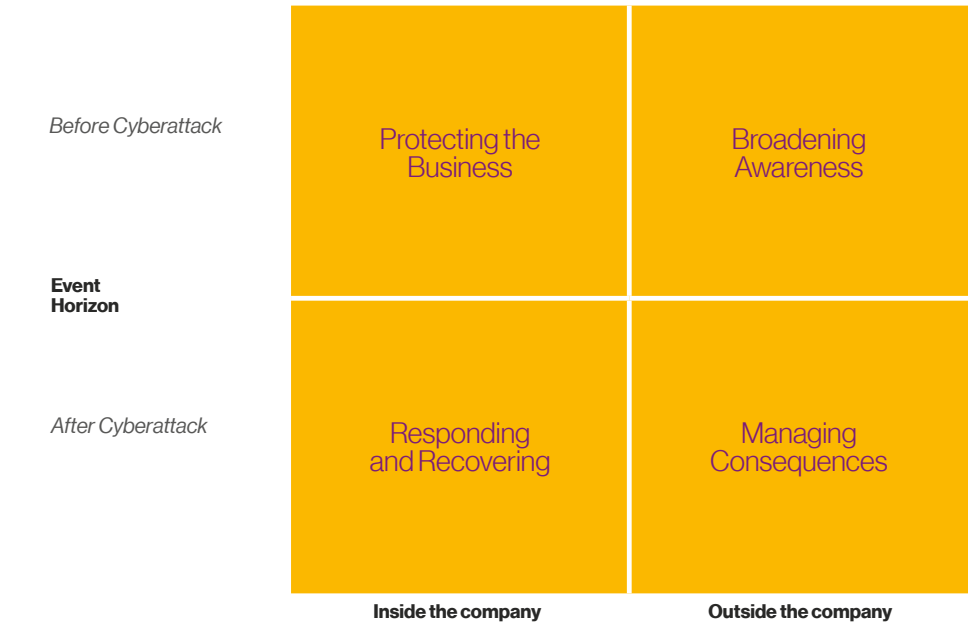
Protecting the business:
Although an important part of cybersecurity strategy remains to protect IT infrastructure and systems, executives advised changing from protecting IT infrastructure to protecting most important business processes. The starting point for that is identifying those three to five business processes that are crucial for business operations, performance, and success.

Broadening awareness:
Executives realised after the cyberattack, that people in other companies knew something was going to happen. The piece of advice they would give to others is to get better hooked into the network of threat intelligence, and to have an external advisor conducting regular cybersecurity audits – just like in financial accounting.

Figure A - Four elements of organizational resilience to cyberattack

	Inside the company	Outside the company
Before Cyberattack	Protecting the Business	Broadening Awareness
Event Horizon		
After Cyberattack	Responding and Recovering	Managing Consequences

[1]To read more about the research:
Hepfer, M., Powell, T.C., "Make Cybersecurity a Strategic Asset." MIT Sloan management review (2020):
https://sloanreview.mit.edu/article/make-cybersecurity-a-strategic-asset/

Managing consequences:
Cyberattacks rarely impact only internal operations, but often times involve managing external stakeholders. As a result, managing the consequences of an attack requires looking outwards to plan for potential effects of cyberattack on customers, suppliers, financial markets, and the company's reputation. According to the executives in our study, what has proven really valuable in the wake of cyber attacks was transparent communication with external stakeholders.

Responding and recovering:
Many executives assume their organization is not an attractive target for attackers and thus neglect preparing for cyberattack. In fact, no organization is immune from cyberattack, and many organizations are not the direct target of hackers

but collateral damage. This is because preventing cyberattacks is impossible, executives' advice was to prepare for cyber attacks, which includes investigating organizational capabilities for responding to cyber attacks.

Companies that suffer the greatest long-term damage from cyber attacks – competitively, economically and reputationally – are those that neglect one or more elements of the model. By far the most common error is to focus on protection while neglecting the other elements. The model raises critical questions that executives can use to lead discussions on the company's approach to cybersecurity strategy – before a cyberattack.

University Of Oxford

The University of Oxford's EPSRC Centre for Doctoral Training in Cyber Security educates a new generation of research leaders as well as the highest tier of security professionals, who appreciate the real-world challenges which arise from security needs in existing and emerging contexts, equipped with both the expertise and adaptability to address those needs. They equip students with the skills and knowledge to become as agile in their thinking as the attackers are – and as resourceful in defence as their counterparts are in attack.

"The real issue underlying what superficially appears to be lack of management attention (to cybersecurity), is often the inability to engage the C-Suite in effective and meaningful communication about cybersecurity risk and threat mitigation strategies. Enabling the quantification of cyber risk exposure and the change in exposure resulting from the adoption of cybersecurity risk and threat mitigation strategies is key to dispelling this issue."

Claudia Piccirilli
Product Director, Cyber Analytics, Willis Towers Watson

Underlying and consequential costs of cyber Security – cost of equity

Information security breaches and the necessity to invest in countermeasures have become top-level items on executives' agendas. To justify information security investments to stakeholders inside and outside the company, corporate decision makers need to conduct holistic cost-benefit analyses on security breaches and investments in attack-deterring countermeasures. However, quantifying benefits and losses associated with security investments and attacks is difficult. Given the lack of data and frameworks, practitioners and researchers alike tend to focus on tangible or obvious costs associated with information security. However, to conduct effective economic net benefit analyses of security investments, decision makers also need to pay attention to intangible or non-obvious costs of investing in security measures and being attacked. This type of costs can be termed underlying and consequential costs.

In his research on "Finance & Cyber Security: uncovering underlying and consequential costs associated with corporate cyber security", Dennis D. Malliouris, a PhD student at the University of Oxford's EPSRC Centre for Doctoral Training in Cyber Security, uncovers such hidden costs over the course of multiple empirical studies. Here, we focus on one particularly interesting study on financial systematic risk, a metric needed to estimate companies' cost of equity, a measure at the core of virtually all major corporate finance activities including capital raising, share issues

and buybacks, as well as shareholder value management.

Based on the capital asset pricing model (CAPM), cost of equity is the rate required by shareholders to compensate for the investment risk incurred. A major component in determining the risk premium is beta, a measure of exposure to non-diversifiable, systematic, or market risk. A security breach can alter equity investors' risk assessment of a company's ability to generate future cash flows. For instance, investors might price additional reputational hazard, which can result in lower revenues and greater revenue volatility. Rational economic agents expect to be remunerated accordingly for additional risk and in turn may require greater equity returns, which can be reflected in terms of beta.

Previous research on changes in systematic risk following security breaches used small and industry-specific samples. Additionally, only regular beta models, instead of dual-beta models that reveal changes in bull and bear markets were used. To update and extend previous empirical evidence, a sample was constructed containing only severe security breaches (i.e., those that resulted from intentional malicious efforts to exploit weaknesses in security systems causing large-scale disruption) based on Privacy Rights Clearing house security breach announcements.

The analysis of 202 incidents between 2005 and 2019 revealed that severe security breaches are
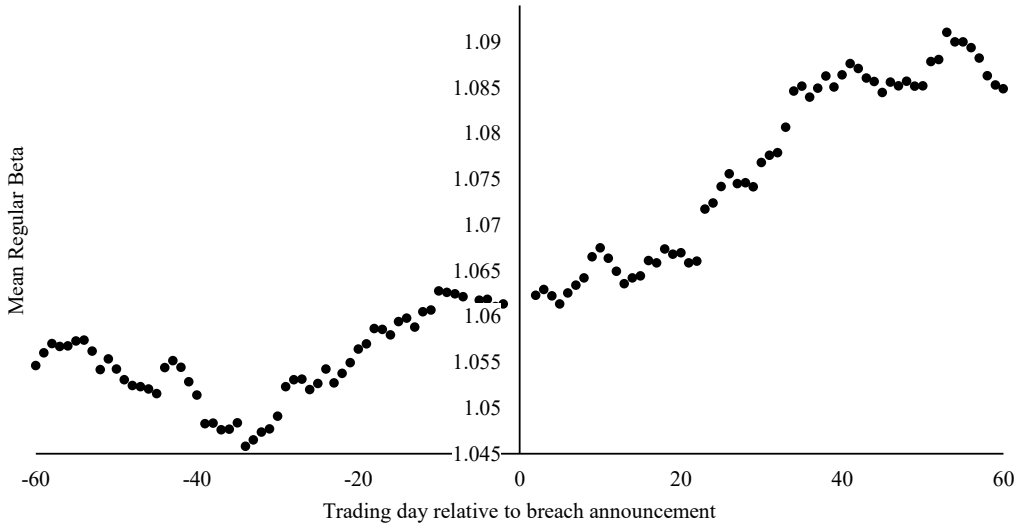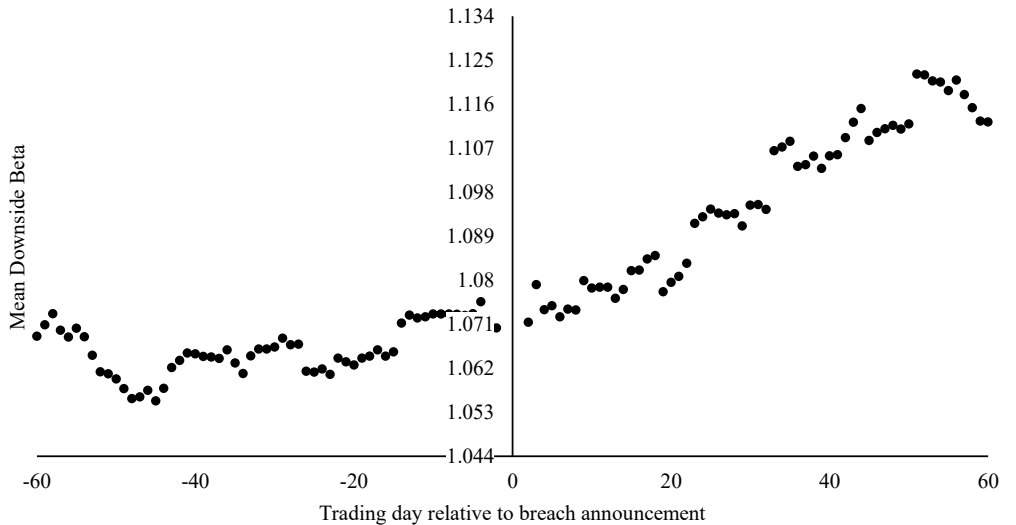

Figure A: Regular beta

FIgure B: Downside Beta

associated with significantly positive increases of systematic risk (regular beta) and systematic downside risk (downside beta). Figures A to C show how regular, downside, and upside beta change over the period of 60 days before and after a severe security breach. It becomes obvious that regular and downside betas on average increase almost constantly in the 40 days following a security breach. The security breaches' effect on regular and downside beta seems to wane after around 50 trading days.

For upside beta, the picture is less distinct. Upside beta seems to increase following a security breach announcement, but the change is less pronounced and more volatile.

The increase in systematic risk shows that market participants expect breached companies' operational risk to increase, rendering them less able to react flexibly to evolving market conditions and consumer demand. The increase furthermore indicates that investors expect a greater risk premium when investing in a breached company's stock. The average increase in downside beta of 0.031 (equalling

an increase of 2.92%) implies that – all other things being equal – companies' cost of equity is increased by almost 3% following security breaches in bear market times. By extension, increasing cost of equity result in greater cost of capital. A greater weighted average cost of capital can have a substantial influence on what projects companies choice to invest in and eventually results in lower share prices.

In order to decide whether it is economic for a company to insure against risks, outsource cyber security, or invest in systems, processes, and staff within the organisation, executives need to be aware of all costs associated with information security breaches and investments in countermeasures. The study on surges in financial systematic risk contributes new insights into hidden costs of information security breaches that can be used to inform corporate cyber security investment models. Further studies in the EPSRC-sponsored and Willis Towers Watson supported research programme will cover additional hidden costs of security breaches to inform a new more holistic model of cyber security investment.
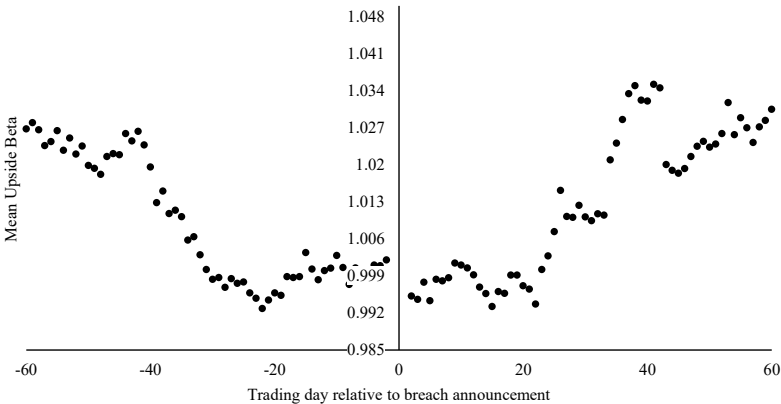

Figure C: Upside beta

University Of Oxford

The University of Oxford's EPSRC Centre for Doctoral Training in Cyber Security educates a new generation of research leaders as well as the highest tier of security professionals, who appreciate the real-world challenges which arise from security needs in existing and emerging contexts, equipped with both the expertise and adaptability to address those needs.

Loss prevention technologies

The emergence of technology, and ways in which it can transform our exposure and vulnerability, provides the insurance industry with new factors to consider when evaluating risk. However little is currently known about the quantitative effect loss-prevention technologies can have on property portfolios and what economic net-benefits the asset owner can gain by investing in this area. This project, in conjunction with the University of Southern Denmark, seeks to reduce the gap in the literature and gain in-depth insight into how underwriters respond to the use of loss prevention technologies under premium determination. In addition, it will look at what quantitative effect can be observed in retrospect to estimating the future effect of using such technologies. The project will help insurance buyers determine the extent of loss prevention needed to gain a positive economic net-benefit when risk is transferred to an insurance company.

Technological advancement in methods for loss-prevention present novel ways for people to cope with the risk . From typical scenarios such as fire, crime, natural catastrophes and cyber risk, the technical installations present within the building influence the potential exposure. However, technology advancements in helping manage risks have been occurring more rapidly than the existing market, and insurance systems have not been able to adapt to them fully. whilst various loss-prevention technologies, e.g., Fire alarm systems, sprinkler systems, burglar alarms,

Access Control, CCTV, water leaks detection systems etc., are commonly recognized in the industry, little is actually known about the economic net benefit for the property owner or the quantitative effects on property damage.

In order to gain an unprecedented understanding of these economic net-benefits, a collaboration between Willis Towers Watson, fourteen clients, two insurance companies and the University of Southern Denmark was established in 2019. This collaboration has enabled the research to provide a deeper understanding of the market's response to loss-prevention technologies and the quantitative effect said technologies can have on property damage.

The WRN will present the research in a series of articles through 2021 and 2022. The first article will report on the challenges the insurance market has when pricing risk heterogeneity in the tail of the risk distribution, and thus how loss-preventions effect on insurance premium might vary depending on where in the distribution the effect is expected to influence carrier's risk. The article will be based on data from 40 Danish municipalities' insurance purchases and will include information on building characteristics, use of loss-prevention, claims history, insurance bids insurance bids and more over the period from 2008 to 2019.

The second article will address how property damages can be influenced by the use of loss-prevention technologies when there is no risk transfer. Data on recorded losses, the use of loss-prevention and building characteristics will be collected for approximately 5,000 buildings owned by Danish municipalities from 2014 to 2018. The article will add to the quantitative understanding of how automatic fire alarm systems, sprinkler systems, burglar alarms, access control, CCTV, automatic water leak detection systems are influencing property risk.

In the third and last article the project will be operationalized, and a framework for a decision-making model will be presented. The model is expected to support policyholder's future investments in loss-prevention and guide in the determination of the need for property loss-prevention, risk transfer and acceptance of own-risk. Whilst the initial work leverages access to data and the Danish market, it is expected that this research can help feed discussions in a consistent manner across other regions.

SDU
UNIVERSITY OF
SOUTHERN DENMARK

University of Southern Denmark

The University of Southern Denmark works purposefully to create dialogue between the university's researchers and the surrounding society. The answers to societal challenges are often found in the interaction between highly specialized academic environments. When these environments collaborate, perspectives are expanded, and new insights emerge. The University of Southern Denmark welcomed the first students onto its campus in September 1966. It now has five faculties with more than 32,000 students, almost 20% of whom are from abroad, and more than 4,000 employees distributed across its campuses in Odense, Slagelse, Kolding, Esbjerg and Sønderborg. Several international studies document that SDU conducts world-class research and is one of the top 50 young universities in the world.

Emerging Risks

⚠ Emerging Risks

Dealing with change in an interconnected world

We live in an interconnected world, driven by technology and challenged by both traditional and emerging forms of risks like; climate change, pandemic, cyber threats and the growing health-wealth gap. This increased volatility challenges all aspects of our global economy and society. That is why it is an imperative to expand traditional risk management to address classes of risks that are increasingly relevant, but lack comprehensive solutions that address risk mitigation, incident response and compensation for loss.

2020 has highlighted the exact type of transformative challenges posed by long-tail risks. These risks, once thought rare, are now becoming common and can happen at any moment, with an impact that grows more severe over time. A good risk manager will look at both sides of the coin and often the process of considering emerging risks can be used to explore new futures and build future resilience.

Our research themes in the Emerging Risks hub link closely with the work underway across the wider WRN portfolio, but they all focus on core topics – identifying the change, dealing with uncertainty, and taking into account the interconnected interplay of risks, themes and global trends. With COVID-19 continuing to dominate the headlines and board agendas, it can be easy to lose focus of the wider risk landscape. Bill Gates once wrote, "we always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don't let yourself be lulled into inaction." Whilst he was discussing the evolution of personal computing, it is this perspective that needs to be challenged as we build forwards from a disruptive – and disrupted – 2020.

Reviewing emerging risks is about more than maintaining a risk register, or scoring acceleration, impact and severity. The CRO Forum describe emerging risks as "risks which may develop or which already exist that are difficult to quantify and may have a high loss potential. Further, emerging risks are marked by a high degree of uncertainty; even basic information, which would help adequately assess the frequency and severity of a given risk, is often lacking." This can encompass both new risks and changes in societal, governance or financial systems that bring new dynamics to longstanding risks.

Our partnership with the Cambridge Centre for Risk Studies at the Judge Business School, University of Cambridge continues to explore the application of their rigorous scenario framework to a wide range of principal and emerging risks to businesses, with a particular focus on resilience with our Airport Risk Community. We are also learning about the future of Technology, Media, and Telecommunications from our new partnership with the Mack Institute for Innovation Management.

Other areas of research continue to be explored. In his round up of the first National Preparedness Commission, Lord Toby Harris added "Black Jelly-fishes" to the metaphors outlined by WRN Director Hélène Galy in A modern bestiary for risk managers. Lord Harris described them as "things we think we know about and understand, but which turn out to be more complex and uncertain, sometimes with a long tail and a nasty sting at the end". [1]

Lucy Stanbrough
Head of Emerging Risks research

[1] https://www.linkedin.com/pulse/national-preparedness-commission-has-its-first-meeting-toby-harris

Emerging risks and resilient futures

2020 has shone the brightest of lights on the need to revisit basic assumptions about the way we categorise and consider risks, trends, and how people and organisations think and respond in order to improve the quality and accuracy of decision making. Emerging risks are an essential part of this – and a good risk manager will know that the process of considering them goes beyond the annual process cycle. Reviewing emerging risks is about more than maintaining a risk register, or scoring acceleration, impact and severity. Their consideration enables a process to highlight trends, identify risks and opportunities, explore plausible and extreme futures, identify where resilience can be developed, and above all enact change. This is something we have been exploring with Willis Re's Enterprise Risk Management team in a webinar on the topic.

2020: an (Un)precedented year

In the case of COVID-19, we had evidence that the wolf was already in the herd, if only the shepherd had taken a closer look or heeded warning from the disaster risk community. In November highlighted a selection of examples from expert institutions warning about the potential of this risk at the FINEX "Beyond the limits - A blueprint for the future" conference:

- The threat of infectious diseases or a pandemic influenza were both near or at the top of the 2017 U.K. National threat register in terms of one of highest impact, and likelihood.

- Globally, and put out at the end of 2019, the Global Preparedness Monitoring Board, an independent monitoring and advocacy body co-convened by the World Bank and WHO had highlighted the need to really take decisive action on the threat.

- Just before that in October 2019, a global pandemic exercise 'Event 201' was held in New York in October 2019, orchestrated by the John Hopkins Center for Health Security, the World Economic Forum and the Bill and Melinda Gates Foundation. The event brought together 15 global participants, made up of business, government and global health leaders, with participants walking through a 'hypothetical' scenario of a novel coronavirus transmitting from bats to pigs to humans before spreading exponentially across the globe.

It's easy in hindsight, but the risk landscape picture was a little blurry because there are a lot of shepherds, no shortage of wolves out there, or what can feel like people crying wolf! And yet this pandemic exposed major shortfalls in the preparedness of businesses, organisations and nations around the world. Many turned out to be much less well prepared to deal with the crisis than they should have been and thought they were.

What should bring comfort and spark thinking for 2021 is the number of scenario based exercises and expert assessments of the global risk landscape that are available to be used as a starting point for those looking to increase their awareness of risks, or to be fed into existing risk analysis to augment thinking.

Awareness continues to build around operational risks

With no universally accepted definition for emerging risks there are many ways to consider them, and every organisation will have a definition and criteria that supports their thinking. Emerging risks appeared at number 10 in the 2020 Willis Towers Watson 'Most dangerous risks to insurers' survey as a category of their own[1]. In the insurance industry the Chief Risk Officers Forum added three new risks to their 2020 radar map: Digital Misinformation, Plastics and Microplastics, and Skills Shortage and Reskilling[2] . Within the WRN Emerging Risks hub a review for an insurance association produced a long list of 90+ emerging risks for members to consider and prioritise. Every organisation will have their own view of risk and ensuring the process is integrated into strategic planning and operational activities will help to stress test those views.

There are plenty of low frequency, high severity risks where planning may be out of date for our current society, their impacts not fully recognised, or there's a potential for clash between threats. It also highlights the need to consider where the pain points are. Cyber attacks, solar storms, and pandemics all result in different kinds of impacts where the main outcome is business interruption. Cyber Business Continuity Plans tend to focus on picking up the office and moving to a secondary location. And yet, with this pandemic secondary location was useless with social distancing requirements, and finance directors were compelled to accelerate digital investment to get up and running. The threat of a solar storm could see nationwide power cuts where all devices requiring powers and connectivity struggle.

[1]https://www.willistowerswatson.com/en-US/Insights/2020/02/2020-most-dangerous-risks-to-insurers
[2]https://www.thecroforum.org/2020/06/30/emerging-risk-initiative-major-trends-and-emerging-risk-radar-2020-update/

Governance drivers

Provision 28 of the U.K. Corporate Governance Code 2018 requires boards to undertake a "robust assessment of the company's emerging and principal risks"[3] including risks that result in events that may threaten the organisation's business model, future performance, solvency and reputation. When uncertainty is your only certainty, it is easy to see why investors want to know companies are on the case, and curious about a wide range of areas, and why systems perspectives and the connectivity of risks are also creeping into regulatory requirements.

Stakeholders want to know you understand the wider risk landscape, and COVID-19 is likely to trigger further interest as financial institutions attempt to gauge resilience and how interconnectivity is being considered, and how organisations intend to build forwards. A good example of this is climate risk, which although well recognised by scientists and regulators as a key risk, has facets that continue to emerge as stakeholders enact and react to change such as the green incentives tied to COVID-19 recovery plans. The direction of travel towards mandatory climate disclosure is becoming ever more apparent. For example, the Financial Conduct Authority's (FCA) recent commitment

to introduce climate disclosure, on a 'comply or explain' basis from 2022, beginning next year, for U.K. premium listed firms is particularly notable alongside new regulatory requirements on banks and insurers to assign individual accountability to senior management is particularly notable[4]. It should also serve as a prompt for firms to look at the maturity of their thinking across their entire programme around other systemic risks – what doesn't get measured doesn't get managed, and what doesn't get managed will end up under the regulatory microscope eventually.

Stress test your risk lists and understanding

Foreseeing trends is often a matter of perspective and sometimes it helps to take a step back and look at challenges with fresh eyes. Decades worth of digital acceleration under COVID-19, shifts in business travel, and the rise of home working will all have changed the landscape in ways that may not yet be apparent. We will be exploring some of these trends with the Aviation and Technology, Media and Telecommunications communities through two upcoming projects that are reassessing the risk landscape.

- Our Airport Risk Community (ARC) are working with the Centre for Risk Studies at the University of Cambridge Judge Business School to develop an annual index of possible disruptors for 110 international airports, covering current trends and emerging threats that they face. The index will explicitly consider resilience to 19 severe disruptor threats over the next 3-5 years, and support benchmarking and risk understanding.

- The first half of 2021 will also see Willis Towers Watson will publish its 'Willis Towers Watson Technology, Media and Telecommunications Futures Report: Risks on the horizon!'. This report, created with input from WRN partner the Mack Institute for Innovation and Risk Management, will aim to help companies strategically plan as well as mitigate the risk implications brought about through the advancement of technology. The research will allow Willis Towers Watson to continue to help corporate decision makers prepare for a more strategic role and allow companies to better prepare for the changing risks.

With transport and technology both forming important themes for global businesses these studies will provide a view into the risks facing sectors that are only one step removed from your key risks. Should their risks be on your register?

If you had pandemics on your risk register, was there a scenario comparable to the impacts we've seen or a scenario for another risk that shared characteristics? Did it include the escalating tensions between nation states and the competition and shocks to global supply chains, or the need for your CFO to approve the purchase of laptops to facilitate the home office? This is where flexibility and building resilience capabilities is essential. It is as much a culture challenge as an operational one – businesses need to be ready for multiple scenarios, and reactive when the exact situation doesn't unfold as scripted.

[3]https://www.airmic.com/sites/default/files/webinar-archive/Risk%20culture%20in%20today%27s%20business%20world%20-%209%20June.pdf

[4]https://www.willistowerswatson.com/en-GB/Insights/2020/11/TCFD-coming-ready-or-not

More importantly, how has your risk register changed to account for the new world we find ourselves in? If nothing has changed it is time to dig out this list and put it under the microscope in this new world of the "new normal" or "never normal" (with a faster pace of change), challenging your own decision making and the connections your brain is making without you even noticing. We tend to use information that comes to mind quickly and easily when making decisions about the future ("availability heuristic"). Certain events and experiences are memorable and will come to mind – even when evidence can counteract them. This pandemic will set new mental paths, but not all pandemics will be like this one and the past is often not the best guide for the future. The same goes for emerging risks, which is why it is so important to continually stress test thinking and work with diverse groups, outside of your sector and your comfort zone. And cherish the devil's advocate in the room[1].

Will 2021 will be the year of resilience?

In the end, we have to recognise that we don't have a crystal ball, and that despite all the continuous scientific advances, and the most open-minded will in the world, we can't predict with certainty what will happen. 2020 has made that clear to businesses and institutions around the world, and the increasing interest in evolving risk management to include

resilience management. This trend can be seen everywhere – from the rise of Resilience Officer positions to the new National Preparedness Commission[2] launched in the U.K. in November. The central theme of the commission is the need for resilience to be designed into the fabric of society. The Commission's Chairman, Lord Harris of Harringey explained "Robust response plans must be fit for purpose when faced with the real event, societal structures and economic and financial systems must be strengthened. This means not just investing in resilience and preparedness but adopting a cultural shift from a 'just in time' philosophy to one of 'just in case.' WRN Director Hélène Galy is representing Willis Towers Watson on the commission and we will look to share WRN best practice from our sector and stress test our own thinking.

Our Emerging Risk programme in the WRN continues to explore the art of the possible. This has never been more important for risk managers: to ensure scenario planning and business continuity exercises remain relevant, and to empower boards with a credible landscape of potential futures to steer through and gain a competitive edge. Cross sector working groups and access to state-of-the art science can play a role in understanding the art of the possible, and our team is tapping into this knowledge and bringing it closer to our clients.

[1]https://foreignpolicy.com/2020/05/06/want-to-avoid-the-next-pandemic-hire-a-devils-advocate/
[2]https://nationalpreparednesscommission.uk/

Geopolitics of risk

Over the last 12 months we've seen the ripples of natural, man-made and political upheaval spread far and wide; and environmental, technological and political changes continue to highlight new uncertainties as global trends set new domino chains in motion. All of these have highlighted the need for organizations to create stronger links between their c-suites and operational managers to produce the required integrated and rehearsed responses.

At the beginning of 2020, Cyber risk was the one to watch for many people, but the potential of a global pandemic had been on the risk board, even though it came as a surprise to many. Epidemics and pandemics have a clear geopolitical dimension due to the potential to ignite an already charged landscape with

aftershocks including food and water security, overwhelmed public health systems, and weakened national institutions[1].

What's been apparent is that the connections — the direct and indirect relationships between events and themes — are as important as the risks themselves, and this is something we have continued to explore with our partners, and will continue in the coming year through corporate forums like the C-suite 'Finding Your Geopolitical Feet' series and its focus on business resilience. The regular interaction and follow up has grown into a community of risk owners, decision makers and research organizations who have the opportunity to raise the big questions, interact with subject experts and build the insights and learning back into their respective places of work.

While the COVID-19 pandemic is primarily a problem of human health, it has carried inevitable consequences for geopolitics as well as domestic politics. After all, geopolitics goes beyond international relations; it is about how businesses sit within the economy, policy and geography, and the impact that events like pandemics have on this relationship.

Our partners have been sharing their perspectives on these challenges to bring fresh opportunities to respond, and starting new conversations that highlight the importance of integrated responses. Stress testing views with our partners and using a conscious system-wide geopolitical risk approach provides a way for organizations to identify and understand how they may be impacted, in order to mitigate the risks and seize new opportunities.

Digital Dialogues: the geopolitics of COVID-19

With the shift out of the physical Boardroom and into digital, we looked for new ways to bring proactive insight to our community. In May the WRN Emerging Risks hub held the first of our Digital Dialogues series on "the geopolitics of COVID-19" where Sam Wilkin, Director of Political Risk Analytics, Financial Solutions joined WRN partners Elisabeth Braw, RUSI and Simon Coote, Oxford Analytica to discuss the short- and long-term geopolitical implications of the pandemic.

These sessions are a way to continue the discussion in a more accessible and digital way, with key questions tackled by a virtual panel of experts, both in-house and in our worldwide network of partners. Particular interest was paid

to highlighting countries that might be hit hardest by the pandemic, with Simon sharing insights from the recently updated VAPOR (Value at Political Risk) ratings, which led to 21 country downgrades.

Elisabeth focused on the reactions from governments across the world, pulling on her insights from the Modern Deterrence programme and On the Cusp[12] podcast to share insights into the ways China and Russia moved to help Italy during the early stages of the crisis, and the knock-on effects for EU member state relations and trust.

Even with the hope of a vaccine on the horizon, multinational businesses with many operations centres, multiple markets and complex supply chains are going to need to be vigilant to finance, economic and trade risks that are going to emerge as a result, and the thoughts from Elisabeth, Simon and Sam provided insights on futures to watch out for. Elisabeth's highlight of the potential for the U.S. to step up and lead global coordination becomes increasingly likely with the latest election results. Her move to the American Enterprise Institute to continue her work on modern deterrence and grayzone aggression, while retaining her links to the WRN, is a fortunate development for our geopolitical risk research network.

Airmic annual members survey

This approach of multidisciplinary perspectives also carried into our collaboration with Airmic on its annual member survey, bringing the multiple lenses from the Willis Towers Watson Geopolitical Risk team. This report explored the impacts of geopolitics and populism on risk in the midst of the COVID-19 pandemic, underpinning

[1] https://blogs.imf.org/2020/06/24/reopening-from-the-great-lockdown-uneven-and-uncertain-recovery/

[1] https://rusi.org/content/cusp
[2] https://www.aei.org/tag/on-the-cusp-podcast/

our ongoing work to support risk professionals identify and understand geopolitical risks, their drivers and the connections between them, so they can mitigate the risks and seize new opportunities.

If organizations can pre-empt the changes in the way businesses and the economy will operate in the ensuing six to 12 months, they can move from reacting into strategic planning. This will help to gain competitive advantage in the "new normal" and improve resilience. This is essential because none of the other risks go away – cyber-attacks, floods, earthquakes, terrorism incidents sadly still occur.

As the U.K. went into lockdown by the end of March 2020, risk professionals were most concerned about the risks of business interruption following a cyber event – what followed was a very different scenario with more extreme disruption, highlighting the importance of continuing to explore uncertainty and clash events.

It isn't all negatives – the COVID-19 experience may bring opportunities such as more incentive to evaluate different, more cost-effective ways of working, build a more resilient society, larger home markets and establish more reliable supply chains.

Key findings from the report, include:

- Individual and corporate exposure to cyber threats is expanding at a rapid rate. Artificial Intelligence techniques, while still in their infancy, are being utilised in more state and criminal operations for faster and harder-to-detect attacks. Targeting of operational technology is increasing as outdated analogue systems digitise and converge with IT networks at corporate headquarters.

- Businesses will bear the brunt of climate change. These will cause knock-on effects that will disrupt supply chains and impact staff, ultimately leading to lost revenues and reputational damage. Yet many businesses still see climate action as external to them – something for governments instead to deal with.

- Trust and reputation have become increasingly important to businesses. With the pandemic, all businesses and organisations have been placed under additional stress. One might think they may be more easily forgiven for their errors, but consumers continue to find many corporate transgressions unacceptable.

- The nature of risks today, especially geopolitical risks, is that they are increasingly interconnected. Indeed, while much has changed, there is a surprising element of continuity in the geopolitical threats that companies face in the COVID-19 era.

- Risks in relation to governance, laws and regulation continue to be a exhibit a significant concern for risk professionals and their organisations.

- This article appears to be written in third person, in contrast to the first article which is in first/second person.
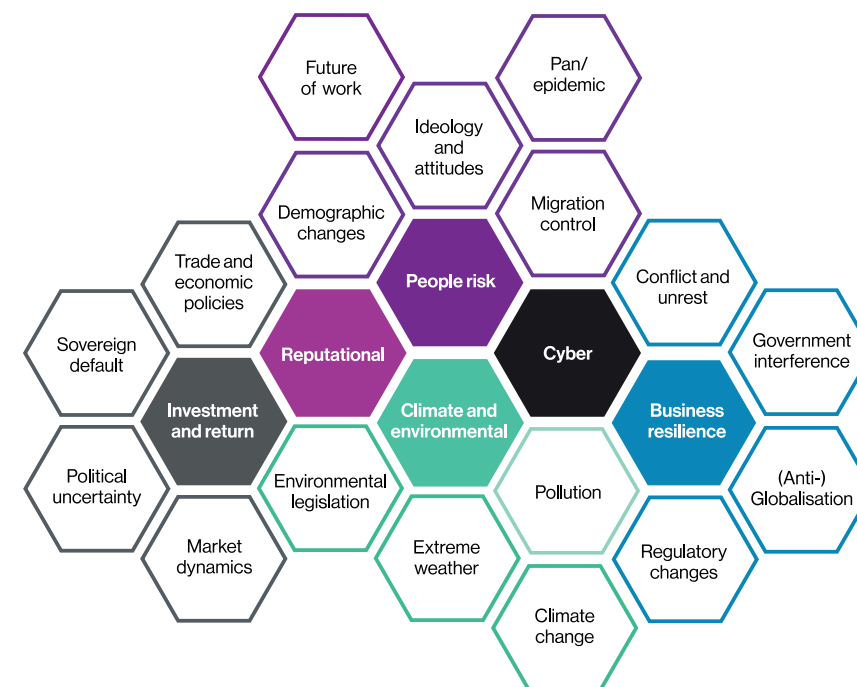
Natural resources market reviews

To bring company risks to life, the use of adverse scenarios allows businesses to consider interconnectivity between risks and trends, whether the right assumptions are being made, the appropriate questions are being asked and whether the key issues are being sufficiently examined, and how prepared the organisation is to face the ensuing cascading risks.

> " Those who ignore Geopolitical events do so at their peril "
>
> **Neal Croft,** Global Client Relationship Director, Willis Towers Watson

Figure A: The six lenses within the context of geopolitical risks

This is the approach the Geopolitical Risk team have taken with the Willis Towers Watson natural resource reviews for the energy, power, renewables and mining sectors. Drawing on research from our partners on the art of the possible, scenarios highlighting the connections between lenses were created around changing political landscape, ESG trends, and digitalization.

By examining risk drivers and their associated risks through six key interconnected lenses Figure A (Cyber, Climate/Environmental, People, Reputational, Business Resilience and Investment/Return), our Geopolitical risk team encourages the identification of integrated solutions that can be tailored and address insurable and non-insurable risks seamlessly.

This structured, evidence-based approach provides an effective framework to assess, quantify and mitigate geopolitical risks in an integrated fashion; and allows the development of Red Teaming initiatives to challenge or test the adopted plans and thinking, and risk register stress testing. The ability to use Red Teaming to get c-suite and operational risk managers around the table with external voices can bring about intra- and inter-organizational insights that shines a light on the human elements of decision making and operations.

Continuing the research journey

As COVID-19 continues to unfold, boards and their risk managers should be proactive and review their risk profiles, appetites, and identify the relevant tipping points. Successful organizations will be those that are able to understand, assess and quantify the connected

risks, in order to take advantage of opportunities and mitigate or manage the risks of these geopolitical relationships.

Businesses need to stretch their thinking, and where possible embrace intelligence led capabilities that help to reduce the surprise and shock of regional, national and global events. Using a range of tools and scenario planning, organizations can gain a holistic view of their risks and drivers, bringing more clarity to complex risk landscapes, and thereby gain competitive advantage. The WRN and Geopolitical C-Suite forums have a track-record of bringing together diverse expert panels, customised to our clients' needs, to help in this process.

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. Willis Towers Watson have been working with Oxford Analytica since 2006. For more information please visit their website.

RUSI

Royal United Services Institute for Defence and Security Studies The Royal United Services Institute for Defence and Security Studies (RUSI) is the world's oldest independent think tank engaged in cutting edge research on international defence and security issues. Founded in 1831 by the Duke of Wellington, RUSI embodies nearly two centuries of forward thinking, free discussion and careful reflection on a range of topics, from air power & technology to sanctions. https://rusi.org/

Learn more about the Willis Research Network

To view previous brochures and for upcoming WRN events and communications please visit our website at willisresearchnetwork.com
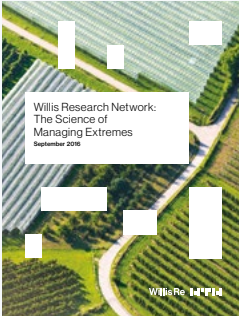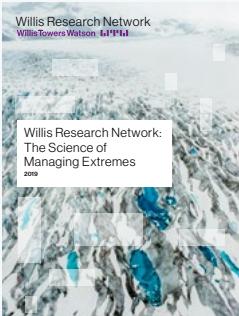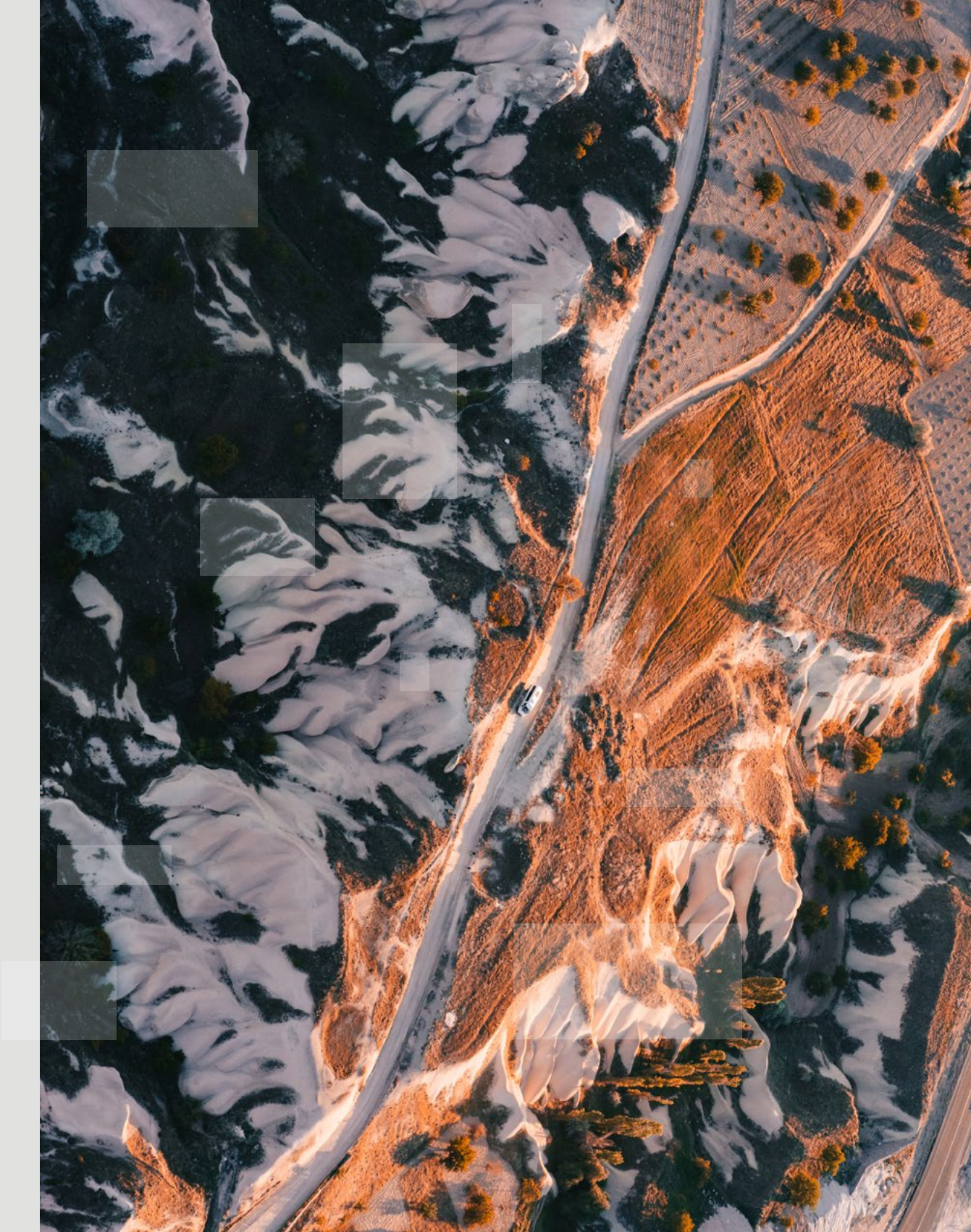

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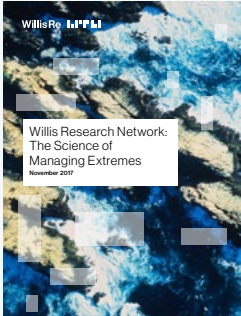
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Setareh Mayel Afshar
Marketing Coordinator
+44 (0)20 3124 8659
setareh.mayelafshar@willistowerswatson.com

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