Insurance Development Forum

How technology can help bridge the protection gap

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How technology can help bridge the protection gap

Forewords

Efforts to close the protection gap surrounding natural catastrophes have expanded and intensified over the past decade. But the protection gap persists and in many countries it is growing. There are no easy solutions to this global problem. But there is reason for optimism due to the growing realization of the scope and scale of the problem and the concerted efforts by public and private institutions to address it. There is also the extraordinary potential to harness the power of technology and advancements in data analytics to do more — and to do it faster, better, more efficiently. Technology is not a silver bullet, but there is perhaps no greater game changer in the battle to reduce losses and provide disaster risk financing for natural disasters.

With this in mind, the IDF, led by its Law, Regulation and Resilience Polices Working Group undertook the preparation of this paper, which is intended to provide an overview of some of the key technological developments underway and to highlight some of the key legal, regulatory and public policy issues that arise in this context. This paper is not intended to be an exhaustive description of developments or to provide a comprehensive discussion of the legal, regulatory and policy issues that are relevant. Our goal is simply to help frame the issues and stimulate the important discussions that need to take place around this topic.

I want to thank Clyde & Co for their tremendous efforts in taking the lead in collecting the valuable insights that so many IDF stakeholders and others provided to us and for their help in drafting, editing and the publication of this paper. A special thanks is due to Wynne Lawrence for all she did. A thank you as well to our working group members who added valuable content and comments.

I hope you find this paper of interest and that it stimulates thoughts and most importantly action.

Bill Marcoux

Chair, Law Regulation and Resilience Policies Working Group

Protecting populations, public assets and economies against natural catastrophes is an urgent need. Over the last several years there has been a dramatic increase in activity in this area, but solutions and meaningful progress have proven difficult, for a number of reasons.

New technologies and innovations are providing valuable new tools for closing the protection gap. For example, we increasingly have the means to forecast the likelihood and severity of a weather event at a given location. We have historical data to build on, and scientific models that can help us understand what the impacts of climate change may be into the future. We are also gaining a more granular view of risk; there is a proliferation of risk-relevant data to be captured from mobile phones, planes or drones, weather stations on the ground, and mega-constellations of satellites with enhanced radar technology. With the help of cognitive computing, we are able to harness the value of that data.

These technologies hold the potential for us to better understand, manage and transfer risk, increasing resilience. Tech-enabled insurance – and those operating in the risk management ecosystem – may have a key role to play in building global resilience.

However, the exponential pace of technological change means that laws, regulation, policy and regulatory architecture can struggle to keep up. There is a clear need to regulate for innovation, to ensure that citizens' privacy and their data is protected, while at the same time gathering data that will help us close the protection gap.

This paper is intended to foster discussion about some of the ways that law, regulation and policy may enhance our use of technology for resilience. In preparing this paper, we have had widespread and active engagement from a cross-disciplinary and global team of contributors including leading lawyers and academics on insurance law and smart contracts, senior members of the insurance industry, senior personnel at multilateral development banks, development practitioners and policymakers, as well as leading thinkers and practitioners in artificial intelligence and satellite technology applications. The result, we hope, is something unique, which draws together current thinking on a seemingly disparate range of topics, but which if drawn together through careful regulation, policy and legal frameworks may play an important role in enhancing global resilience.

Nigel Brook

Partner, Clyde & Co

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Introduction

The protection gap – a problem for sovereigns and sustainable development

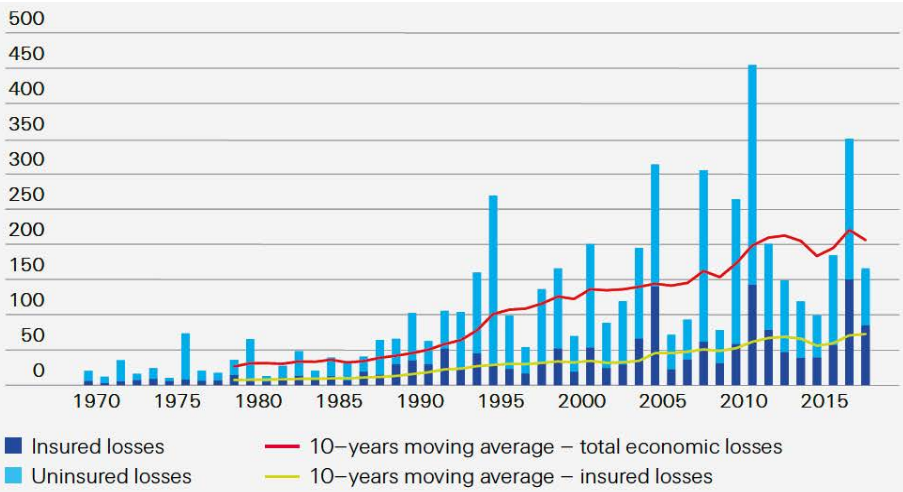
Every year, natural disasters and adverse weather damage communities, businesses and national infrastructure, setting back sustainable growth and development.

A significant protection gap exists worldwide, with the amount of insurance payouts for natural disasters far outstripped by the scale of uninsured losses. An estimated US$163 billion of assets are underinsured in the world today.[1] As depicted in the figure below, the gap is growing.[2] Global average annual loss from disasters is expected to increase from around US$260 billion in 2015 to US$414 billion by 2030.[3] The problem is being magnified by climate change.

Where there is insufficient insurance penetration in a country or region, when natural catastrophes strike, national governments and international donors step in to fund disaster response, protect communities, support economies and rebuild infrastructure. Disasters have a devastating impact on development; infrastructure is destroyed, families lose homes, livelihoods and loved ones, communities lose businesses, jobs and services, children - particularly girls - miss school.[4]

The cost of rebuilding means that funds are diverted from other government programs. Disasters set back broader development goals - according to a 2017 World Bank Group report, it is estimated that disasters keep an additional 26 million people locked in extreme poverty each year.[5]

Insured vs uninsured losses, 1970–2018, in USD billion at 2018 prices



Economic losses = insured + uninsured losses
Source: Swiss Re Institute

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Severe climate shocks threaten to roll back decades of progress against poverty. Storms, floods, and droughts have dire human and economic consequences, with poor people often paying the heaviest price. Building resilience to disasters not only makes economic sense, it is a moral imperative.

Jim Yong Kim, World Bank Group President 2012-2019 ”

In the face of climate change, a growing number of national and sub-national governments are adopting disaster risk finance strategies that include insurance to enable more rapid, coherent and comprehensive disaster relief, recovery and reconstruction. There is increasing evidence that countries with widespread insurance coverage recover faster from the financial impacts of extreme events.[6] Governments are also interested in harnessing the knowledge, tools and capital of the insurance industry to better understand their disaster risk, build national or regional resilience, and mitigate losses.

1 Lloyd’s of London, *Emerging economies have $160bn insurance gap*, October 2018, https://www.lloyds.com/news-and-risk-insight/press-releases/2018/10/emerging-economies-have-160bn-insurance-gap

2 Swiss Re, *Sigma no. 2/ 2019, Natural catastrophes and man-made disasters in 2018: “secondary” perils on the frontline,* 2019, https://www.swissre.com/dam/jcr:c37eb0e4-c0b9-4a9f-9954-3d0bb4339bfd/sigma2_2019_en.pdf; Lucia Bevere, Swiss Re, Sigma 2/2019: *Secondary natural catastrophe risks on the front line, April 2019*, https://www.swissre.com/institute/research/sigma-research/sigma-2019-02.html

3 UNISDR, *Disaster Risk Reduction and Resilience in the 2030 Agenda for Sustainable Development,* October 2015, https://www.unisdr.org/files/46052_disasterriskreductioninthe2030agend.pdf

4 Oxfam International and Christian Aid, *How Disasters Disturb Development – Recommendations for the post-2015 development framework,* December 2013, https://sustainabledevelopment.un.org/getWSDoc.php?id=2488; and Handicap International Federation, *Policy Paper - Inclusive Disaster Risk Reduction,* 2017, https://reliefweb.int/sites/reliefweb.int/files/resources/PP13_InclusiveDRR.pdf

5 Hallegatte, Stephane, Adrien Vogt-Schilb, Mook Bangalore, and Julie Rozenberg. 2017. *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters.* Climate Change and Development Series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1003-9. License: Creative Commons Attribution CC BY 3.0 IGO https://www.gfdrr.org/sites/default/files/publication/Unbreakable_FullBook_Web-3.pdf

6 The Geneva Association, *Climate Change and the Insurance Industry: Taking Action as Risk managers and Investors – Perspectives from insurance industry’s C-level*, January 2018 executives https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public/climate_change_and_the_insurance_industry_-_taking_action_as_risk_managers_and_investors.pdf

The sustainable development goals (SDGs) and disaster risk reduction

Reflecting the importance of disaster planning, recovery and response to international sustainable development, four of the UN's Sustainable Development Goals - 1, 2, 11 and 13 - refer to the need for nations and communities to address the challenges related to natural hazards and disasters.

SDG1 - End poverty in all its forms everywhere[8]

Target 1.5

By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

SDG 13 - Take urgent action to combat climate change and its impacts[11]

Target 13.1

Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

SDG 2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture[9]

Target 2.4

By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

SDG 11- Make cities and human settlements inclusive, safe, resilient and sustainable[10]

Target 11.5

By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

7 The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals, which are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests. UN, Sustainable Development Goals Knowledge Platform, https://sustainabledevelopment.un.org/?menu=1300

8 UN, Sustainable Development Goals Knowledge Platform, *Sustainable Development Goal 1*, https://sustainabledevelopment.un.org/sdg1

9 UN, Sustainable Development Goals Knowledge Platform, *Sustainable Development Goal 2*, https://sustainabledevelopment.un.org/sdg2

10 UN, Sustainable Development Goals Knowledge Platform, *Sustainable Development Goal 11*, https://sustainabledevelopment.un.org/sdg11

11 UN, Sustainable Development Goals Knowledge Platform, *Sustainable Development Goal 13*, https://sustainabledevelopment.un.org/sdg13

Technology may hold the key to bridging the protection gap

There are three closely interrelated categories of technological advancements that are contributing to a more detailed understanding of natural hazard and weather risks: (i) increasing availability of data (earth observation (EO), the internet of things (IoT), crowdsourcing etc.); (ii) the increasing capacity to process that data (artificial intelligence (AI), cloud computing, etc.); and (iii) new tools for communicating risk data and mitigation advice (including insurance distribution).[12]

These new technologies are enabling the insurance industry to create innovative services and products which can help governments understand natural hazard risks and design systems to protect their citizens and infrastructure. We now have the ability to observe and react not just to the aftermath of disaster, but to its portents, permitting better warning systems and interventions before drought leads to famine, or a pressure system leads to hurricane and coastal flooding.

There is broad consensus that the digitization of insurance will lower transaction costs and permit new and more customer-centric products and solutions, enabling better penetration of insurance in societies, thereby allowing individuals, businesses and communities to understand their risks and bounce back from shocks.[13]

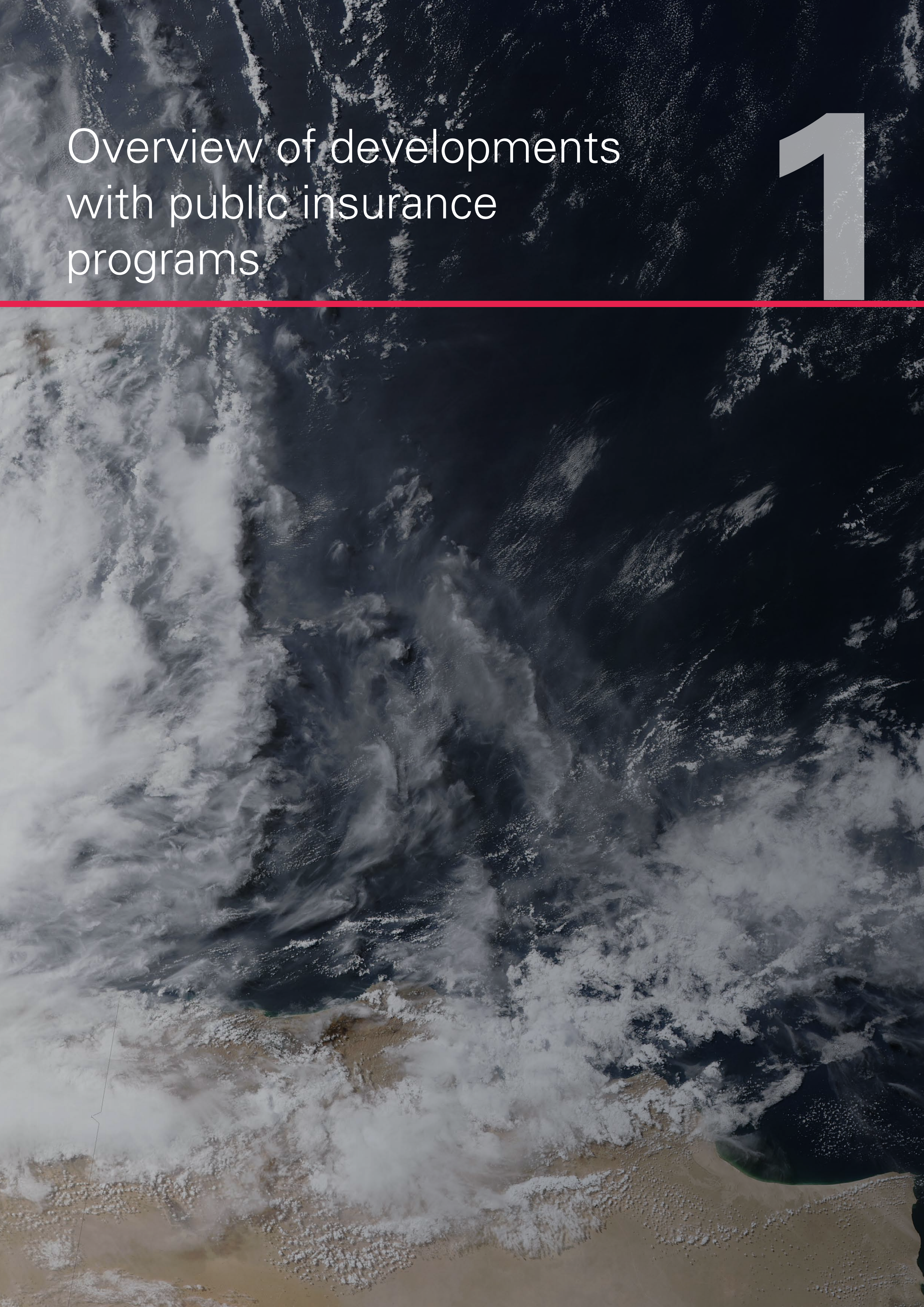
Technology is also transforming a number of aspects of insurance provision for public insurance programs including underwriting, risk management and mitigation, distribution, and the speed of claims payments. However, since innovation by definition challenges the traditional, there are legal, regulatory and policy issues that can arise: from data protection concerns to airspace regulations. In some cases, or in some countries, law, regulation or policy may need to be developed or amended to allow tech-enabled insurance to reach its full potential.

This paper explores some of the innovations that are bringing the benefits of insurance protections to enhance sovereign disaster preparedness and response, as well as the legal and regulatory issues that may need to be considered to unlock such benefits.

12 With thanks to the OECD for this helpful formulation, see: OECD, www.oecd.org; OECD Science, *Technology and Innovation Outlook 2016*, 2016 https://www.oecd-ilibrary.org/sites/sti_in_outlook-2016-5-en/index.html?itemId=/content/component/sti_in_outlook-2016-5-en

13 The Geneva Association (2016), *Harnessing Technology to Narrow the Insurance Protection Gap* (Kai-Uwe Schanz and Fabian Sommerrock), https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public//harnessing-technology-to-narrow-the-insurance-protection-gap.pdf

1 Overview of developments with public insurance programs



1

Overview of developments with public insurance programs

There is now a wide range of insurance schemes which operate at the intersection of state and market by mobilizing global (re)insurance capital to protect sovereigns and sub-sovereigns (provinces, states, regions, cities or municipalities).[14]

Such schemes range from government programs that pool risk to provide protection to individuals, to schemes that insure public entities against damage to national infrastructure, to schemes that provide cover enabling a sovereign to rescue, respond or rebuild.

Sovereigns can also support the uptake of disaster insurance schemes by individuals through premium subsidies or otherwise encourage greater insurance penetration through policy measures, including those designed to foster financial inclusion. Governments can implement such measures in the form of insurance vouchers and tax benefits or, as is the case in China, in schemes that proactively encourage provinces to use part of their budget to purchase insurance.[15]

Public insurance programs can provide a rapid injection of capital in the immediate aftermath of natural disaster. With the confidence that such funds will be available when needed, sovereigns can budget and plan for their disaster response in advance. Timely, well-designed and targeted interventions can mitigate or avoid the worst impacts of natural disasters on sustainable growth.

Insurance for disaster protection

Various types of insurance and other risk transfer products can play an important role in disaster risk financing. For example:

Indemnity Insurance

Indemnity insurance is a more "traditional" form of insurance protection which is designed to provide compensation based on the policyholder's actual losses, often assessed by a loss adjuster. Greater damage means a higher payout. This type of insurance is usually considered best suited to longer-term reconstruction as the loss adjustment process can take many weeks, months, or (in some cases) years. Outside of natural disaster insurance, the vast majority of insurance is arranged on an indemnity basis.

Parametric Insurance

In contrast, payment in parametric insurance (also called 'index-based' insurance) is triggered by reference to an index. For example, a product designed to respond to an earthquake could be triggered to pay if a certain magnitude on the Richter scale is measured at a given location. A parametric product for hurricane damage could be triggered if winds reach a certain velocity in a defined zone. Analysis of whether the threshold for payment has been reached will depend on the analysis of quantitative data, ordinarily provided or verified by a recognized independent third party or via a bespoke data analysis system. A key advantage of parametric insurance is speed: since there is no loss assessment, payouts can be expected within a few weeks of qualifying disaster events.[16] Many of the technology-enabled insurance products discussed in this paper operate on a parametric basis.

14 For a detailed review of public insurance schemes, see: Jarzabkowski, P., K. Chalkias, E. Cacciatori, R. Bednarek, (2018). *Between State and Market: Protection Gap Entities and Catastrophic Risk*. Cass Business School, City, University of London, 26th June 2018, https://www.poolre.co.uk/wp-content/uploads/2018/06/PGE-Report.pdf

15 Swiss Re, Sigma no. 5/ 2019, *Indexing resilience: a primer for insurance markets and economies*, 2019, https://www.swissre.com/dam/jcr:292e65ba-95e7-432c-93e0-ccefadb87369/sigma5_2019_en.pdf

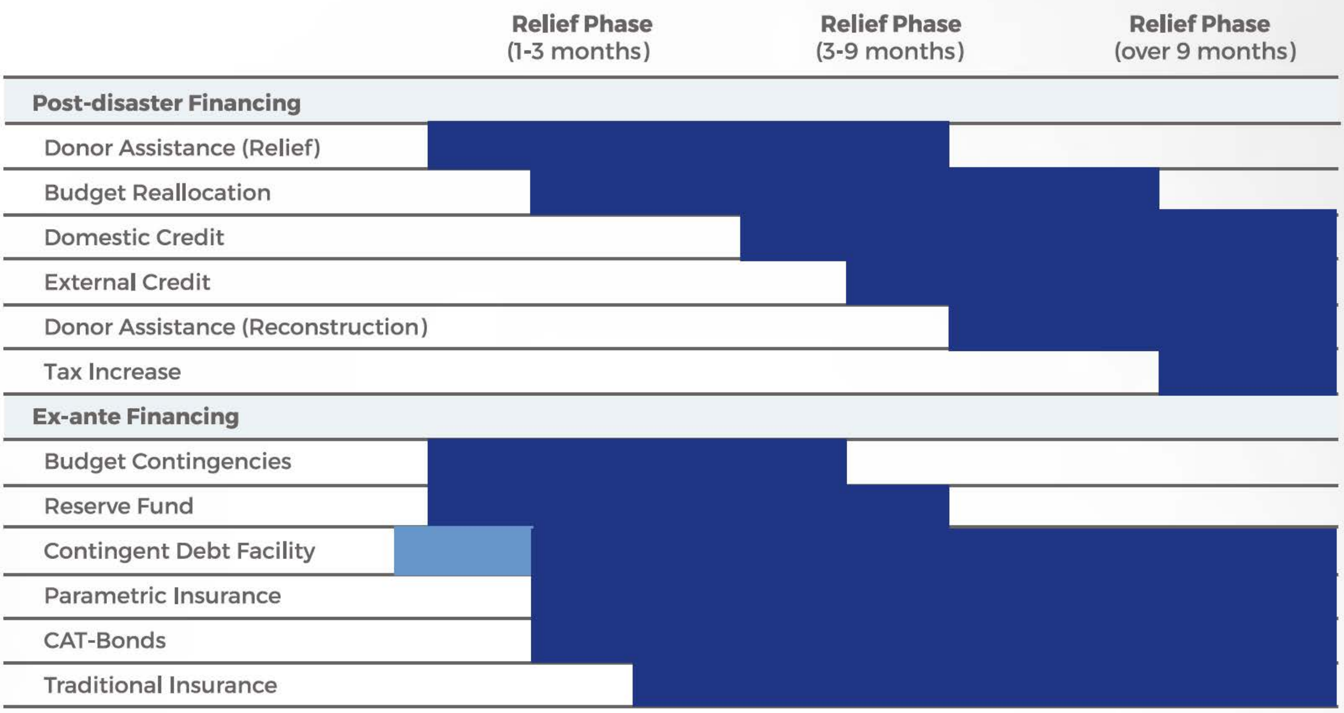
16 With thanks to Development Asia, an initiative of the Asian Development Bank for the succinct definitions of parametric and indemnity insurance; See: Development Asia, *Using Parametric Insurance to Address Rapid Post-Disaster Financing*, March 2019, https://development.asia/insight/using-parametric-insurance-address-rapid-post-disaster-financing

The benefits of ex ante disaster risk finance

Ex post (after disaster strikes) sovereign disaster finance mechanisms include budget reallocation, post-disaster credit, tax increases or international donor assistance. Such ad hoc interventions have their place, but may be uncertain, inefficient, come at a high cost, or with a time lag that can exacerbate or compound losses.

By contrast, pre-loss or *ex ante* disaster financing (such as through payment of insurance premiums) imposes a smaller drop in consumption, helps put mitigation measures onto the policy agenda and encourages development of disaster response planning, which can ensure that such response is more cost-effective, efficient, and consistent with long-term objectives.[17] Predictable resources can be linked to plans for effective and timely recovery, relief and rebuilding.

The diagram below shows the speed of payout of different risk financing instruments.[18]



17 OECD, Budgeting for Disasters, https://www.oecd.org/gov/budgeting/42407562.pdf; Overseas Development Institute, *Disaster risk insurance and the triple dividend of resilience*, September 2017, https://www.odi.org.uk/sites/odi.org.uk/files/resource-documents/11759.pdf
18 CCRIF, *Use of CCRIF Payouts 2007 – 2018*, https://www.ccrif.org/sites/default/files/publications/Use_of_CCRIF_SPC_Payouts_2007_2018.pdf

Collateral benefits of sovereign insurance schemes

Through public insurance programs, sovereigns can also support the development and deployment of insurance-related technologies and methodologies which enable a more forensic understanding of disaster risk, enabling better disaster preparedness, risk mitigation and response.
In addition, the collaborations that enable public insurance programs can build capacity in understanding disaster risk for sovereigns, informing public policy and promoting national resilience and adaptation strategies, particularly in the face of climate change.

Public insurance programs may involve collaboration between a number of stakeholders in the private and public sector:

- One or more governments (sovereigns and sub-sovereigns);
- One or more development organizations, such as the World Bank;
- Donor organizations, such as the UK's Department for International Development (DFID)[19] or the German Federal Ministry for Economic Cooperation and Development (BMZ);[20]
- Scientific and modeling companies and organizations;
- (re)insurance industry companies as providers of technical support and capital.[21]

The resultant public insurance program may be focussed on a single sovereign, represent a multi-sovereign risk pool, or be directed to offer risk transfer at the sub-sovereign level. Below are some examples of established sovereign insurance schemes.

Disaster Risk Financing and Insurance

The World Bank Group has developed a specific program to strengthen financial resilience: the Disaster Risk Financing and Insurance Program (DRFIP). DRFIP's main objective is to increase the financial resilience of countries by minimizing costs and optimizing the timing of post-disaster funding. Through this program, the World Bank helps governments identify beneficiaries, prioritize efforts and create solutions capable of leveraging the capacity of the market. Through funding and expertise, DRFIP supports countries to develop and implement tailored financial protection strategies that increase the ability of national and local governments, homeowners, businesses, agricultural producers, and low-income populations to respond more quickly and resiliently to disasters.[22]

19 UK Government, Department for International Development, https://www.gov.uk/government/organisations/department-for-international-development
20 German Federal Ministry for Economic Cooperation and Development (BMZ), https://www.bmz.de/en/
21 With thanks to Cass Business School for this helpful summary of the constituent elements of 'Protection Gap Entities'. See: Jarzabkowski, P., K. Chalkias, E. Cacciatori, R. Bednarek, (2018). *Between State and Market: Protection Gap Entities and Catastrophic Risk*. Cass Business School, City, University of London, 26th June 2018, https://www.cass.city.ac.uk/__data/assets/pdf_file/0020/420257/PGE-Report-FINAL.pdf
22 The World Bank, Disaster Risk Financing and Insurance Program, *Overview*, https://www.worldbank.org/en/programs/disaster-risk-financing-and-insurance-program

Single sovereign risk transfer programs

A number of countries have established public risk transfer programs to address underinsurance or to respond to specific perils or losses that have traditionally been underinsured. For example, in Mexico, FONDEN, the Natural Disasters Fund, was established in the late 1990s as a mechanism to support rapid rehabilitation of federal and state infrastructure affected by adverse natural events.[23] Resources are leveraged with market-based risk transfer instruments - parametric catastrophe bonds ("cat bonds") and parametric reinsurance.[24] In France, the Caisse Centrale de Réassurance is a public reinsurer covering a range of risks, such as flooding, earthquakes, volcanoes or landslides. Consorcio de Compensación de Seguros in Spain covers "Extraordinary Risks" (natural catastrophes and terrorism); such cover is mandatorily included in policies for property damage and personal injury issued by private insurers. In the UK, Flood Re[25] is a private not-for-profit entity owned and managed by the insurance industry and funded via a levy on insurance contracts; it operates as a pool for reinsuring homes with a high risk of flooding.

Multi-sovereign risk pools

Recognizing that on a regional level, populations are particularly exposed to certain risks, countries have collaborated to pool risk in multi-sovereign risk capacity pools. In this way, sovereigns can pool diverse exposures, lower premium, and enhance their purchasing power in international markets.[26] Multi-sovereign pools will retain some risk and transfer the excess to capital and reinsurance markets.

African Risk Capacity (ARC)[27]

ARC is a risk pool for 33 members of the African Union composed of two entities: the Specialized Agency and a financial affiliate, ARC Insurance Company Limited. The Agency is a cooperative mechanism that provides general oversight and supervision of the development ARC capacity and services, provides capacity building to individual countries, approves contingency plans and monitors their implementation. The Company is the financial affiliate that carries out commercial insurance functions of risk pooling and risk transfer.

ARC's first product is designed to respond to weather-related food security risk in Africa as a result of agricultural drought. The product relies on Africa RiskView, a software platform developed by the UN World Food Programme to interpret satellite-based rainfall data, model the risk of drought, and estimate response costs across the continent.[28] In addition to supporting ARC risk transfer, Africa RiskView provides decision-makers with information on the expected costs of drought response before an agricultural season begins and as the season progresses for every first-level administrative district in every country in sub-Saharan Africa. Identifying and quantifying risk in this way can help countries and their partners direct appropriate drought response actions and target food security investments.

Work is ongoing for ARC to include risks due to river flooding and tropical cyclones which impact African lives and livelihoods, as well as a product that addresses financing needs in containing outbreaks of diseases common to the African continent. ARC is also developing the Extreme Climate Facility (XCF), a data-driven, multi-year, insurance-like vehicle that will provide financial support to eligible African Union countries based on a multi-hazard index. XCF will be a mechanism for those states to access financing to respond to the impacts of increased climate volatility.

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23 World Bank. 2012. *FONDEN : Mexico's Natural Disaster Fund - A Review.* World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/26881 License: CC BY 3.0 IGO.
24 World Bank. 2012. *FONDEN : Mexico's Natural Disaster Fund - A Review.* World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/26881 License: CC BY 3.0 IGO.
25 FloodRe, https://www.floodre.co.uk/
26 Jarzabkowski, P., K. Chalkias, E. Cacciatori, R. Bednarek, (2018). *Between State and Market: Protection Gap Entities and Catastrophic Risk.* Cass Business School, City, University of London, 26th June 2018, https://www.cass.city.ac.uk/__data/assets/pdf_file/0020/420257/PGE-Report-FINAL.pdf
27 ARC, https://www.africanriskcapacity.org/
28 ARC, *Africa RiskView: Introduction*, October 2016, https://www.africanriskcapacity.org/2016/10/31/africa-riskview-introduction/

ARC in action

Members of ARC's risk pool for drought receive a payout when rainfall deviation is sufficiently severe that estimated response costs cross a pre-defined threshold. When that occurs, qualifying members receive a payout within 2-4 weeks of the end of the rainfall season, thereby allowing them to begin early intervention programs before vulnerable populations experience hunger, displacement, or conflict over resources. Established in 2012, the pool requires each country to submit a contingency plan regarding the use of the claim payment and allows each member country to customize and define its own parameters for insurance cover.

Frequently impacted by drought, Mauritania was among the first countries to purchase an insurance policy from ARC for an estimated premium of $1,394,000 for a total cover of $9,000,000 for the agricultural season from July through November 2014. After a very poor rainy season, Mauritania received a payout of approximately $6,326,000 in January 2015. The country was able to use the rapid payment to alleviate a humanitarian crisis, by providing 50,000 households with 50 kilograms of rice and 4 liters of oil each over 4 months. The timeliness of the payout protected livelihoods and prevented migration and the distressed sale of livestock.[29]

The Caribbean Catastrophe Risk Insurance Facility (CCRIF)[30]

CCRIF is backed by the World Bank and other donors and provides parametric insurance through a private not-for-profit company[31] for 21 member states in the Caribbean and Central America, insuring against the risks of hurricanes, earthquakes and heavy rainfall. CCRIF limits the use of the claim payouts to financing member governments' disaster response expenses or maintaining basic government functions after a covered event. Since its inception in 2007, CCRIF has made 38 payouts totaling almost US$139 million to 13 member governments on their tropical cyclone, earthquake and/or excess rainfall policies for 18 different events – all within 14 days of the event.

CCRIF member governments have used payouts for a variety of purposes including: immediate recovery and repair activities; humanitarian aid for affected persons; stabilizing facilities such as water treatment plants; improving critical infrastructure such as roads, drains and bridges; mitigation activities to increase resilience against natural hazards and climate change; and to "keep the wheels of government turning", for example by paying salaries of critical government personnel.[32]

29 Jarzabkowski, P., K. Chalkias, E. Cacciatori, R. Bednarek, (2018). *Between State and Market: Protection Gap Entities and Catastrophic Risk*. Cass Business School, City, University of London, 26th June 2018, https://www.cass.city.ac.uk/__data/assets/pdf_file/0020/420257/PGE-Report-FINAL.pdf

30 CCRIF, https://www.ccrif.org/content/about-us

31 CCRIF Segregated Portfolio Company SPC, https://www.ccrif.org/content/about-us

32 CCRIF, *Use of CCRIF Payouts 2007 – 2018*, https://www.ccrif.org/sites/default/files/publications/Use_of_CCRIF_SPC_Payouts_2007_2018.pdf

Pacific Catastrophe Risk Insurance Company (PCRIC)[33]

PCRIC is an insurance program to assist Pacific Island Countries (PICs) with post-disaster funding; it is a captive insurance company owned by the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)[34] Foundation. PCRAFI aims to provide PICs with disaster risk modeling and assessment tools. It also aims to engage in a dialogue with PICs on integrated financial solutions for reduction of financial vulnerability to natural disasters and climate change.[35] When an earthquake, tsunami or tropical cyclone affects one of the PICs, the government sends a Notice of Applicable Event to PCRIC, which then instructs the Calculation Agent, Air Worldwide, to estimate the impact of the disaster. The Calculation Agent downloads event parameters from a reporting agency (for tropical cyclone, JTWC,[36] and for earthquakes/tsunamis, USGS[37]) and calculates the event footprint and estimated damage, using risk modeling software. Based on this, and the terms of the policy purchased by the government, PCRIC confirms whether an insurance payout is triggered and transfers the amount to the recipient government. After tropical Cyclone Gita in 2018, Tonga received a payout of US$3.5 million within 7 days.[38]

Southeast Asia Disaster Risk Insurance Facility (SEADRIF)[39]

SEADRIF, an ASEAN+3 initiative, is a regional platform that is being developed to provide access to disaster risk financing solutions and increase financial resilience to climate and disaster risks. SEADRIF provides ASEAN countries with advisory and financial services for rapid post-disaster funding to reduce impacts on people and their livelihoods. In December 2018, Cambodia, Indonesia, Lao PDR, Myanmar, Singapore, and Japan agreed to establish SEADRIF as a trust to own a general insurance company in Singapore. The first financial solution offered by SEADRIF is a regional catastrophe risk pool for flood risks developed by and for Cambodia, Lao PDR, and Myanmar with technical assistance from the World Bank DRFIP (see above). SEADRIF plans to provide financial solutions to other middle-income ASEAN countries such as Indonesia, which are developing or enhancing insurance arrangements for public assets.[40]

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33 Understanding Risk, *CEO, Pacific Catastrophe Risk Insurance Company*, https://understandrisk.org/opportunity/ceo-pacific-catastrophe-risk-insurance-company/
34 PCRAFI, http://pcrafi.spc.int/
35 PCRAFI, http://pcrafi.spc.int/; World Bank, *PCRAFI Facility: Phase II, Enhancing the financial resilience of Pacific Island Countries against natural disaster and climate risk*, http://pubdocs.worldbank.org/en/178911475802966585/PCRAFI-4-pager-web.pdf
36 Joint Typhoon Warning Centre, https://www.metoc.navy.mil/jtwc/jtwc.html
37 US Geological Survey, https://www.usgs.gov/
38 Financial Protection Forum, *Pacific Catastrophe Risk Insurance Company (PCRIC) – What happens when a disaster strikes*, February 2019, https://www.financialprotectionforum.org/publication/pacific-catastrophe-risk-insurance-company-pcric-what-happens-when-a-disaster-strikes
39 SEADRIF, https://www.seadrif.org/
40 World Bank, *Southeast Asia Disaster Risk Insurance Facility (SEADRIF) Technical Briefing for Japanese Insurance Industry*, January 2019, https://www.worldbank.org/en/news/feature/2019/01/17/southeast-asia-disaster-risk-insurance-facility-seadrif-technical-briefing-for-japanese-insurance-industry-drmhubtokyo

Pandemic Emergency Financing Facility

The Pandemic Emergency Financing Facility (PEF) – a financing mechanism housed at the World Bank and currently sponsored by Japan, Germany and Australia – is designed to provide an additional source of financing to help the world's poorest countries respond to cross-border, large-scale outbreaks of disease. Launched in July 2017, the PEF arose from the experience of the devastating, cross-border 2014-15 West Africa Ebola outbreak, which claimed more than 11,000 lives. At the time, the world lacked appropriate financial mechanisms to drive resources for quickly escalating outbreaks. The PEF has a cash window and an insurance window.

The insurance window provides coverage of up to US$425 million to eligible countries for diseases that are listed by the World Health Organization (WHO) as likely to cause major epidemics if contagion spreads across national borders, including: pandemic influenza, SARS, MERS, Ebola, Marburg and Crimean Congo hemorrhagic fever, Rift Valley fever, and Lassa fever. The PEF has been triggered twice, for the 9th and 10th Ebola outbreaks, in 2018 and 2019 respectively. Payments of US$31.4 million in total have been made to fight Ebola in the Democratic Republic of Congo (DRC) - US$11.4m in 2018 and US$20m in 2019.[41]

Sub-sovereigns

There has in recent years been an uptick in sub-sovereign schemes offering protection at the state, province, municipal or city level. This reflects the urbanization trend. Globally, more than 54% of the world's population now resides in urban areas with that number projected to rise to 68% by 2050.[42] There is inevitably an associated increase in financial clout and decision-making power of city governments. Particularly at the city level, sub-sovereigns are taking greater responsibility for risk management and resilience.[43]

A proposed Philippine City Disaster Insurance Pool (PCDIP) developed by the Asian Development Bank (ADB) envisages that payouts for earthquakes or typhoons would be available to target cities within 15 business days of an insured event.[44]

A number of sub-sovereign insurance schemes have been provided at the provincial level. For example, the World Bank facilitated a program which provides 25 provinces in the Philippines with the equivalent of US$390 million in insurance against major typhoon and earthquake events.[45]

The People's Insurance Company of China and other Chinese insurance companies have partnered with global reinsurer Swiss Re to provide commercial natural disaster protection schemes in China. One covers 28 rural counties in Heilongjiang province,[46] and another covers seven prefectures in Guangdong.[47] In both cases, the maximum protection amounts to about US$350 million. In 2019, an agriculture natural catastrophe insurance program was launched to cover seven counties in Shangluo.[48]

41 World Bank, *Pandemic Emergency Financing Facility: Frequently Asked Questions*, May 2017, https://www.worldbank.org/en/topic/pandemics/brief/pandemic-emergency-facility-frequently-asked-questions
42 UN Department of Economic and Social Affairs, *68% of the world population projected to live in urban areas by 2050*, says UN, May 2018, https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html
43 See for example, the work of C40 Cities and its city members https://www.c40.org/
44 Asian Development Bank, *Philippine City Disaster Insurance Pool: Rationale and Design*, December 2018, https://www.adb.org/sites/default/files/publication/479966/philippine-city-disaster-insurance-pool-rationale-design.pdf
45 World Bank, *World Bank Doubles Philippines Natural Disaster Risk Insurance with US$390 Million in Coverage*, January 2019, https://www.worldbank.org/en/news/press-release/2019/01/14/world-bank-doubles-philippines-natural-disaster-risk-insurance-with-us390-million-in-coverage
46 Josh Chen, Swiss Re, *Enabling recovery: China's growing resilience to climate risks*, May 2019 https://www.swissre.com/risk-knowledge/mitigating-climate-risk/natcat-2019/enabling-recovery-china-growing-resilience-to-climate-risks.html
47 Reuters, *Swiss Re covers China's Guangdong against cyclone, rainfall losses*, October 2016, https://uk.reuters.com/article/swiss-re-china/swiss-re-covers-chinas-guangdong-against-cyclone-rainfall-losses-idUKFWN1CY0NJ
48 Josh Chen, Swiss Re, *Enabling recovery: China's growing resilience to climate risks*, May 2019, https://www.swissre.com/risk-knowledge/mitigating-climate-risk/natcat-2019/enabling-recovery-china-growing-resilience-to-climate-risks.html

Insurance Industry Development Goals for Cities

Part of the United Nations Environment Programme Finance Initiative (UNEP-FI), the Principles for Sustainable Insurance (PSI) initiative has articulated "Insurance Industry Development Goals for Cities",[49] a global action framework for the insurance industry to help make cities inclusive, safe, resilient and sustainable in line with the SDGs. These include:

— **Goal 6: Leverage data, risk analytics and technology** Possible actions: 6.1 Explore how data, risk analytics and technology can be improved and be more accessible, reliable and usable; and leverage them to enhance risk assessment and risk management services, insurance solutions, and investments.

— **Goal 7: Promote risk management, insurance and financial literacy** Possible actions: 7.1 Promote risk management, insurance and financial literacy to individuals, communities, businesses and local governments in order to better understand and manage risks.

Trends and challenges in public insurance programs

The Geneva Association, the leading international insurance think-tank for strategically important insurance and risk management issues, produced a 2017 report "The Stakeholder Landscape in Extreme Events and Climate Risk Management" which presents the complex stakeholder landscape and multi-stakeholder initiatives in extreme event and climate risk management – including many of the examples cited above – and highlights the major developments in expanding risk transfer and insurance over the last decade.[50]

That analysis indicated progress in four main areas:

1. Enhancing risk knowledge and expansion of risk assessment capacities to the public sector;
2. Promoting the integrated approach to disaster and climate risk management;
3. Developing solutions in disaster risk financing and risk transfer; and
4. Expanding innovative insurance products in the agriculture sector.

However, despite evident progress and achievements, the report's authors considered that multi-stakeholder engagement and related initiatives remain highly fragmented. The development of sustainable and scalable risk management practices could benefit from stronger strategic public-private partnerships that leverage stakeholders' strengths, avoid redundancies and align priorities.[51]

49 UNEP-FI, *The Insurance Industry Development Goals for Cities*, https://www.unepfi.org/psi/wp-content/uploads/2018/06/Insurance-Industry-Development-Goals-for-Cities.pdf
50 The Geneva Association, *The Stakeholder Landscape in Extreme Events and Climate Risk Management*, January 2017, https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public/stakeholder-landscape-in-eecr.pdf
51 Golnaraghi, M., Surminski, S. and Schanz, K. (2016) *An Integrated Approach to Managing Extreme Events and Climate Risks*, The Geneva Association, Zurich https://www.genevaassociation.org/media/952146/20160908_ecoben20_final.pdf

2

Transaction issues & technology-enabled solutions

2

Transaction issues & technology-enabled solutions

Although the ARC and CCRIF regional schemes cover different regions and (currently) respond to different types of peril (e.g. catastrophic drought in Africa; earthquake, tropical cyclone and excess rainfall in the Caribbean), they have in common the use of parametric triggers which rely on satellite data to enable rapid release of funds.

A number of sovereign risk transfer mechanisms rely on this type of high-tech application, sometimes built on "smart" contracts and/or blockchain, and using the power of cognitive computing to crunch large amounts of data from satellites or other sensors.

Parametric insurance – a disaster risk "first responder"

As described briefly above, more "traditional" indemnity insurance requires an assessment of the loss experienced by policyholders. In the context of (say) crop cover in a poor province, this type of assessment could be costly and impractical and could slow down the release of funding that is vitally important in the aftermath of a natural disaster or adverse weather event. Indemnity insurance also customarily has various conditions, exclusions and limitations which can introduce uncertainty and delay.

By contrast, parametric insurance products provide a near-automatic payout not on the basis of actual losses, but when a particular parameter (for instance, wind speed in certain locations, or total rainfall), an index of parameters or pre-modeled loss, reaches a pre-determined threshold.

To facilitate rapid disaster response, many of the schemes cited above operate on a parametric basis to make speedy claims payouts. For example, when the city of Shanwai was struck by super-typhoon Haima it received a payout from Swiss Re less than a week after the impact.[52] Such quick liquidity can enable early intervention to mitigate the worst effects of natural disasters and prevent longer term detriment to economic growth. For this reason, parametric insurance products are increasingly being sought by national and regional governments to form part of their disaster risk toolbox.

52 Swiss Re, *Swiss Re reinsures biggest natural disaster insurance programmes in China*, October 2016 https://www.swissre.com/our-business/public-sector-solutions/thought-leadership/biggest-natural-disaster-insurance-programmes-china.html

AXA Climate: A parametric company

AXA Climate (previously AXA Global Parametrics) offers parametric insurance and risk transfer solutions with a focus on weather and climate-related exposures. AXA Climate seeks to provide immediate protection to communities and businesses against climate risks, through parametric solutions.[53] For example, AXA Climate offers insurance against climate risk to crop production via a product called YIELD Protection. YIELD Protection uses regional reference yield as an index. The parties to the contract establish a trigger threshold below the five-year average in the region. In 2016, a prolonged heat wave period resulted in 40% crop shortfall in wheat production. After applying a pre-defined 10% deductible, a payout of 30% of the Sum Insured was transferred to the client within two weeks upon the publication of the results by a government agency.[54]

In September 2019, the first parametric agricultural insurance program was launched in Cameroon, by AXA Cameroon and AXA Climate in collaboration with the World Bank Group's Global Index Insurance Facility (GIIF)[55] working with local insurer ACTIVA Assurance. The project will insure the livelihoods of nearly 8,000 cotton growers in Northern Cameroon, covering them against low crop yield due to drought. The parametric insurance product features policies that will pay out based on satellite data that measures drought conditions in the covered areas.

"This innovative collaboration is directly aligned to our mission to provide immediate protection for communities against climate risks. Parametric insurance is instrumental in supporting growth of risk transfer solutions across emerging countries."

— Antoine Denoix, CEO of AXA Climate

53 Steve Evans, Artemis, *AXA's parametric unit rebrands to AXA Climate, adds new hires*, May 2019, https://www.artemis.bm/news/axas-parametric-unit-rebrands-to-axa-climate-adds-new-hires/

54 AXA Climate, *Products: Yield Protection*, https://www.climate.axa/products/yield/

55 The GIIF is a dedicated World Bank Group program that facilitates access to finance for smallholder farmers, micro-entrepreneurs, and microfinance institutions through the provisions of catastrophic risk transfer solutions and index-based insurance in developing countries. Funded by the European Union/ACP, the governments of Germany, Japan, and the Netherlands, GIIF has facilitated more than 4.6 million contracts, with $730 million in sums insured, covering approximately 23 million people, primarily in Sub-Saharan Africa, Asia, and Latin America and the Caribbean. See: International Finance Corporation, https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/financial+institutions/priorities/access_essential+financial+services/global+index+insurance+facility

Parametric products can be offered at the sovereign or 'macro' level where one or more governments are the purchaser(s) and beneficiary (see examples cited above). Parametrics also have important applications that can close the protection gap at the micro level (where products are targeted at and purchased by individuals and small enterprises, potentially with donor or government sponsorship or subsidy) or at the meso level (where mid-level groups, entities and other subnational organizations might be the main client and an alternative channel to deliver a form of protection to micro levels).[56]
All are facilitated by technology.

Parametric insurance products can be based upon a smart contract. Smart contracts are pieces of computer code that are designed to carry out tasks automatically in response to external triggers, such as receiving storm or flood data. They often use distributed ledger technology (DLT) (for example blockchain)[57] to record and enact the event. Smart contracts represent a "a set of promises, specified in digital form, including the protocols within which the parties perform on these promises" (Szabo, 1996) or "if X occurs, do Y" (Savelyev, 2017). Smart contracts can enable claim payments to be made automatically upon satisfaction of a parametric trigger. Blockchain and smart contracts might allow rapid response payments to flow automatically upon satisfaction of data points, often able to be analyzed only through the use of AI.

Skyline Partners[58]

Skyline Partners aims to provide commercially viable and affordable financial protections to underserved markets in order to close the insurance protection gap. Skyline uses technology and data to make parametric insurance more accessible and affordable to small and medium enterprises. The company uses smart contracts to make automatic payments to policyholders based on weather events such as flood or drought. The company's first product will be for tea farmers in India. Agriculture accounts for around 20% of GDP in India, which means there is great demand for parametric insurance products. Supply of such financial products is low whilst the penetration of smartphones is increasing, making digital distribution feasible. In Skyline Partners' Indian pilot, the distribution partner is an AgriTech company, which has a mobile app.

56 See: International Association of Insurance Supervisors (IAIS), *Issues Paper on Index-based Insurances, particularly in Inclusive Insurance Markets*, June 2018 https://www.iaisweb.org/page/supervisory-material/issues-papers/file/75169/issues-paper-on-index-based-insurances-particularly-in-inclusive-insurance-markets

57 Blockchain is a distributed ledger technology that records transactions between two or more counterparties in a tamperproof way that ensures records can be completely relied upon. Transactions are grouped in 'blocks' and each block is linked to prior and succeeding blocks, using the same cryptographic techniques.

58 Skyline Partners, https://www.skylinepartners.org/

A unique benefit of parametric products is that they can be designed to respond to harbingers of more destructive losses and provide anticipatory funding aimed at preventing misfortune from becoming catastrophe.[59] For example, parametric insurance can provide payment where a crop looks likely to fail (e.g. by reference to deviation in temperatures or rainfall in a certain area) so that relief structures are put in place prior to actual crop failure.

START Network, ARC Replica, and Senegal

Not only sovereigns, but humanitarian organizations are leveraging *ex ante* disaster funding through parametric insurance. For example, the START Network is an international network of 42 humanitarian organizations whose aim is to find smarter ways to improve the deployment of aid in emergencies.[60] One of the ways they are doing so is by supporting the development of parametric insurance policies to provide funding for humanitarian interventions in African nations at the first signs of drought. The first such climate risk insurance policy, called an "ARC Replica", was prepared for the World Food Programme (WFP)[61], funded by the German government and signed between WFP and ARC in 2018.

In September 2019, severe rainfall deficits and drought during the 2019 agricultural season in Senegal triggered the country's parametric insurance policy with ARC. ARC's software Africa RiskView, which underpins the ARC parametric model, alerted the Government of Senegal to the irregular and insufficient rainfall in the western regions of the country as early as August 2019. It warned that a minimum of 964,000 people would be affected by the rainfall deficit this year. ARC is set to pay US$22 million in total to cover losses due to resulting crop failures. The Government of Senegal will receive a minimum amount of US$12million. START Network will receive the balance of US $10million in line with its ARC Replica policy for Senegal.[62]

59 See, for example, the work of START Network https://startnetwork.org/start-fund/crisis-anticipation-window
60 START Network, https://startnetwork.org/about-us
61 WFP, *Climate risk insurance: Germany supports new initiative*, September 2018, https://www.wfp.org/news/climate-risk-insurance-germany-supports-new-initiative
62 Steve Evans, Artemis, *African Risk Capacity to pay Senegal $22m after drought triggers policy*, September 2019, https://www.artemis.bm/news/african-risk-capacity-to-pay-senegal-22m-after-drought-triggers-policy/

The 'basis risk' problem

What a parametric model gains in speed it may lose in accuracy, since actual damage on the ground may be more or less than the pre-determined payment ("basis risk"). Unlike indemnity insurance, with parametric insurance there is no assessment of the actual loss. Triggers must be properly designed so that payments aren't released when they aren't needed or in excess of the sum required,[63] or, conversely, to prevent the insurance policy failing to respond when it should, or paying out too little when compared with the actual loss.[64]

Examples of basis risk

Basis risk can arise due to unsuitable trigger design or false positives in input data. These examples highlight basis risk and the importance of accurate and up-to-date input data and models.

Overpayment
With FONDEN, payment parameters are based on the magnitude of the earthquake or the minimum pressure for a storm. A magnitude 8.1 earthquake struck off the coast of Mexico in September 2017 which triggered the parametric protection for the maximum sum of US$150 million, yet the nation suffered limited losses.[65]

Underpayment
In 2016, a policy issued to Malawi by ARC was not immediately triggered even though there was widespread crop failure. Subsequent investigations by ARC revealed that the model had performed as expected given its parameters and the satellite-based rainfall data used. Subsequently, ARC conducted extensive fieldwork and household surveys in partnership with Malawian technical experts. This work revealed that farmers had switched to a greater extent to growing a different type of crop than that assumed in the model. When ARC re-customized the Africa RiskView to correct this crop assumption, it resulted in the model outcome providing a reasonable representation of the situation on the ground.[66]

63 "perverse basis risk".
64 "adverse basis risk". For a detailed exploration of basis risk in parametric insurance, see International Association of Insurance Supervisors (IAIS), *Issues Paper on Index-based Insurances, particularly in Inclusive Insurance Markets*, June 2018, https://www.iaisweb.org/page/supervisory-material/issues-papers/file/75169/issues-paper-on-index-based-insurances-particularly-in-inclusive-insurance-markets
65 SCOR, *Combining Science & Technology to Enhance Insurability and Spur Innovation*, February 2019, https://www.scor.com/sites/default/files/2019_02_scor_focus_combining_science_and_technology_web.pdf
66 ARC, *PRESS RELEASE – Malawi to receive USD 8M insurance payout from African Risk Capacity* , November 2016, https://www.africanriskcapacity.org/wp-content/uploads/2016/11/EMBARGO-ARC-Press-Release-14-Nov-2016-ENG-FR.pdf

The potential for basis risk remains the oft-cited potential downside to insurance (and other) products with a parametric trigger. Since policyholders will pay for a risk premium commensurate with expected losses, parametric cover should approximate as accurately as possible the expected coverage by clients.

Regulators for consumer insurance products (offered at the micro or meso level) are understandably uncomfortable with the possibility of basis risk, as it may undermine consumers' and businesses' trust in the value of insurance and has the potential to leave policyholders out of pocket if their losses exceed the modeled payout. Consumer education can help policyholders better evaluate the benefits and costs of parametric insurance as compared to indemnity insurance; otherwise, lack of understanding about how and when a policy will respond has the potential to inflate consumer dissatisfaction and the perception of basis risk.[67]

Sovereigns with numerous competing budget pressures may be wary of risking the political or financial repercussions if a sovereign or sub-sovereign level insurance scheme does not respond as expected. Accordingly, a great amount of work and effort is spent by donors, insurers, governments and other project partners in ensuring that the trigger design for parametric products – the modeled extent and impacts of the loss-causing event – is as accurate as possible.

Advances in technology – whether the ability to gather data or to analyze it – have the potential to reduce basis risk dramatically. The increasing volume and granularity of risk-relevant data and improvements in analysis and modeling may reduce basis risk and enable ever-swifter, more accurate, and more cost effective parametric products to transfer sovereign and sub-sovereign risk and provide vital post-disaster liquidity.

Early vs accurate

When providing disaster liquidity to governments it may be most important to assess the likelihood of damage and what interventions will be needed to restore civil society, rather than to undertake any detailed damage assessment. In a disaster scenario, a small, early payment to provide immediate liquidity is potentially worth more in terms of recovery and damage limitation than a later, larger or more accurate payment that might be provided through indemnity insurance. It is arguable that in many instances - particularly for sovereign and sub-sovereign insurance schemes – a (limited) deviation between a parametric payment and actual loss may not be a particular issue, as long as some payment is released by operation of the trigger. Alternatively, to overcome the issue, there can be a hybrid trigger, with a parametric partial payment and later loss adjustment on an indemnity basis. Some schemes have a built-in or discretionary means for recalibration to be made if there is a gulf between the loss modeled to release payment and the actual loss suffered.

67 Lin, Xiao (Joyce) and Kwon, W. Jean, *Application of Parametric Insurance in Principle/Regulation-Compliant and Innovative Ways* (July 1, 2019), SSRN: https://ssrn.com/abstract=3426592 or http://dx.doi.org/10.2139/ssrn.3426592

Reducing basis risk – the role of technology

Reducing basis risk is considered vital to increasing sovereigns' confidence in parametric insurance solutions as a national or sub-national disaster financing mechanism and also in providing a broader and more accessible array of risk transfer products to citizens and businesses within the jurisdiction. Accurate data and loss modeling is key to ensuring that any gap between payments based on the modeled loss and the actual loss is as small as possible.

Historically, the lack of reliable data has been a challenge, especially where there is relative "data poverty" in emerging economies.[68] For example, the World Meteorological Organization (WMO) estimated in 2014 that an additional 4,000 to 5,000 basic meteorological observations were needed across the African continent.[69] In 2017 there were only 1,100 active weather stations across the 54 countries in Africa[70] and an indication that the limited number of weather stations was shrinking at that time due to inadequate government funding, maintenance costs and limited resources.[71]

The lack of available weather or natural hazard data and modeling capacity is why many sovereign schemes will also have a mandate to help fill the "risk knowledge gap" that often accompanies the protection gap.[72] For example, PCRAFI's stated role is to develop technical expertise in understanding earthquake and cyclone perils in the Pacific Ocean and to quantify the potential loss from these perils for its sovereign-state members in the region. Such risk management and mitigation is an important function and collateral benefit of public insurance schemes.

Increasingly, advances in technology mean that there are leaps and bounds in where and how relevant risk data is gathered: through the increasing use of sensors that are remote (by drones,[73] aerial platforms, or satellites) or earth-based (via weather stations or IoT). The ability to analyze such large volumes of data is also improving, with developments in data analytics and AI being coupled with the experience, tools and expertise of the insurance industry to better model and predict loss and damage.

These technologies have the potential to expand and unlock data about both climatic conditions and hazards, as well as the exposures and vulnerability of infrastructure, crops, property or populations, in order to make ever more accurate risk measurements and models. This will in turn enable greater understanding, quantification and transfer of risk. Improvements in the capture and analysis of risk-relevant data also mean there can be a broader range of geographies and types of perils that can be understood and insured.

Data from air and space: Earth observation

Earth observation (EO) is the process of acquiring observations of the Earth's surface and atmosphere via remote sensing instruments. Aerial observations from planes can provide the best data and resolution of imagery, but the costs of chartering planes and paying for pilots and technicians can restrict its use.[74]

68 Leidig M, Teeuw RM (2015) Quantifying and Mapping Global Data Poverty. PLoS ONE 10(11): e0142076. https://doi.org/10.1371/journal.pone.0142076 or http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0142076
69 Rogers, David P., and Vladimir V. Tsirkunov. 2013. *Weather and Climate Resilience: Effective Preparedness through National Meteorological and Hydrological Services*. Directions in Development. Washington, DC: World Bank. doi:10.1596/978-1-4648-0026-9. License: Creative Commons Attribution CC BY 3.0 https://openknowledge.worldbank.org/bitstream/handle/10986/15932/81113.pdf;sequence=1
70 Simmons D., BBC, *How missing weather data is a 'life and death' issue*, November 2017, https://www.bbc.co.uk/news/business-41967241
71 Simmons D., BBC, *How missing weather data is a 'life and death' issue*, November 2017, https://www.bbc.co.uk/news/business-41967241
72 Jarzabkowski, P., K. Chalkias, E. Cacciatori, R. Bednarek, (2018). Between State and Market: Protection Gap Entities and Catastrophic Risk. Cass Business School, City, University of London, 26th June 2018, https://www.cass.city.ac.uk/__data/assets/pdf_file/0020/420257/PGE-Report-FINAL.pdf
73 Also referred to as unmanned aircraft systems (UAS) or unmanned aerial vehicles (UAV).
74 ESA, *Newcomers Earth Observation Guide*, July 2019 https://business.esa.int/newcomers-earth-observation-guide

Drones are more cost-effective, but regulations and low carrying capacity can impose limitations. Satellites allow for reliable, global coverage, even above the most remote locations, enabling regular repeat collections of data (temporal resolution) over large areas (scale) and with fast turnaround.[75]

Amongst the most advanced of EO systems is Synthetic Aperture Radar (SAR) which transmits electromagnetic pulses towards the Earth's surface and detects return pulses to generate imagery. SAR is used for detecting ships and oil spills and for monitoring sea ice, deforestation, soil moisture, flooding and critical infrastructure. Most EO systems cannot detect through cloud cover, but SAR can: it is therefore particularly useful for mapping and monitoring the extent of flooding during major storm events. Lidar (Light Detection And Ranging) EO is based on the same principle as SAR but works in infrared, visible or UV wavelengths. Lidar can provide precise measurement of topographic features, penetrate through vegetation cover to highlight hazardous terrain and map coastal bathymetry down to depths of about 30 meters; Lidar can profile clouds, measure winds, study aerosols and quantify various atmospheric components.[76]

The Kenya Livestock Insurance Programme – parametrics, earth observation and mobile phones

An example of the interaction of various technologies, including remote sensing, and insurance is the Kenya Livestock Insurance Programme (KLIP),[77] the first government-backed livestock insurance scheme in Kenya, which was launched in 2016. The program is a collaboration between the Kenyan government, international donors, development organizations and the (re) insurance industry and has insured 30,000 vulnerable households. KLIP uses satellite imagery to assess the state of grazing conditions by measuring deviation in the color of ground vegetation with a measure called the Normalized Difference Vegetation Index (NDVI),[78] a means of observing whether there is live green vegetation.[79] When a certain NDVI threshold is reached, indicating drought conditions, insured farmers receive a lump sum payment – the majority via their mobile phones.[80]

75 London Economics, Value of satellite-derived Earth Observation capabilities to the UK Government today and by 2020: Evidence form nine domestic civil use cases, FINAL REPORT, July 2018, https://londoneconomics.co.uk/wp-content/uploads/2018/07/LE-IUK-Value-of-EO-to-UK-Government-FINAL-forWeb.pdf

76 See Office for Coastal Management, Digital Coast, Introduction to Lidar, https://coast.noaa.gov/digitalcoast/training/intro-lidar.html and NASA, NASA Airborne Science Program, https://airbornescience.nasa.gov/category/type/Lidar

77 Index-Based Livestock Insurance, https://ibli.ilri.org/index/; World Bank, Kenya's Pastoralists Protect Assets from Drought Risk with Financial Protection, November 2018, https://www.worldbank.org/en/news/feature/2018/11/05/kenyas-pastoralists-protect-assets-from-drought-risk-with-financial-protection

78 The Normalized Difference Vegetation Index (NDVI) which measures from space the 'greenness' of land, thereby detecting crop failures and drought, is critical for agriculture-related parametric models and can be sourced from Open Data government-backed satellite imagery sources, such as Landsat and Sentinel.

79 According to KLIP, NDVI fits a number of the prerequisites required for a data source to serve as an insurable index: it is cheap (in this case free) to procure; neither the insurer nor the insured can feasibly manipulate it; it is an objective measure; and it is auditable. Index-Based Livestock Insurance, https://ibli.ilri.org/index/

80 Mumenthaler C., Group Chief Executive Officer, Swiss Re Group, Wold Economic Forum, *Tech-driven insurance solutions to help bridge the $180 billion protection gap*, January 2018, https://www.weforum.org/agenda/2018/01/tech-driven-insurance-solutions-to-help-bridge-the-usd-180-billion-protection-gap/

EO can also be used for geohazard risk management,[81] for example, a project funded by the European Space Agency (ESA) and the World Bank worked with partners in St Lucia, Grenada and St Vincent and the Grenadines to support landslide hazard assessment.[82]

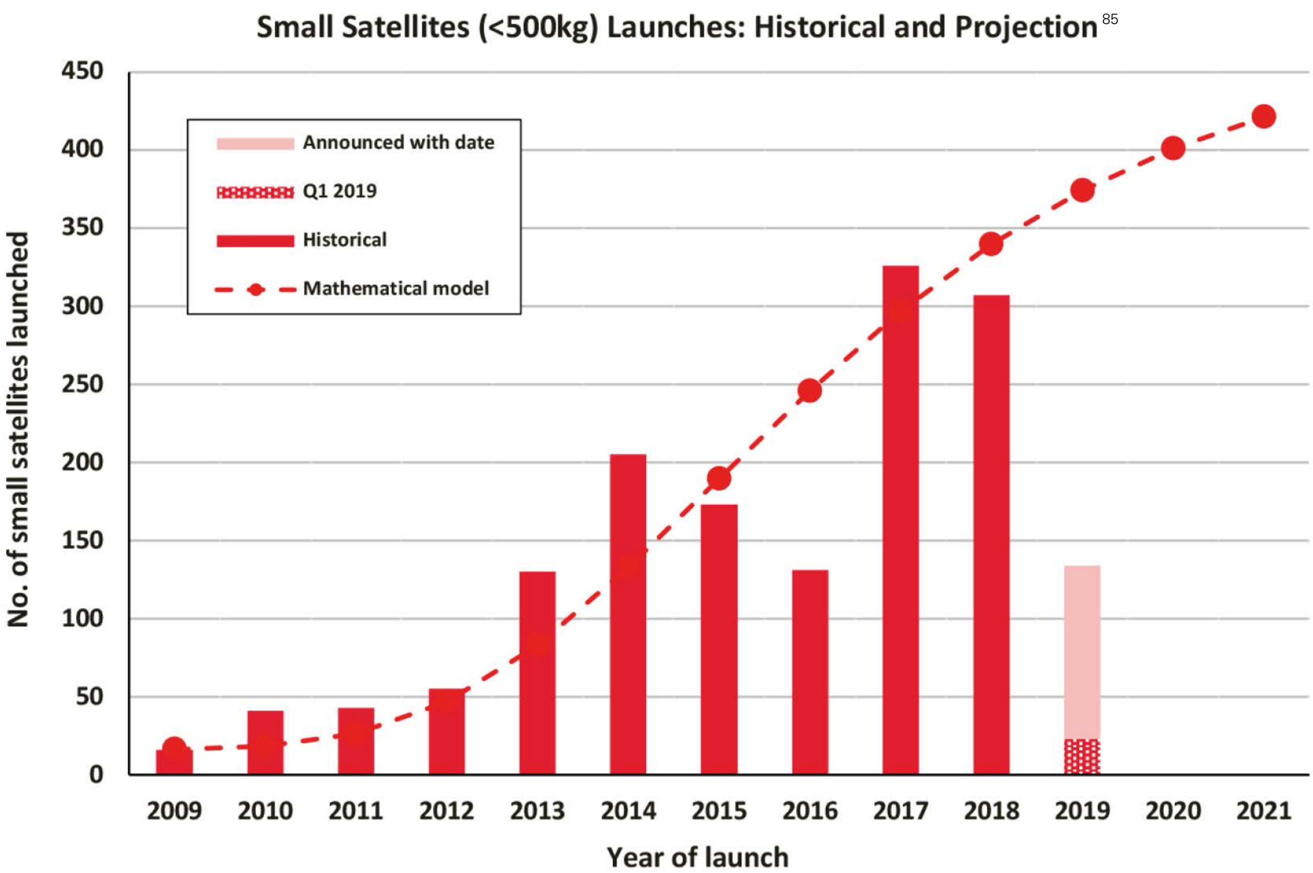
Advances in satellite EO technology include improved on-board processing and improvements in camera technology which permit better spatial resolution, greater data storage and transfer capacity, standardization and higher reliability. There is also a move from a few large, complicated and costly EO satellites to "mega constellations" of numerous small and relatively cheap satellites. There will soon be a proliferation of EO data from commercial satellites benefitting from reduced launch costs and the miniaturization of technology (such as "small satellites", or "nanosatellites" which can weigh as little as 1kg).[83] The next generation constellations of satellites will greatly enhance both the spatial resolution and temporal frequency of EO data. Massive capacity, low cost, as well as accessible and ubiquitous service will coalesce to create increasingly better coverage and revisit time, enabling near-real time EO monitoring.[84]

81 Jordan C., Head of Earth & Planetary Observation & Monitoring, *Remote Sensing to Manage Geohazard Risks*, September 2016, http://rspsoc.org.uk/images/5_Jordan.pdf

82 World Bank, Caribbean Islands - Land Use Land Cover (LULC), June 2016, https://datacatalog.worldbank.org/dataset/caribbean-islands-land-use-land-cover-lulc; See also, World Bank (WBG) - European Space Agency (ESA) Database, https://datacatalog.worldbank.org/group/world-bank-wbg-european-space-agency-esa-database

83 Singh I., Geospatial World, *What are nanosatellites and why do they matter?*, October 2016, https://www.geospatialworld.net/blogs/nanosatellites-or-small-satellites-are-going-to-play-a-big-role/; Alen, A Basic Guide to Nanosatellites, https://alen.space/basic-guide-nanosatellites/#grande; OECD, The Space Economy in Figures How Space Contributes to the Global Economy https://www.oecd-ilibrary.org/sites/bd1505f8-en/index.html?itemId=/content/component/bd1505f8-en&mimeType=text/html

84 ESA, *Newcomers Earth Observation Guide*, July 2019 https://business.esa.int/newcomers-earth-observation-guidehttps://business.esa.int/newcomers-earth-observation-guide



85 Satellite Applications Catapult Limited, Small Satellite Market Intelligence Report, 2019, https://s3-eu-west-1.amazonaws.com/media.newsa.catapult/wp-content/uploads/2019/05/30124810/19052056-Small-Sat-Market-Intelligence-report-Q1-2019.pdf

Some interesting new missions and EO platforms include:[86]

- **ICEYE** – an 18 SAR microsatellite constellation with the ability to image any location on Earth every 1-3 hours[87]
- **HAPS** – high-altitude pseudo-satellites which are un-crewed airships, planes or balloons watching Earth from the stratosphere as an intermediate sensor between airborne and space-borne imaging[88]
- **Copernicus High Priority Candidate Missions** – which include methods of measuring biodiversity and soil moisture, sea-surface temperature, and atmospheric carbon dioxide. The sheer volume and quality of freely available satellite data since the launch of the Copernicus Missions has made many applications much more affordable and accessible[89]
- **Landsat-9** – NASA's Landsat program offers the longest continuous global record of the Earth's surface. Landsat-9 is the long-term replacement for Landsat-7 scheduled for a 2020 launch. Landsat-9 will continue the Landsat mission of monitoring land use and land use change[90]

The increasing number of small satellites now enables daily coverage and consequently mitigates issues previous remote sensing had with cloud cover because the likelihood of getting a cloud-free scene over a given area significantly increases. It also represents a huge step forward compared to the 8 to 16 days revisit time of more traditional systems, such as the Landsat sensors. Moreover, radar nanosats such as ICEYE[91] will not only improve the spatial resolution to sub-meter levels, but also reduce the revisit time to a few hours.

For example, Spire[92] is a weather satellite constellation that uses a Low Earth Multi-Use Receiver (LEMUR) CubeSat platform to track maritime, aviation and weather activity from space. Measuring 10x10x34.5 cm and weighing less than 5kg, the LEMUR is powered by a deployable solar array, flying at 400-650 km in orbit for about 2 years. Spire uses small, power-efficient sensors and by staying in Low Earth Orbit (LEO) Spire can pass over each place on Earth hundreds of times per day. Video satellite constellations like Earth-I[93] and Sen[94] will enable streaming of high definition real-time video of the Earth from space.

86 With thanks to Christophe Christiaen of Satellite Applications Catapult for his input on new missions and applications in remote sensing.
87 ESA, *ICEYE*, https://earth.esa.int/web/guest/missions/3rd-party-missions/current-missions/iceye
88 ESA, *Could High-Altitude Pseudo-Satellites Transform the Space Industry?*, November 2018, https://www.esa.int/Our_Activities/Preparing_for_the_Future/Discovery_and_Preparation/Could_High-Altitude_Pseudo-Satellites_Transform_the_Space_Industry
89 ESA, *Candidate Missions*, https://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Candidate_missions
90 NASA, Landsat Science, *Landsat 9*, https://landsat.gsfc.nasa.gov/landsat-9/
91 ICEYE, https://www.iceye.com/
92 Spire, https://spire.com/en/solutions/weather-ro-data
93 Earth-I, https://earthi.space/about/
94 Sen, https://www.sen.com/

Planet – a "Queryable Earth"

Planet (formerly Planet Labs) is a commercial satellite company founded by ex-NASA scientists with the stated goal of "using space to help life on Earth". With 150+ satellites in orbit, Planet can image the Earth daily at 3 meter and 72 centimeter resolutions. Using Planet's high resolution images and change alerting, insurers and others can monitor assets and analyze before, after, and ongoing imagery of events to quantify disaster spread and assess damage. Planet's aim is for a "Queryable Earth" by indexing physical change on Earth and making it searchable with questions like "How many new buildings were developed this month in India?" or "How many square-kilometers of crops were impacted by the hail storm in Kansas last week?".[95]

Data from Earth: Weather stations and IoT

Another source of data to inform risk modeling is through land-based sensors. IoT is unlocking new data sources from smart phones, vehicles and other sensors embedded in everyday objects. For example, the average smart phone will have at least five sensors including temperature, pressure, moisture and light sensors as well as location and motion sensors such as GPS, accelerometers and gyroscopes. If weather-relevant data can be extracted and analyzed from IoT, it could lead to even more accurate and locally relevant weather risk analysis and forecasting.

The proliferation of weather stations, too, is going to have an impact. The WMO's Global Observing System includes approximately 11,000 stations on land, making observations at or near the Earth's surface of meteorological parameters such as atmospheric pressure, wind speed and direction, air temperature and relative humidity.[96] Weather Underground[97] and Natamo[98] are global communities of people providing "hyperlocal" data by connecting data from environmental sensors, such as weather stations and air quality monitors. CN Rail in Canada and other rail carriers (for example, Amtrak in the US) are using micro-weather stations to help identify flooded tracks and wind conditions that require adjusted operations and which aren't covered by traditional weather tracking or reporting measures. The price of such systems is dropping, which will lead to increased uptake and more use cases.

95 Marshal W., Planet, Queryable Earth: Our Vision for Making Daily Global Imagery Accessible and Actionable, July 2018, https://www.planet.com/pulse/queryable-earth-our-vision-for-making-daily-global-imagery-accessible-and-actionable/
96 The GOS also includes upper-air, marine, aircraft-based, satellite, radar and other observation platforms; See World Meteorological Organisation, Global Observing System, https://public.wmo.int/en/programmes/global-observing-system
97 Weather Underground, https://www.wunderground.com/pws/overview
98 Natamo, https://www.netatmo.com/en-gb/weather/weatherstation

IBM GRAF

Expected in 2019 is IBM's launch of the Global High-Resolution Atmospheric Forecasting System (GRAF) which pulls together previously untapped sources from millions of sensors worldwide, including in-flight data; it is the first commercial weather system to include wind speeds and temperature readings taken by sensors on airplanes around the world.[99] This is made possible through a relationship with FlightAware, which works with airlines and air traffic control stations globally to collect 10 million high-altitude data points from aircraft every day. Each plane transmits readings every 5 seconds while flying through the atmosphere at 500-600 miles per hour. GRAF will utilize 3.5 petabytes of capacity from the IBM Elastic Storage Server. The model updates hourly and is designed to predict something as small as a thunderstorm virtually anywhere on the planet.[100]

ClimaCell

ClimaCell[101] is an InsurTech start-up and part of the third cohort of the Lloyd's insurance market's innovation accelerator at Lloyd's Lab in London.[102] ClimaCell takes an IoT approach to weather observation by tapping into multiple connected network layers to extract weather data, creating proprietary "MicroWeather" data aimed at providing hyper-accurate local forecasts. ClimaCell has partnered with Current by GE[103] to gather data from IoT sources and enable better "nowcasting".

99 The Weather Company, *IBM GRAF Weather System: Vastly Improving Global Forecast*s, January 2019, https://business.weather.com/blog/new-weather-system-improved-forecasting-around-the-world
100 The Weather Company, *IBM GRAF Weather System: Vastly Improving Global Forecasts*, January 2019, https://business.weather.com/blog/new-weather-system-improved-forecasting-around-the-world
101 ClimaCell, https://www.climacell.co/
102 Lloyd's of London, *InsurTechs selected to help support the Future at Lloyd's*, August 2019, https://www.lloyds.com/news-and-risk-insight/press-releases/2019/08/insurtechs-selected-to-help-support-the-future-at-lloyds
103 GE Current, https://www.currentbyge.com/

Data analytics – making sense of risk-relevant data

The amount of data generated from satellites and IoT is already far more than humans can analyze and it's growing exponentially: satellites are sending terabytes of images of our planet on a daily basis. Having volumes of raw data is not enough; once data is gathered, it needs to be analyzed.

Here, too, advances in technology - storage capacity, computation capacity as well as software and techniques - are enabling greater precision and speed in interpreting the vast data being generated. At the moment, imagery analytics and interpretation is often performed by human analysts and at great expense. That is set to change with advances in AI enabling greater and faster analysis and more decision-useful information for businesses and governments at a cheaper price.

There have been rapid advances in "machine-vision" or "computer-vision", with neural nets such as FasterRCNN[104] and YOLO[105] improving object detection and now able to identify cars, buildings, or changes in landscape over time. With "change detection", an algorithm creates a map wherein changed areas are separated from unchanged ones. Change detection has applications in crop and land use monitoring, urban infrastructure, environmental and humanitarian crisis monitoring. Automated change detection after a catastrophic event can enable a rapid assessment of the extent of damage, validate claims, aid recovery planning and inform first responders.

The vast amount of land surface change information collected by EO satellites since the 1980s – "Big Earth Data" – has recently been analyzed using so-called "Data Cube" technologies.[106]

EO Open Data Cube enables automated detection and monitoring of many natural hazards over many decades (e.g. landslides, flood-prone areas, coastal erosion), with summary Analysis Ready Data (ARD) produced for emergency planners and policymakers.[107] One of the most effective systems of Data Cube processing of large archives of satellite imagery is Google Earth Engine.[108] An example of the application of Google Earth Engine, in conjunction with other data sources, is Global Forest Watch, an online platform that allows anyone to access near real-time information about where and how forests are changing around the world.[109]

104 Ren S., He K., Girshick R., Sun, J., Microsoft Research, *Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks*, https://papers.nips.cc/paper/5638-faster-r-cnn-towards-real-time-object-detection-with-region-proposal-networks.pdf

105 Chablani M., *YOLO — You only look once, real time object detection explained*, August 2017, https://towardsdatascience.com/yolo-you-only-look-once-real-time-object-detection-explained-492dc9230006

106 Committee on Earth Observation Satellites, *The 1st CEOS Open Data Cube Workshop*, 2017 http://ceos.org/home-2/1st-ceos-open-data-cube-workshop/

107 Giuliani, G., Chatenoux, B., De Bono, A., Rodila, D., Richard, J-P., Allenbach, K., Dao, H. & Peduzzi, P. (2017) *Building an Earth Observations Data Cube: lessons learned from the Swiss Data Cube (SDC) on generating Analysis Ready Data (ARD), Big Earth Data*, 1:1-2, 100-117, https://doi.org/10.1080/20964471.2017.1398903

108 Google Earth Engine, https://earthengine.google.com/

109 Global Forest Watch, https://www.globalforestwatch.org/

CommonSensing for small island developing states (SIDS)

CommonSensing - a project funded by the UK Space Agency - is developing Open Data technologies, with an initial project to assist the governments of three Small Island Developing States (SIDS): Fiji, the Solomon Islands, and Vanuatu.[110]

The CommonSensing project is also developing training materials for climate change resilience uses of EO Open Data layers in SIDS. The aim is to improve the information management capacity of SIDS, enabling their national disaster management agencies to be better prepared for and respond faster to disasters, thus mitigating impacts. Once the Data Cube and tools are in place, there will be further applications.

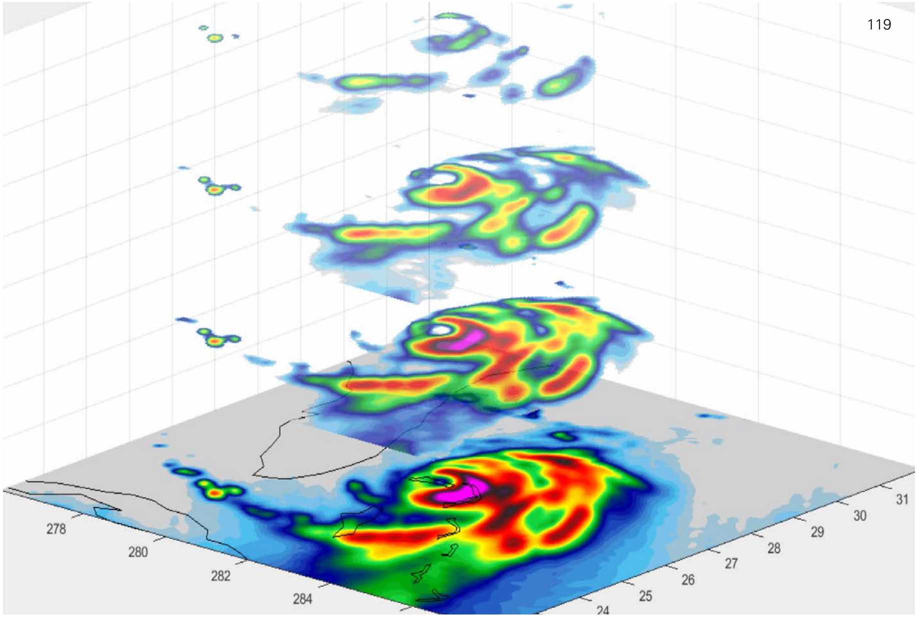
Reflecting the importance of data analytics, there is a move in the satellite industry from simply providing images to providing user-friendly access and analytics platforms, such as SentinelHub,[111] Descartes Labs,[112] and Ursa Space.[113] NASA's Landsat programs contain more than 40 years of global historical earth observations, which means data is available through Landsat for areas where no ground-level data was ever collected.
This is being leveraged by companies like Mantle Labs[114] and Vandersat[115] to create risk profiles of agricultural land in developing countries based on historical observed satellite data that can, in turn, inform credit and insurance products.

Such data analytics value-added services are predicted to grow quickly in the coming years.[116] However, there are still limitations. For quicker events, satellites cannot capture sufficiently frequent time samples. In addition, real-time precipitation analysis does not (yet) have enough spatial coverage and resolution and current AI tools are not particularly well-designed for satellite imagery as they are not optimized to see very small objects in very large images.[117]

110 SIDS: in this case, Fiji, Vanuatu and the Solomon Islands) with climate change resilience and climate finance initiatives; UN Institute for Training and Research, *CommonSensing: Building Climate Resilience in Small Island Developing States*, February 2018, https://reliefweb.int/report/world/commonsensing-building-climate-resilience-small-island-developing-states
111 Sentinel Hub, https://www.sentinel-hub.com/
112 Descartes Labs, https://www.descarteslabs.com/
113 Ursa Space, https://www.ursaspace.com/
114 Mantle Labs, http://www.mantle-labs.com/
115 Vandersat, https://www.vandersat.com/
116 Komissarov V., Spacenews, *Op-ed | How will the Earth-observation market evolve with the rise of AI?*, February 2018 https://spacenews.com/op-ed-how-will-the-earth-observation-market-evolve-with-the-rise-of-ai/
117 Komissarov V., *AI Applications for Satellite Imagery and Satellite Data*, May 2019, https://emerj.com/ai-sector-overviews/ai-applications-for-satellite-imagery-and-data/

CubeSat and Hurricane Dorian

Known as a "CubeSat" and the size of a box of cereal, TEMPEST-D (Temporal Experiment for Storms and Tropical Systems Demonstration) is an experimental NASA weather satellite that uses a miniaturized version of a microwave radiometer: a radio wave instrument used to measure rain and moisture within clouds. TEMPEST-D will reduce the risk, cost and development time of a future constellation of nanosatellites to directly observe the time evolution of clouds and study the conditions that control the transition from non-precipitating to precipitating clouds.[118]



[119]

On 3 September 2019 TEMPEST-D was deployed to analyse Hurricane Dorian as it approached Florida. TEMPEST-D produced images of multiple vertical layers of the storm, showing where the strongest convective "storms" within the hurricane were pushing high into the atmosphere and indicating where the rainfall was heaviest. TEMPEST-D could lead to a train of CubeSats that work together to track storms around the world, improving local storm coverage and forecasting data.

118 NASA, *Temporal Experiment for Storms and Tropical Systems Demonstration* (TEMPEST-D), https://www.jpl.nasa.gov/cubesat/missions/tempest-d.php

119 NASA, *An Inside Look at Hurricane Dorian from a Mini Satellite*, September 2019, https://www.jpl.nasa.gov/news/news.php?feature=7494

Risk modeling and mapping

Innovations in EO and cognitive computing are not a standalone silver bullet, but need to be integrated as part of the broader suite of existing datasets, risk modeling instruments and methodologies that have been developed by the insurance industry and others. With the ability to crunch large volumes of data provided by data analytics and AI, risk modeling and mapping is becoming increasingly sophisticated. At the same time, the costs of such models are likely to significantly decrease as datasets and software are shared as open source resources.

A number of countries provide governmental datasets on an open basis; see, for example the US's Data.gov website.[120] Initiatives like the Open Data Institute (ODI)[121] and GODAN (Global Open Data for Agriculture & Nutrition)[122] seek to promote sharing of open data generally, or around particular issues relevant to global human society. In the case of GODAN, project partners - national governments, non-governmental, international and private sector organizations - promote making information about agriculture and nutrition available, accessible and usable in order to deal with the urgent challenge of ensuring world food security. NASA's Global Flood Monitoring System provides real-time satellite data and hydrological runoff analysis as an online resource[123] and the OpenQuake Platform[124] by the Global Earthquake Model Foundation[125] allows modeling analysts to share datasets and tools to assess earthquake risk. The Africa RiskView software used by ARC risk pool can be freely accessed by employees of national governments or organizations that have entered into its Software License Agreement.

Over the last 30 years Catastrophe (CAT) Loss Modeling, arguably the first "InsurTech" offering in the form of innovative tools ("Cat models"), has transformed (re)insurance industry's capacity to assess, price and manage risk for Property Catastrophe business and has provided a shared common language for risk transfer. Today, Cat models are used across the world, addressing a growing suite of hazards for an increasing number of countries.[126]

An insurance industry initiative, the Oasis Loss Modelling Framework[127] provides an open source platform for developing, deploying and executing Cat models. Models are packaged in a standard format and the components can be from any source, such as model vendors, academic and research groups. The Wave is an international project sponsored by Oasis with the aim of creating more openness, interoperability and lowering the costs of risk modeling and data. The Wave brings together international stakeholders across industries to collaborate and pool resources to offer the most cost-effective way of understanding risk.[128] The Insurance Development Forum (IDF) via its Risk Modeling Steering Group (RMSG) 'interoperability project' is working with Oasis to create an industry-owned, platform-independent exposure data standard and open-source toolkits to convert between different platform formats.[129]

120 U.S. Government's open data, https://www.data.gov/
121 Open Data Institute, https://theodi.org/
122 Global Open Data for Agriculture & Nutrition, https://www.godan.info/what-is-godan
123 Wu H., *Global Flood Monitoring System (GFMS) - Real-time quasi-global hydrological calculations at 1/8th degree and 1 km resolution*, http://flood.umd.edu/
124 OpenQuake Platform, https://platform.openquake.org/
125 Global Earthquake Model Foundation, https://www.globalquakemodel.org/
126 Golnaraghi, M., Nunn, P., Muir-Wood, R., Guin, J., Whitaker, D., Slingo, J., Asrar G., Ian Branagan, I., Lemcke G., Souch C., Jean, M., Allmann, A. , Molly, J., Bresch, D., Khalil, P. and Beck, M. *Managing Physical Climate Risk: Leveraging Innovations in Catastrophe Risk Modelling*, 2018 https://www.genevaassociation.org/research-topics/extreme-events-and-climate-risk/managing-physical-climate-risk%E2%80%94leveraging
127 Oasis Loss Modeling Framework, https://oasislmf.org/
128 Oasis, The Wave, https://oasislmf.org/the-wave
129 Oasis, *Oasis Gathering Pace*, https://oasislmf.org/news/oasis-gathering-pace

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We are about deep collaboration, knowledge mobilization and choice. Please engage with Oasis and its partners for the benefit of all.

Dickie Whitaker, Chief Executive, Oasis Loss Modelling Framework[130] ”

Oasis Platform for Climate and Catastrophe Risk Assessment – Asia

Oasis is co-developing new and open catastrophe risk models for flood in the Philippines and cyclone in Bangladesh and analyzing the impacts of climate change. The models are being developed on the open source Oasis Loss Modelling platform described above.

The project is supported by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), bringing together a multinational public-private partnership to build solutions to understand and manage the increasing costs of disasters.[131]

As with other technological disruption, it seems likely that with an ever-growing range of applications and users and an increased rate of knowledge-sharing, the accuracy of risk modeling will increase and the costs decrease.

Better, more widely available and more detailed information will enable sovereign insurance scheme collaborators, including donors, governments and reinsurers to quantify risk, so that it can be understood, adapted to, and, if necessary, transferred to capital markets. With a more forensic view of risk, insurance can be offered for a wider range of exposures and with more accurate pricing. With better mapping of hazards and an understanding of their effects through models, governments can prepare for disaster, mitigate exposures, and target funds most effectively towards resilient infrastructure. These advances should also lead to steady improvements in the accuracy of parametric triggers, and thus significantly reduce basis risk for parametric solutions.

130 Oasis, *Oasis Gathering Pace*, https://oasislmf.org/news/oasis-gathering-pace
131 International Climate Initiative, *Oasis Platform for Climate and Catastrophe Risk Assessment* – Asia, August 2019, https://www.international-climate-initiative.com/en/nc/details/project/oasis-platform-for-climate-and-catastrophe-risk-assessment-asia-18_II_165-3018/

Tech-enabled insurance: legal, regulatory and policy issues

3

3

Tech-enabled insurance: legal, regulatory and policy issues

Rapid technological change and disruption can give rise to unique legal, regulatory and policy issues.

Law and regulation relies on categorization, and new technologies, tech-enabled partnerships and new market players can defy regulatory or legal categories. For commercial products offered at the micro or meso level, a key aim for national regulators is to find a proportionate solution to regulation that achieves a balance between innovation and safety;[132] between growing the insurance market, thus closing the protection gap, whilst maintaining adequate protection for consumers. At the sovereign level, international agreement or standard-setting on data protection, cyber security, telecommunications regulation and air and space law may all be pertinent in the context of tech-enabled risk management and transfer.

The following is an overview of some of the legal, regulatory and policy issues that can arise.

Insurance law

Is it insurance?

Even though parametric insurance has an established track record in many countries, some regulatory and legal uncertainty remains. Parametric insurance products may not be addressed in law and statute. Regulatory frameworks for parametric products are usually not firmly codified and remain largely untested. In many common law jurisdictions, case law is yet to be established that would inform understanding of how these types of policies will operate and be legally enforced. Questions revolve primarily around two elements of what legally constitutes insurance: insurable interest and the indemnity principle.

Insurable interest. Parametric insurance products face legal uncertainty in jurisdictions where the insured must have an 'insurable interest' at the time the policy is underwritten and/or at the time the loss occurs.

Certainty and speed of payment are two of the key features that drive the perceived benefits of parametric insurance, so a requirement that the insurable interest is checked at point of claim could have a material impact on the attractiveness of such products. There could be a question around whether the purchaser has an insurable interest at all. It seems readily arguable that local, regional or national governments have an insurable interest in the effects of a natural disaster on their populations, since without insurance backing they would have to fund the cost of disaster response from state funds and could be expected to suffer losses, for example in tax revenue. A Non-Governmental Organization (NGO) might have plans in place to intervene in a crisis (for example if crops were to fail) even though it is not the NGO itself that is suffering the loss directly. Here the 'insurable interest' may be slightly more tenuous, although on balance such

132 The Geneva Association (2016), Harnessing Technology to Narrow the Insurance Protection Gap (Kai-Uwe Schanz and Fabian Sommerrock) https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public//harnessing-technology-to-narrow-the-insurance-protection-gap.pdf

a purchaser would likely be able to show a legitimate interest in the cover, rather than it representing a mere speculation. There is of course a wider social good in encouraging such innovative humanitarian relief and so countries may wish to take a proactive step to encourage or support these types of cover for NGOs that have operations within their jurisdiction.

Indemnity principle. There can also be uncertainty where there is a requirement in law or regulation for the size of the insurance payout to correspond to the actual loss suffered by the insured.

This 'indemnity principle' can mean that in certain jurisdictions an insurer must assess the amount of the insured's loss before claims can be paid. This could be impractical and would certainly delay payment. Whether the product provides an indemnity may have an impact on how a product is classified, regulated and taxed. If insurance law and principles are rigid and do not allow for non-indemnity, contingent benefit contracts and/or valued policies, it may be difficult for index-based insurance to be categorised as insurance and fall to insurance regulation or be provided by regulated insurers.

Does it matter?

It is possible that certain products which fall outside of legal strictures on the indemnity principle or insurable interest may be categorized as derivatives rather than insurance. What is in essence the same instrument can in many cases be framed either as insurance (where the customer has an insurable interest, and the provider is authorized as an insurer) or as a derivative. Derivatives offer the possibility in most jurisdictions to bypass the insurance indemnity/insurable interest issue as a means of bringing a parametric risk transfer product to market.

Professionals with the expertise required to model exposure and design a trigger can and do move between the two fields, and a number of insurance groups have divisions that design and issue derivative instruments. Insurance and derivatives can be used side by side. Alternatively, an insurer might issue a parametric insurance policy and hedge its exposure by purchasing a derivative, or pass the risk to capital markets through Insurance Linked Securities (ILS) products.

Insurance markets have huge potential access to capital but can be prohibited from providing products unless they are considered insurance.

Permitting a parametric product to be provided by either insurers or capital market providers may bring more providers to market, fostering competition and reducing cost.

In addition, derivatives may be regulated as a financial instrument that can be sold to professional customers only. As a result, categorizing products as derivatives may be a stumbling block for uptake by retail customers, government bodies or NGOs.

Legal categorization may not be a particular issue for sovereigns, which will usually simply agree specific exemptions for parametric products offered at the country level, but clarity on this may nonetheless be welcome to project partners. Providing regulatory and legal clarity around index insurance can also benefit countries that wish to increase uptake of such products by local insurance entities wishing to hedge weather or disaster risk, or for companies seeking to offer such products directly to consumers via mobile platforms (micro), or via an established local intermediary such as a community organization or NGO (meso), all of which may assist in closing the national protection gap by increasing the availability and range of insurance products.

Anticipatory triggers

There is potentially large social benefit from anticipatory triggers; if they are properly structured and priced, such products could operate to provide pre-emptive rather than reactive funding for natural catastrophe planning, humanitarian aid and response, and food security. For example, in the face of an incoming weather system, an index product with an anticipatory trigger based on offshore wind speed and direction could release funding for first responders to intervene immediately in the aftermath of the actual storm.

In Hong Kong, a parametric index insurance policy is available for corporations that would incur revenue losses due to a mandatory closure of their operations following a level 8+ typhoon warnings issued by the Hong Kong Observatory. Under the Extreme El Niño Insurance Product (EENIP) in Peru, the direct cause of loss is flooding during the February – April period. However, the pay-out is triggered based on the changes in the sea surface temperatures in November and December during the previous year. In this forecast insurance, the government uses the sea surface temperature as the predictor of flooding.[133]

Of course, there is an even higher basis risk where the actual event remains contingent at the 'strike moment' for the index-based product to release funds.

There may need to be in-built contractual mechanisms for sequestering or reinvesting funding made available and not deployed in such circumstances. In addition, it may be even more challenging in some jurisdictions to understand that a product with an anticipatory trigger is insurance. Where a fortuity is anticipated and its effects minimized and mitigated, potentially in full, by an early payment there may at the most extreme end of the spectrum be no "loss" to indemnify. Supervisors will need to balance the potential benefits of such products with the definitional challenges under insurance law and concerns regarding wagering. It may be necessary, for example, for regulators and legislators to consider potential carve-outs from insurance law to enable payments to prevent or reduce losses to qualify as 'insurance' in order to bring such products within in the insurance regulatory fold.

133 With thanks to W. Jean Kwon, School of Risk Management, St John's University for highlighting these examples of anticipatory triggers.

Insurance regulation

Does the existing regulatory structure welcome new players and partnerships?

With new technologies, new market entrants – such as mobile network operators, commercial satellite companies and tech firms – may become involved in the insurance and risk management value chain as insurance intermediaries or risk-carriers. Novel entities and partnerships can defy regulatory categorizations, and may require equally novel solutions from national regulators. Companies that have not previously had exposure to the insurance industry are finding that their applications have an important insurance "use case", but may not be familiar with existing regulatory and legal strictures around insurance provision. Also, entirely new types of technology-enabled products or distribution mechanisms may be developed that are not readily adaptable to existing regulatory categories.

A number of national insurance and financial services supervisors and regulators have adopted regulatory "sandboxes" or other "test-and-learn" approaches to enable new market players or tech-enabled products to be trialed in a supportive regulatory environment. This assists regulators in understanding how best to regulate innovative insurance whilst permitting and supporting innovation. There is a need for supervisors to take flexible approaches to nurture and accommodate technological advancements, which can move faster than the ability of legislators and supervisors to implement new laws and/or change existing regulatory frameworks. One approach might be for supervisors who are in the process of considering regulatory frameworks to have a built-in flexibility that permits case-specific directives or provisions to be issued on an ongoing basis. These issues are most relevant for products provided by private companies to consumers and of less relevance for sovereign risk transfer.

A further question is how public insurance schemes will be licensed, monitored and supervised on an ongoing basis given the public-private and national-international nature of these partnerships. Supervisors and governments will need to consider carefully how pilot programs are regulated, to ensure core principles of insurance supervision are maintained in the interest of financial stability and policyholder protection.[134]

Is there a risk of regulatory duplication or arbitrage?

For innovative insurance solutions offered commercially at the sub-sovereign level, regulatory overlap can also be an issue, with telecommunications, insurance or other financial regulators all potentially involved in a single application of technology in insurance. In many jurisdictions, such regulatory duplication creates uncertainty, which in turn can increase costs and stifle innovation, inhibiting insurers from entering the market or local innovators from thriving. Improving the situation might call for a refresh of the existing regulatory architecture, better coordination amongst regulators at a national or sub-national level, or guidance to educate market players or to smooth regulatory requirements. Legislators may need to provide for a clear delineation between the remit and priorities of regulators.

134 International Association of Insurance Supervisors, *Insurance Core Principles*, https://www.iaisweb.org/page/supervisory-material/insurance-core-principles

Are regulatory requirements designed for a digital age?

In some jurisdictions there may be existing requirements for insurance contract formation that hamper innovation; for example, requirements for insurers to provide proof of cover in paper format or for insureds to physically sign the policy document. This can cause issues for underwriting and distribution for some tech-enabled consumer products. In many countries, regulation still stipulates that mobile money accounts be linked to bank accounts, which can mean that the potential for mobile payment systems are minimized. Regulatory reforms which enable the digitization of client data and electronic payment systems as well as the creation of national databases which leverage individual biometrical data, are important for capturing the full potential of mobile microinsurance.[135] There may be specific legislative requirements governing distance selling and conclusion of contracts over the internet or mobile networks which may not be adapted to current or nascent technologies. Insurance regulators may need to consider and gain familiarity with new aspects of regulation in order to manage cyber risks and ward against digital fraud.

Is there scope for regional coordination and harmonization?

As insurers operate across jurisdictions it may be helpful wherever possible if insurance supervisors can join up regulatory approaches. Some regional initiatives have sought to establish cross-border collaborations, with regulatory responses deployed across jurisdictions to streamline bringing to market tech-enabled risk transfer and management solutions within a region. Regionally-relevant approaches to pilot programs (potentially designed around risks such as earthquake or tsunami in the ring of fire, drought in sub-Saharan Africa or flooding in Southeast Asia) could be fostered through effective collaboration between supervisors. A formalization of regulatory approvals can pool resources in understanding new technology, sharing knowledge and know-how to ensure greater transparency for insureds, reducing costs for insurers in approaching new markets, and thereby reducing costs of market entry. For example, a cross-jurisdictional approach to index-based insurance could provide a framework for future international collaboration to adopt and regulate novel forms of risk transfer. The next horizon enabled by technology may well require further coordinated cross-jurisdictional inputs from regulators and collaboration where possible to ensure transparency, accountability and appropriate taxation.

Taxation

There is a need for clarity on what taxation regime applies to sovereign insurance schemes and/or tech-enabled products. Where a product purchaser is a sovereign or sub-sovereign it may not make sense to add insurance premium tax on top of the cost for the product, and may require suitable carve outs in national legislation, or discussions and agreement between different parts of government (national/state, for example) to ensure that every dollar spent by a sovereign, sub-sovereign or city can be risk-bearing.

135 Prashad, P., Saunders, D. and Dalal, A. (2013) *Mobile Phones and Microinsurance, Microinsurance* Paper No. 2, Geneva: International Labour Office, http://www.impactinsurance.org/sites/default/files/MP26%20v3.pdf; The Geneva Association (2016), *Harnessing Technology to Narrow the Insurance Protection Gap* (Kai-Uwe Schanz and Fabian Sommerrock) https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public//harnessing-technology-to-narrow-the-insurance-protection-gap.pdf

Data protection and cyber security

Is personal data protected?

Perhaps the most important issue to consider when developing tech-enabled risk transfer solutions is data protection, particularly in respect of personal data - data that identifies a living individual. Insufficient privacy protections will harm consumers and erode trust, while overly strict regulation can limit the benefits of data to society.[136] Where devices or services process personal data, they will need to do so in accordance with applicable data protection law, such as the EU's General Data Protection Regulation (GDPR). There may be overlapping regulations where data crosses borders and so international agreement and harmonization can be important in this area.[137]

The way that data is regulated can limit its usefulness in disaster response and there are necessarily trade-offs between enhancing risk management and protecting personal data. In a study done in the aftermath of Hurricane Odile in Mexico in 2014, information about population movements was analyzed using big data to understand financial transactions before, during and after the Hurricane. This permitted an understanding of the economic impact on those most affected which could be used to target post-disaster assistance. The data was anonymized and aggregated in conformance with Mexican data protection laws so that individuals could not be identified. However, it is reported that the value of analysis suffered because of such anonymization.[138]

During the Ebola epidemic in West Africa mobile operators refused to share call data records due to possible legal exposure, because of a lack of clarity regarding data privacy.[139]

Who owns and can use data?

Specific policies may need to be in place regarding ownership of data generated before and during disasters. Data generated by satellites can be analyzed and modeled by insurance industry partners or loss modelers. Project participants will need to consider how data is anonymized (and any limitations for use which arise as a result) and whether it can be shared with others, or contains or has generated through data analytics sensitive information related to national security or private citizens. Data may be made available specifically in the context of disaster response, such as via the International Charter for Major and Space Disasters, which has had more than 600 activations for disaster events (see further below). Such data can have a wide range of applications beyond risk transfer; it can be used by governments and supplied to planning departments or engineers for use in resilience and disaster risk mitigation strategies. There can be questions around accessibility and access to data or regarding intellectual property in data and analysis and there may need to be careful consideration between project partners around how data generated or created in a risk transfer application is compiled, stored, redeployed and, possibly, erased.

136 The Geneva Association, *Big Data and Insurance: Implications for Innovation, Completion and Privacy*, March 2019, https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public/big_data_and_insurance_-_implications_for_innovation_competition_and_privacy.pdf

137 Kai-Uwe Schanz and Fabian Sommerrock, The Geneva Association, *Harnessing Technology to Narrow the Insurance Protection Gap*, 2016 https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public//harnessing-technology-to-narrow-the-insurance-protection-gap.pdf

138 ITU, *Disruptive technologies and their use in disaster risk reduction and managemen*t, 2019 https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Documents/2019/GET_2019/Disruptive-Technologies.pdf

139 The Economist, *Waiting on hold*, October 2014, https://www.economist.com/science-and-technology/2014/10/27/waiting-on-hold

Can sensors be made secure?

Whilst they provide more granular data that enables parametric insurance solutions, the proliferation of earth-based and remote sensors creates the opportunity for sensitive information to be compromised, particularly where personal data is gathered: for example, through personal devices or in homes, such as wearable health trackers, thermostats, televisions, smoke detectors, cameras, washing machines, etc. Hackers may gain entry to IoT to extract personal data or potentially cause real world damage, such as through taking control of heating systems, air conditioning, lighting or physical security systems. Parametric triggers or input data sources may need to be securitized to prevent false trigger results which can erode policyholder trust. There may need to be regulatory standards around securitization of IoT devices or to prevent eavesdropping on wireless networks. There can be ethical and policy implications surrounding which objects may contain data-gathering sensors - for example, sensors located in "smart toys" for children – and how such devices are secured. Securitizing IoT devices can be a challenge given that most have low power and computing capability.

Various standards for IoT security have arisen, including the ETSI technical specification on Cyber Security for Consumer Internet of Things.[140] The UK Department for Digital, Culture, Media and Sport (DCMS), in conjunction with the National Cyber Security Centre (NCSC) has created a Code of Practice for Consumer Internet of Things Security.[141] The Code includes requirements for device manufacturers not to install default passwords, keep software and security patches updated, keep unused ports closed, and services not available if not in use.

Device manufacturers and IoT service providers should provide consumers with clear and transparent information about how their data is being used, by whom, and for what purpose. Where personal data is processed on the basis of consumers' consent, they should have the opportunity to withdraw such consent at any time. Device manufacturers should also make it easy to delete personal data if items change ownership or are recycled. Cyber-security needs to be built-in and must be considered at the design phase of all such solutions. Project partners will also need to consider liability risks and assess where obligations and risks lie within contractual arrangements.

140 ETSI, CYBER; *Cyber Security for Consumer Internet of Things*, 2019 https://www.etsi.org/deliver/etsi_ts/103600_103699/103645/01.01.01_60/ts_103645v010101p.pdf

141 UK Department for Digital, Culture, Media & Sport, Code of Practice for Consumer IoT Security, October 2018, https://www.gov.uk/government/publications/code-of-practice-for-consumer-iot-security

Air and space law and regulation

Does airspace regulation permit and control the use of drones?

Drones can quickly survey disaster-affected areas with great precision and detail and so can be highly useful for remote sensing to enable loss adjustment for indemnity insurance products, or when used to gather data for disaster risk planning and preparedness, or parametric triggers. Drones will often need to be registered under mandatory schemes and comply with airspace regulations and their use may be restricted, particularly in crowded urban areas. Some jurisdictions ban the use of drones entirely due to security concerns. Drones can pose a danger to commercial flights and there may be a need to protect airspace through enforced geofencing[142] around airports. There may need to be systems for safe and efficient ways to bring drones to ground so they can be identified and offending operators sanctioned; in other words, a means of enforcement.

The International Civil Aviation Organization (ICAO), a UN Specialized Agency, has proposed a single, global database requiring the registration of all drones[143] and hosts an online toolkit to help states in realizing effective operational guidance and ensuring safe domestic operations.[144]

ICAO has also discussed a common global framework for traffic management systems for drones, including communications systems for control and tracking of drones and geofencing to prevent the operation of drones in sensitive, restricted or dangerous areas.[145] Drones are subject to the provisions of Article 8 of the Convention on International Civil Aviation (the Chicago Convention) on 'Pilotless Aircraft'.[146]

Humanitarian UAV Code of Conduct[147]

In 2014 more than 60 relief organizations developed a code of conduct related to legal and other issues concerning drone use in humanitarian work, led by the Humanitarian UAV Network (UAViators), including relief agencies such as OCHA, UNICEF, the Office of the United Nations High Commissioner for Refugees, the United Nations Disaster Assessment and Coordination, the International Organization for Migration, the World Food Programme and the American Red Cross. The code has 15 key guidelines, including that "UAV operations must be in compliance with relevant international and domestic law, and applicable regulatory frameworks including customs, aviation, liability and insurance, telecoms, data protection and others. Where national laws do not exist, operators shall adhere to the ICAO RPAS Circular 328-AN/190 with the approval of national authorities". There is further guidance provided relating to data protection, for example.[148]

142 "Geofencing" is the use of GPS or RFID technology to create a virtual geographic boundary, enabling software to trigger a response when a mobile device enters or leaves a particular area.
143 ICAO, *Unmanned Aircraft Systems* (UAS), 2011 https://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf
144 ICAO, The ICAO UAS Toolkit, https://www.icao.int/safety/UA/UASToolkit/Pages/Narrative-Regulation.aspx
145 Thompson M., Cooper J., Harman J., *Drones*: *An unsolvable regulatory problem?*, Clyde & Co December 2017, https://www.clydeco.com/insight/article/drones-an-unsolvable-regulatory-problem
146 ICAO, *Convention on International Civil Aviation 2006*, https://www.icao.int/publications/Pages/doc7300.aspx
147 Humanitarian UAV Code of Conduct, https://uavcode.org/
148 Humanitarian UAV Code of Conduct, Humanitarian UAV Guidelines on Data Protection, https://uavcode.org/further-guidance/131-2/

What are the space law considerations for remote sensing activities?

National space legislation, the work of the International Telecommunications Union (ITU) in allotting orbital slots and regulating radiocommunications, as well as international space law – in particular the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the "Outer Space Treaty")[149] - will be relevant to the use and deployment of satellites in EO; for example, there are strictures on registration of space objects and requirements around space debris mitigation.

With the rapid commercialization of space it is considered that much of existing space law is outdated and not fit for purpose. For example, General Assembly Resolution 41/65 on Principles Relating to Remote Sensing of the Earth from Outer Space dates from 1986.[150] Legal and regulatory issues for space applications can include orbit and spectrum access and coordination; "end of life" requirements and space debris (including whether non-functioning or fragmented objects should be registered); joint launches (whose national regime applies); registration, responsibility and liability;[151] and post-mission disposal services. For example, it is unclear what happens if a commercial operator of a mega-constellation of satellites becomes insolvent; who takes responsibility and de-orbits debris?

The International Charter on "Space and Major Disasters"

The International Charter on "Space and Major Disasters" is a worldwide collaboration among space agencies, through which satellite-derived information and products are made available to support a disaster response effort. The Charter can be activated at the request of disaster management authorities in instances of fast-onset disasters of natural or technological origin, but not for slow-onset disasters like droughts. Currently, the following global space agencies participate in the mechanism: ESA, CNES, CSA, NOAA, CONAE, ISRO, JAXA, USGS, UKSA & DMCii, CNSA, DLR, KARI, INPE, EUMETSAT, and ROSCOSMOS. The Charter also benefits from satellite data provided by Planet (see above) and DigitalGlobe.[152]

149 UN Office for Outer Space Affairs, Knowledge Portal, *Outer Space Treaty*, 1966 http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html

150 UN General Assembly, *Resolution 41/65 on Principles Relating to Remote Sensing of the Earth from Outer Space*, 1986, http://www.unoosa.org/oosa/en/ourwork/spacelaw/principles/remote-sensing-principles.html

151 ESA, *Legal and practical considerations of registering constellations and space debris*, April 2016 http://www.unoosa.org/documents/pdf/copuos/lsc/2016/symp-01.pdf

152 UN Office for Outer Space Affairs, Knowledge Portal, *International Charter Space and Major Disasters*, http://www.un-spider.org/space-application/emergency-mechanisms/international-charter-space-and-major-disasters

Other regulatory and policy considerations

Telecommunications regulation and access

Many countries are seeking ways to minimize the digital divide and foster mobile penetration and inclusion. Network speeds, internet access and cost of data can all have an impact on the penetration of the types of technologies which may provide risk-relevant data, or the types of products of which sovereigns can avail themselves to benefit their citizens, some of which will rely on mobile payment platforms to provide post-disaster liquidity directly to individuals, households or other entities. Mobile networks are also critical for bridging the protection gap at the micro level, by enabling new methods of insurance distribution to individuals.

Superfast 5G (5th generation) mobile internet connectivity will offer faster data download and upload speeds, wider coverage and more stable connections. This promises great benefits for the speed and availability of data, and this new capacity could be deployed to assist in closing the protection gap. As countries are currently rolling out 5G regulations, it may be relevant to think about risk management applications and how these networks and the regulatory frameworks in which they are situated can be used to best enhance risk management.

Open standards can lower costs and ensure interoperability of different technologies. For example, the ITU - which regulates the world's use of radio frequencies - Standardization Bureau has a Study Group carrying out work on IoT and smart cities and communities[153] to address the standardization requirements of IoT technologies, with an initial focus on IoT applications in smart cities.

Meteorological good governance[154]

The World Meteorological Organization (WMO) sets the standards for operational meteorological and hydrological and climate services of member states. Through the development of the Global Framework for Climate Services, adopted by member states at the third World Climate Conference in 2009, WMO in collaboration with other UN partners is working to enable access to climate data through national climate services. Through two critical resolutions, Resolution 40 (Congress XII)[155], and Resolution 60 (Congress XVII),[156] WMO has engaged all member states to agree on exchange of meteorological, hydrological and climate related data to enable research, early warnings and accessibility to data for managing risks associated with weather, water and climatic conditions.

153 ITU, SG20: Internet of things (IoT) and smart cities and communities (SC&C), https://www.itu.int/en/ITU-T/studygroups/2017-2020/20/Pages/default.aspx; ITU, Study Group 20 at a glance https://www.itu.int/en/ITU-T/about/groups/Pages/sg20.aspx

154 With thanks to Dr Maryam Golnaraghi, Director, Climate Change & Emerging Environmental Topics, at The Geneva Association for her insights and guidance on the work and priorities of the WMO in this area.

155 Resolution 40 (Congress XII), http://www.wmo.int/pages/prog/hwrp/documents/wmo_827_enCG-XII-Res40.pdf

156 Resolution 60 (Congress XVII), https://library.wmo.int/doc_num.php?explnum_id=4192

WMO coordinates the work of the National Meteorological, Hydrological and Climate services of its 191 Members, through:

1. WMO Global Integrated Observing System (WIGOS) enables the collection of data from satellites, hundreds of ocean buoys, thousands of aircrafts and ships and nearly 10,000 land-based stations per standards by member states;
2. WMO Global Telecommunication System (GTS) is composed of a dedicated network of surface and satellite-based telecommunication links and centers operated around the clock all year round. It interconnects all operational meteorological and hydrological services for collection and distribution of meteorological and related data, forecasts and alerts, including tsunami and seismic related information and warnings. More than 50,000 weather reports and several thousand charts and digital products are disseminated through the WMO GTS daily. WMO is building on its GTS to achieve an overarching WMO Information System (WIS), enabling systematic access, retrieval, dissemination and exchange of data and information of all WMO and related international programs. WIS will also be able to provide critical data to other national agencies and users dealing with many sectors including disaster risk management;
3. WMO Global Data-Processing and Forecasting System (GDPFS) involves three World Meteorological Centers and 40 Regional Specialized Meteorological Centers, including Regional Specialized Meteorological Centers (RSMCs), Regional Climate Centers (RCCs) and Regional Drought Management Centers. They process data and routinely provide countries with analysis and meteorological forecasts, supporting early warning capacities through the National Meteorological Hydrological Services (NMHSs).

To encourage more and more accurate meteorological measurements, the WMO suggests that national meteorological services clarify roles between stakeholders that are providing and benefiting from weather and climate services. WMO advocates that such roles are reflected in national and local regulatory frameworks, planning, and budgets and are supported by standard operating procedures and good practice guidelines.[157]

157 WMO, A Disaster Risk Reduction Roadmap for the World Meteorological Organization, April 2017, https://library.wmo.int/doc_num.php?explnum_id=3537

Smart city planning and infrastructure

Risk management thinking can be incorporated into the deployment of smart city planning and infrastructure. IoT sensors or the objects in which they are embedded may need to comply with environmental or other laws regarding sensor locations or around visual pollution.

There may need to be consideration of the type, materials and locations of public sensors as well as security and data storage considerations. A joined up approach could be established between meteorological services, mobile network operators, telecommunications companies and others involved in smart city infrastructure which can enable better risk management and warning systems, with data unlocked to enhance city services and resilience measures.

For example, the Institute of Electrical and Electronics Engineers (IEEE) Standards Association has issued a draft standard on an architectural framework for IoT which provides an architectural blueprint for Smart City implementation leveraging cross-domain interaction and interoperability among various components of a Smart City.[158]

There can be a knowledge gap in cities' planning departments around process design or documentation for tech-enabled solutions that support resilience. Cities can work with initiatives that share best practice; for example, through the original 100 Resilient Cities network of the Rockefeller Foundation.[159] As new products and technologies are piloted, project partners – cities, donors and (re) insurers – can document the pilot process in order to share and disseminate learning and build standard operating procedures in deploying new technologies to best advantage.

157 WMO, A Disaster Risk Reduction Roadmap for the World Meteorological Organization, April 2017, https://library.wmo.int/doc_num.php?explnum_id=3537

158 IEEE Standards Association, IEEE Approved Draft Standard for an Architectural Framework for the Internet of Things (IoT), May 2019, https://standards.ieee.org/content/ieee-standards/en/standard/2413-2019.html

159 The 100 Resilient Cities, http://www.100resilientcities.org/

Conclusion: regulating for tech-enabled risk management

Conclusion: regulating for tech-enabled risk management

To foster disaster risk resilience and close the protection gap, there is a wide range of solutions available and new approaches are being developed rapidly.

Technology is a key enabler. More data and more accurate modeling should attract market players to invest in creating products so that risk can be transferred to capital markets. A better understanding of weather and other natural risks brings important co-benefits to sovereigns, permitting adaptation and resilience measures to be put in place, mitigating risks to lives, infrastructure and livelihoods.

The application of the technologies discussed in this paper and their co-development with international partners, (re)insurers, national governments, city planners, regulators, etc. can play an important capacity-building function in understanding risk and integrating resilience planning. With risk modeling and mapping expertise, (re)insurance companies can play a key role in building and sharing knowledge on resilience to fill knowledge gaps at the sovereign and sub-sovereign level. Project partners can assist in putting together resilience "frameworks" to support the building of resilient infrastructure and communities.

For example, in September 2019, at the BRIDGE for Cities 4.0 Event: Belt & Road Initiative: Connecting Cities through the New Industrial Revolution,[160] AIG, and Wood Group helped sponsor a roundtable at the United Nations Industrial Development Organization (UNIDO) aimed at developing a framework for cities to consider when building resilient infrastructure.[161] In another example, the Zurich Flood Resilience Alliance, launched in 2013, is a multi-sector partnership focused on pre-event risk reduction seeking practical ways to help communities strengthen their resilience to floods and save lives.[162] With Zurich as its catalyst, the Alliance includes charitable and academic partners including the International Federation of Red Cross and Red Crescent Societies (IFRC), MercyCorps, London School of Economics and Wharton Business School.

160 BRIDGE for Cities 4.0: Connecting Cities through the New Industrial Revolution, September 2019, https://www.unido.org/4th-bridge-cities-event

161 BRIDGE for Cities 4.0: Connecting Cities through the New Industrial Revolution, Resilience Framework for Projects along the belt and Road, September 2019, https://www.unido.org/sites/default/files/files/2019-09/Resilience%20Framework%20for%20Projects%20along%20the%20Belt%20and%20Road.pdf

162 Zurich, Flood Resilience Alliance 2.0, March 2018, https://www.zurich.com/knowledge/topics/flood-resilience/flood-resilience-alliance-2

Looking forward: the future of risk and resilience

The landscape is shifting rapidly and traditional legal and regulatory siloes are being broken down and challenged through new products, market players and partnerships. In order to regulate or legislate for new risk management technologies, decision-makers need to understand both the benefits and limitations, what products do/don't do, and what safeguards need to be put in place or enabling structures enacted.

This is no small feat as things are moving quickly. It may be a challenge for any one regulator or legislator to keep pace with developments. Accordingly, when setting and assessing legal, regulatory and policy frameworks, international collaboration, harmonization and capacity-building will be key. There are a number of organizations that stand ready to assist, including the World Bank, multilateral development banks, the Access to Insurance Initiative (A2ii), the IDF, the InsuResilience Global Partnership, and the OECD.

It is indisputable that there is an extraordinary pace of change in both the need for risk management and risk transfer – in the face of climate change – as well as the range of technological solutions available to meet the resilience challenge. The pace of change means that stakeholders need not only to take stock of current developments, but anticipate what is coming on the horizon.

It is predicted that weather-related losses will continue to increase year-on-year, potentially creating an even bigger protection gap. However, at the same time, there are going to be better and smaller satellites and a proliferation of mobile phones and other sensors, giving the world a real-time in-depth view of natural hazard (and other) risks. As the granularity of data (hazard and vulnerability) and the ability to analyze it improves, we will move from risk transfer products based on parameters which stand as a proxy for loss (rainfall for drought or flooding; wind speed for property damage), to near-actual real-time knowledge of actual or anticipated losses.

Looking further ahead, as our collective knowledge of risk grows so, too, will the ability to act to mitigate and respond. This could, in due course, give rise to increased scrutiny regarding duties to warn populations, to manage or transfer weather or geohazard risk, and to put in place national or sub-national frameworks and policies for disaster risk reduction and response.

It is important to remember that insurance and disaster risk financing is just one part of this picture. Sovereigns and sub-sovereigns should be enabled not just to establish financial resilience through risk transfer, but also to harness the new technologies discussed in this paper and the skills and knowledge of the insurance industry to plan resilient infrastructure investments, and foster risk reduction and preparedness. These technologies – properly regulated – have the potential to help countries and communities recover from losses caused by disasters, but ideally they will play an important role in preventing such losses occurring in the first place.

Recommendations

In conclusion, we urge regulators, legislators and policymakers to take the following steps to advance the use of technology to close the protection gap for sovereign and sub-sovereign entities:

- Encourage the collection and sharing of critical data – such as sea level, population movement, building density, drought – with data gathered through earth observation (EO) via satellite or drones, deployment of weather stations, the internet of things (IoT) and other resources.
- Support the development and sharing of risk models for emerging countries.
- Promote the use of risk models developed for risk financing in other fields such as emergency response planning and disaster response deployment.
- Pursue regional alliances to:
    - Coordinate and harmonize efforts to use technology and insurance methodology to address the protection gap.
    - Avoid unnecessary duplication of regulation where sovereign programs or data-enhanced solutions straddle borders.
- Consider exempting sovereign insurance products from premium taxes, thereby increasing the funds available for risk financing.
- Update key laws and regulations to enable the use of technology-driven insurance solutions.
  For example:
    - Ensure parametric covers may be offered by insurers and by capital markets.
    - Update regulation of intermediaries to accommodate new forms of insurance distribution, particularly to sovereign entities.
    - Ensure that data privacy rules do not inappropriately impede the use of data in responding to a catastrophe.
    - Consider ways of streamlining authorization for innovative approaches to sovereign risks, such as a "regulatory sandbox".

List of Abbreviations

- **ARC**
  African Risk Capacity
- **CCRIF**
  Caribbean Catastrophe Risk Insurance Facility
- **DRM**
  Disaster risk management
- **DRR**
  Disaster risk reduction
- **FONDEN**
  Fund for National Disasters (Mexico)
- **GFDRR**
  (World Bank) - Global Facility for Disaster Reduction and Recovery
- **IBLI**
  Index-Based Livestock Insurance
- **ICAO**
  International Civil Aviation Organization
- **PPP**
  public–private partnership
- **UNISDR**
  United Nations Office for Disaster Risk Reduction
- **WFP**
  World Food Programme
- **WMO**
  World Meteorological Organization

Glossary of Terms

— **A2ii (Access to Insurance Initiative)**
A global partnership with the mission to inspire and support supervisors to promote inclusive and responsible insurance, thereby reducing vulnerability.

— **Adverse basis risk**
Situation when an adverse event has occurred but the index is not triggered, so insufficient or no payment is made.

— **AI (Artificial Intelligence)**
The study of how to produce machines that have some of the qualities that the human mind has, such as the ability to understand language, recognize pictures, solve problems, and learn.

— **Basis risk**
In parametric or index-based insurance, basis risk refers to the possibility that the index value(s) doesn't accurately capture the actual situation on the ground; it can be either positive or negative. For example, drought-like conditions may affect some farmers even though the precipitation data doesn't show that drought has occurred. Or the opposite: payouts may be made to farmers who nonetheless brought in reasonable harvests.

— **Big Data**
Very large sets of data that are produced by people using the internet, and that can only be stored, understood, and used with the help of special tools and methods.

— **Blockchain**
A distributed ledger technology that records transactions between two or more counterparties in a tamperproof way that ensures records can be completely relied upon. Transactions are grouped in 'blocks' and each block is linked to prior and succeeding blocks, using the same cryptographic techniques.

— **Captive insurance company**
A captive insurance company is a wholly owned subsidiary company that provides risk-mitigation services for its parent company or a group of related companies.

— **Catastrophe (CAT) bond**
A high-yielding, insurance-linked security providing for payment of interest and/or principal to be suspended or cancelled in the event of a specified catastrophe, such as an earthquake of a certain magnitude within a predefined geographical area.

— **EO (Earth observation)**
Earth observation is the gathering of information about planet Earth's physical, chemical and biological systems via remote sensing technologies, usually involving satellites carrying imaging devices.

— **Ex ante risk financing**
Ex-ante risk financing instruments require proactive advance planning and include reserves or calamity funds, budget contingencies, contingent debt facility, and risk transfer mechanisms.

— **Ex post risk financing**
Ex post risk financing instruments are sources that do not require advance planning, such as budget reallocation, domestic credit, external credit, tax increase, and donor assistance.

— **Geofencing**
The use of GPS or RFID technology to create a virtual geographic boundary, enabling software to trigger a response when a mobile device enters or leaves a particular area.

— **IDF (Insurance Development Forum)**
The IDF is a public/private partnership led by the insurance industry and supported by international organizations - standard use of Z throughout which aims to optimise and extend the use of insurance and its related risk management capabilities to build greater resilience and protection for people, communities, businesses, and public institutions that are vulnerable to disasters and their associated economic shocks.

— **Inclusive insurance**
Products designed to sell insurance to the under or uninsured but not specifically focused on a low-income target market, as with microinsurance. Insurance products targeted to the excluded or underserved market, rather than just those for the poor or a narrow conception of the low-income market.

- **Indemnity insurance**
  Traditional indemnity-based insurance contracts pay claims based on an assessment of the damage suffered by the insured.

- **InsurTech (Insurance Technologies)**
  An insurance company, intermediary or insurance value chain segment specialist that utilises technology to either compete or provide valued-added benefits to the insurance industry. InsureTech is the insurance-specific branch of FinTech that refers to the variety of emerging technologies and innovative business models that have the potential to transform the insurance business.

- **IoT (The Internet of Things)**
  A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

- **Microinsurance**
  Risk pooling products that are intentionally designed—in terms of costs, coverage, distribution, and marketing—for low-income individuals, families, and businesses. It is also sometimes used to describe insurance products with small premiums.

- **MNO (Mobile Network Operator)**
  An operator that manages one or more mobile networks.

- **Parametric insurance** (also **index-based insurance**)
  Non-indemnity insurance that makes payouts based on an index or parameter established in the contract. Claims payments are triggered automatically once an agreed-upon threshold is reached. With parametric policies, payouts are not based on loss or damage assessments, but instead on a pre-agreed formula reflecting the severity/intensity of the event as derived from independent and objectives data. These coverages are based on three factors:

  1. The index value: one or more variables that are tightly correlated with the client's revenues or costs.
  2. The threshold level/deductible: the point at which the insurance kicks in. These can be structured in different ways. In a purely binary structure, the full limit is paid when an index value above or below a pre-defined threshold is recorded. Alternatively, the payout size can be linked to the severity or magnitude of an event; for instance, a Category 4 cyclone triggers XX% of the limit while a Category 5 cyclone pays YY%. With a linear structure, the payout size increases incrementally as the index value changes.
  3. The limit: the maximum payout that will be made. And for it to be insurance, the limit has to be less than or equal to the client's actual losses.

- **Perverse basis risk**
  The situation when no adverse event has occurred but the index is triggered and payments are made; false positive pay-outs.

- **Predictive analytics**
  The use of data, statistical algorithms and machine learning techniques to identify the likelihood of future outcomes based on historical data.

- **Remote-sensing**
  The process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area.

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