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UNISDR Case Study Report

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UNISDR CASE STUDY REPORT

DRAFT

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AIR (2009) "Agricultural Risk and the Crop Insurance Market in China", <i>AIRCurrents</i> , from <i>http://www.air-worldwide.com/Publications/AIR-Currents/Agricultural-Risk-and-the-Crop-Insurance-Market-in-China/</i>
Swiss Re (2008) Setting up sustainable agricultural insurance: the example of China, Zurich: Swiss Re
Wang, M. <i>et al.</i> (2011) "Agriculture insurance in China: History, experience, and lessons learned", <i>International Journal of Disaster Risk Science</i> , 2(2):10-22
Wang, Z., Lin, T. and Walker, G. (2009) <i>Earthquake Risk and Earthquake Catastrophe</i> <i>Insurance</i> for the <i>People's Republic of China</i> , Asian Development Bank Sustainable Development Working Paper Series, No. 7
Wong, M. (2011) "Fertile grounds in Asia's giants. Agricultural Feature", <i>Asia Insurance Review</i> , June 2011
World Bank (2007) "China: Innovations in Agricultural Insurance—Promoting Access to Agricultural Insurance for Small Farmers", Washington, DC: World Bank

Foreword by UNISDR

Acknowledgements

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The contributions from these people have made writing this report possible.

Meghan Orie and Walter R. Stahel Editors

Main Findings

Strengthening societal resilience is the shared mission of insurance, governments and the international risk community. But they have different options and limitations to reach the objective and to engage other actors in the effort. Cooperation between insurance and governments can overcome some of the limitations of the individual actors involved and create synergies. Showing ways and means to achieve this is the objective of the report.

Insurance's main approach is to provide incentives for various stakeholders to engage in efforts to reduce catastrophe risks and to mitigate the insured impacts of NatCats after the event. It is important, however, to bear in mind that insurance is a profit-making business model based on risk-based premiums.

Governments through public policy and regulatory regimes can promote or hinder the contributions of the insurance industry. At the best, such cooperation will speed up reconstruction after a natural catastrophe without straining state finances; at worst it can lead to a failure of insurance market solutions.

Government actions can also provide incentives for stakeholders to engage in risk reduction behaviour or warp them, for example causing unnecessary repetitive property losses. Given the global increasing frequency and severity of catastrophic weather events, the manner in which risk mitigation and transfer measures are implemented are all the more important. The strategies of the nine governments studied (U.S., Thailand, The Netherlands, Japan, Norway, Ethiopia, China, India and Ecuador) demonstrate—through obstacles encountered or successes achieved—that a well-coordinated public–private initiative is an effective way to circumvent these obstacles and promote societal resilience.

I. Knowledge-building about insurance is key

The role of insurance in society is often misunderstood by policymakers. Ignoring insurance's unique business model and its social and economic impacts is detrimental to disaster reduction strategies. Broad insurance coverage enables countries' economies to recover in shorter periods than underinsured ones after natural catastrophes. By pooling, transferring, and sharing risk and experience in loss prevention, insurance facilitates the resistance, absorption, accommodation, and recovery from the effects of a hazard in a timely manner, including reconstruction of a society's essential basic infrastructures.

II. <u>Public policy issues can facilitate insurance's effectiveness or warp the incentives it</u> provides subsequently creating reputational and financial risks.

As this report's China case study shows, public policy can establish a necessary legal framework in which insurance can flourish, create growth impulses for insurance in emerging markets, encourage investment in insurable assets, raise risk awareness and promote financial literacy, among others. It can also mandate and finance risk mitigation measures that are necessary for insurance to operate: strict building codes, early warning systems and land use planning. These protective endeavours are essential for disaster risk reduction and provide crucial circumstances for insurance to smoothly operate. Tracking flood risk implementation, the report identifies the dangers both to local economies and insurance of rapid development without the construction of proper risk mitigation measures, while cases like the National Flood Insurance Program (NFIP) demonstrate the risk exposure of governments and fiscal consequences if land use planning is not updated or maintained.

III. Risk-based pricing is an essential mechanism for insurance to mitigate risk.

Risk-based, actuarially-sound pricing is the most effective tool for insurers to communicate risk levels to their customers and encourage low-risk behaviours, thereby effectively implementing preventative measures for risk mitigation. Again, certain public policy measures can distort these incentives. For example, regulators can alter *ex ante* programmes to *ex post* programmes, thereby providing disincentives for individuals to invest

in risk reduction measures on their houses. The importance of risk-based pricing or the consequences of its absence are demonstrated in cases like the California Earthquake Authority (CEA) or NFIP.

Most importantly, insurance can identify and mitigate risks and develop new products, which reward loss prevention with lower premiums, thus tackling issues of insurance affordability. This is best exemplified by programmes that encourage individuals to invest in their assets to ensure they can withstand major climate disasters. Such programmes can be illustrated by the CEA or R4 programme, innovative solutions to ensure asset protection and protect livelihoods.

IV. Insurance has relevant risk reduction expertise and is particularly adept at managing accounts and claims so that liquidity is effectively injected into catastropheaffected economies.

Our case studies demonstrate that the insurance industry efficiently manages accounts, can provide topical expertise and is particularly effective in delivering payments post catastrophe, providing necessary injections of liquidity that help the local economy recovering. This is best demonstrated in the post catastrophe outcome of the Japanese case study. After 11 March, 2011, the Japanese Earthquake Insurance Programme was able to quickly and effectively pay claims which allowed recipients to immediately begin recovery.

V. <u>The role of capital markets and packaging risk in such a way as to attract financial interest is key</u>.

Besides straightforward insurance and reinsurance contracts, insurance has a number of other options to insure risks. For instance, Alternative Risk Transfers (ART) offer innovative insurance products which tap much larger financial capacities available in the capital markets.

VI. <u>Liability litigation post disaster can either be a good means of compensation for</u> victims or a formidable obstacle of victim recovery depending on how it is handled by governments, courts and companies.

Governments and judiciaries are gaining increasing importance in loss rectification, as perverse economic incentives, such as the expansion of contingency fees and litigation funding practices, encourage lawsuits whose victims may not benefit from winnings. There is no single recipe for preventing these perverse economic incentives, but the Bhopal case can be used as a model for handling complex, international, multi-jurisdictional cases to ensure that victims are properly remediated.

Based on these findings, the editors make the following recommendations:

- We suggest a five-pillar disaster risk reduction framework: education, prevention, intervention, pre-financing, and insurance.
- Governments should consider covering public infrastructure through private insurance.
- Governments should employ insurers' expertise in engaging in disaster reduction measures.
- Insurance is making great advancements in global catastrophe risk modelling which could be an effective way to increase local resilience. Thus, the international community should continue to support science's advancement of modelling.
- We recommend that risk transfer be an objective in the Hyogo Framework and in the upcoming redefinition of the Millennium Development Goals. Risk transfer
 - \circ $\,$ is an effective measure of disaster risk reduction,
 - o facilitates disaster risk reduction planning, but
 - o requires truly independent international standards of modelling.

Introduction

Walter R. Stahel

The idea for this report emerged in a meeting between representatives of UNISDR and the Geneva Association, held on 26 October 2011 with Patrick M. Liedtke, former Secretary General and Managing Director; Walter R. Stahel, Head of Research Programme—Risk Management for The Geneva Association; and, representing United Nations Office for Disaster Risk Reduction (UNISDR), Margareta Wahlström, Special Representative of the Secretary-General (SRSG) for Disaster Risk Reduction; Andrew Maskrey, Coordinator of the United Nations Global Assessment Report on Disaster Risk and Bina Desai, Programme Officer at the UNISDR offices in Geneva.

The objective of this report is to research and structure the spider web of links between the different players involved in NatCats. It further looks into which forms of cooperation between these players have in the past, and could in the future, mitigate the effects of extreme natural events (NatCats).

Out of the broad variety of NatCats, ranging from hurricanes and typhoons, volcanoes and earthquakes, avalanches and mudslides to rising average sea levels and thawing permafrost, this first report focuses on case studies from four topics: floods, earthquakes, resilient communities as a proactive approach and liability litigation as a tool for disaster remediation.

This report offers new insights into the links between the players involved in NatCats. It does not double up with the large number of studies and publications that have been, and continue to be, published on specific NatCats. This report consists of a series of case studies written by selected researchers who present their analysis of a specific aspect of natural catastrophes. The aim is to stimulate discussions on new and innovative roles for the actors involved, and to explore new forms of "private public cooperation" which could overcome some of the unsolved issues of NatCats.

* * * * *

This report researches and highlights the type of "links" and cooperation between NatCats, ruled by the law of nature but with different characteristics, and several groups of "players" with different motivations, economic actors, such as individuals, farmers and companies; government offices and authorities, both legislative and executive; judiciary authorities, risk experts and engineers, looking for solutions to restrict losses or restrain nature; and insurance and reinsurance companies.

Cooperation can have lasting beneficial results, by creating communities, which are more resilient to NatCats, but can also lead to unexpected results such as the emergence of new types of liability claims, initiated by government offices, legal experts or courts, linking natural catastrophes with economic actors and ultimately their insurance companies.

* * * * *

1. NatCats

Natural catastrophes are wrongly named; they are in reality human catastrophes when people are in the way of nature. Hence, volcanic eruptions or a possible sea level rise hitting uninhabited parts of the world, such as the Antarctica or Siberia, are irrelevant NatCats because they do not impact human life or economic property. For the same reason, only limited meteorological statistics exist for these areas or none at all; a similar situation exists for large parts of the oceans which make up most of the southern hemisphere.

NatCats come in a wide variety of "original" events, such as hurricanes and typhoons, volcanoes and earthquakes, floods and droughts, avalanches and mudslides, as well as

rising average sea levels and thawing permafrost. In addition, they can trigger devastating "secondary" events, such as tsunamis.

1.1 <u>Sudden and accidental extreme events</u>

These are most frequently caused by water (floods, droughts, ice and snow), wind or a combination of the two, and geologic events (volcanic eruptions, earthquakes). In general, these events are "sudden and accidental" and thus insurable. But in emerging economies, they are often not insured, in which case new forms of private-public cooperation may contribute to a considerably higher quality of life of the population at risk.

Statistics show that the frequency and severity of many of these events have increased since the turn of the century.

Floods: River floods often occur in well-defined and known areas, the floodplains. Exceptional floods—often named "flood of the century"—occasionally touch much larger areas. Floods do not restrict the economic use of floodplains, such as the building of bridges, but necessitate the exercise of risk management, for instance, on the part of engineers, when taking calculated risks.

"Flash floods" can occur anywhere and anytime, with little advanced warning and are normally caused by extreme precipitation or such accidents as burst water mains or dykes, or by natural events such as mudslides. Flash floods are a special hazard for underground structures.

Other floods are caused by spring tides, tsunamis or Monsoon rains.

Droughts: Equally devastating as floods is the absence of water, droughts. Droughts develop slowly, and agricultural crops are their main victims as people have time to escape.

Ice and snow: Ice and snow-related disasters can occur anywhere, but tend to follow certain seasonal and regional patterns.

Avalanches are a special NatCat event in relation with snow. Similar to floods, they mostly occur in defined mountain areas and depend on primary events such as heavy snow fall, strong winds shifting snow or changes in temperatures.

Wind: Extreme winds occur world-wide—periodically in most places—such as tornadoes in the USA, typhoons in Asia and winter storms in Europe.

Volcanic eruptions: These events are linked to active or sleeping volcanoes and are thus geographically known. The predictability of eruptions and possible impacts on people, land and air are low, imprecise and can be far reaching.

Earthquakes: Quakes hit in a wide number of areas and are difficult to predict, as they are triggered by the movement of plaques. Also, earthquakes can cause a combination of secondary disasters, notably the interruption of vital health and transport infrastructure, tsunamis and fires (witness the quakes of Lisbon and San Francisco). As quakes have their biggest impact on built environments and especially urban infrastructures, they are becoming increasingly catastrophic due to a general population shift to megacities.

A new phenomenon is the appearance of liability claims against the scientists who did not predict an earthquake correctly (L'Aquila).

1.2 <u>Slowly evolving hazards</u>

These events are typically linked to accumulation effects due to industrial activity (soil and ground water pollution) or nature. The latter are often intertwined or mutually reinforcing, such as in the case of greenhouse gas (GHG) emissions, climate change and ocean warming.

Rise of average air temperatures: Fluctuations in average air temperatures have now been documented for a million years; in the past, higher temperatures coincided with higher CO_2 concentrations in the atmosphere and seemed to reach a peak approximately every 100,000 years. These fluctuations of air temperature are accompanied by similar variations in other GHGs in the atmosphere such as methane.

Higher GHG concentrations in the atmosphere can be caused by a variety of natural events such as volcanic eruptions, thawing of tundra and peat land, burning of biomass during wildfires and methane vents in the oceans.

With the rise in world population and industrial activities over the last 250 years, higher GHG concentrations in the atmosphere have been attributed to an increase of anthropogenic emissions. Among these activities are rainforest deforestation, the burning of fossil fuels such as coal, oil and gas, and industrial accidents such as underground coal mine fires.

The effects of a rise of air temperatures, also known as global warming, are manifold.

Rise of average sea levels: The melting of polar ice caps and the warming of the oceans due to the rise of average air temperatures are causing sea levels to rise.

The danger of floods in coastal areas, however, is equally due to subsidence—the gradual sinking of an area of land—according to meteorologists. According to these experts, the pumping of water, oil and gas in coastal regions—leading to the sinking of the land—will remain the dominating factor for floods in coastal areas for several decades.

Rise of average ocean temperatures: A separate report by The Geneva Association will look into the phenomenon of ocean warming and its implications for economy and society.

* * * * *

2. Economic actors, such as individuals and companies

Economic actors are pursuing their personal objectives of an economic nature, ranging from the quest of the highest thrill, to survival, increased quality of life or economic gain,

In this pursuit, economic actors tend to amass increasing wealth, look for naturally attractive sites such as coastal zones, which are often more exposed to NatCats, or are driven by economy of scale and global supply chain considerations that do not take into account potentially higher inherent risks.¹

The actors involved in risk-taking, individuals and companies alike, are often also the best to mitigate a specific risk. Mountain climbers take "irresponsible" risks but which they feel are within their capabilities. In German towns along the Rhine River, where floods are frequent, buildings including restaurants have no cellars and often a tiled ground floor. In case of floods warnings, furniture and equipment are moved upstairs, and potential losses are thus restricted to a minimum.

Insurance is thus only one approach that economic actors can take to protect themselves against possible losses. And insurance brings with it moral hazard, or "an invitation to risk-taking", which is the opposite of the attitudes mentioned in the previous paragraph.

However, individuals and companies need to protect themselves against infrequent NatCats. A drought of the century in the USA, Brazil or India will bankrupt many farmers if there is no protection—crop insurance, government subsidies or other.

¹ A higher economy of scale goes hand in hand with a higher dis-economy of risk, for example.

3. Government offices and authorities

Politicians have as one main objective the protection of populations against impairments of their health or wealth, and promoting economic development and quality of life.

Governments are unique in that they have the power to legislate, which includes the option not to legislate. As legislation only makes sense if authorities have the will to impose a law, many politicians prefer other options, such as subsidies, which increase their popularity and help re-election to solve a given problem.

Legislation to protect people and property against specific NatCats include land-use zoning to prevent, for instance, houses built in floodplains, and building codes to increase the resilience of constructions against earthquakes or windstorms. The knowledge of how to do it is often publicly available but involves higher costs or other restrictions on the owner. Governments exercising their political power to impose legislative solutions may thus lose voters.

Governments can also develop early warning systems (EWS), for instance for water hazards; EWS poses several important challenges, such as the need for integrated systems that can respond to multiple different hazards that cross national boundaries. Such initiatives are already being developed, and examples include the European Flood Alert System ² and the World Meteorological Organization's (WMO) Severe Weather Information Centre.³

Education is another option available to governments, but needs some cooperation with other actors. Japan may be the only country where children learn in school what to do in case of a tsunami: "*when a tsunami occurs, do not wait for family, run to higher ground*". This is the only situation when children are asked to abandon their parents and act on their own.

The avalanche forests in the Swiss Alps are a cooperative form of protective legislation, located in a triangular form on the slopes above a village. They prevent avalanches from reaching the village, by diverting or stopping them and are based on the principle of the "commons", which is a public property fulfilling a public objective and maintained by all villagers. A modern approach, that of building metal or wooden structures on the slopes where avalanches start, and avalanche walls above villages, no longer depends on a cooperative spirit, and may also offer protection against such other extreme events as mudslides.

4. Judiciary systems

Judges and courts are emerging as new players in the aftermath of NatCats. As judiciary systems, because of culture and tradition, vary greatly between countries, they constitute a new dimension in the framework conditions surrounding NatCats. Recent examples are the Chevron case in Ecuador, the L'Aquila case in Italy and the new Tort law of the People's Republic of China and its application by local judges.

5. Risk experts, scientists and engineers

With satellite technology and super computers, scientists increasingly have the capability to develop EWS for NatCats. This raises expectations by politicians and the public that hazards are predicted precisely and in time; NatCats can thus become anthropogenic risks, open to liability claims. And, if developed by commercial companies, EWS may pose questions of intellectual property rights and royalties.

Since Roman times, engineers have been in the centre of risk management approaches to limit the impacts of NatCats, by designing structures to prevent losses, by restraining ("taming") nature, increasing the resilience of social structures against extreme events or mitigating their impacts on infrastructure.

² http://ies.jrc.ec.europa.eu/european-flood-alert-system

³ http://severe.worldweather.wmo.int/

To prevent losses, engineers built bridges across major rivers using arched or suspended constructions; these bridges normally span both rivers and floodplains. Despite the fact that only part of the bridge would in normal times have appeared to be necessary, the historic knowledge of previous events justified the additional expense for the longer bridges.

To restrain nature, engineers in the past built dykes or avalanche walls. The construction of tunnels has been another approach to protect railway lines and roads against avalanches.

To protect property and human lives, engineers may also develop resilient structure methods, such as earthquake or typhoon-proof buildings, floating houses (The Netherlands) or structures on pillars.

Operation and maintenance of rainwater run-off systems, dykes, mechanical systems (Thames flood barrier) and pumps are integral parts of engineering efforts to mitigate the impacts of NatCats.

6. Insurance companies

Insurance companies develop affordable insurance products which correspond to the needs of customers and incentivise them to mitigate the unforeseeable impacts of NatCats on individuals, corporations and communities.

Insurance has a broad risk expertise and offers a number of services protecting customers against dangers. In the case of NatCats, these services include insurance contracts against specific dangers, such as floods or windstorms, as well as risk engineering services. But insurance normally does not sell "all risk protection".

The actions of insurance companies are restricted by, for instance, the limits of insurability, including risk-based premiums. Regularly recurring events leading to economic losses may therefore not be insurable. This can tempt governments to establish affordable insurance schemes, such as the U.S. National Flood Insurance Program (NFIP) which compete with insurance companies.

Insurance mainly reimburses financial losses suffered, such as buildings destroyed or the loss of human life, but does not recompense hardship suffered. And insurance contracts have to be signed before a NatCat. This differs fundamentally from governments as insurers of last resort, which often intervene after a major disaster.

In the case of NatCats, insurance can have a crucial role in the rapid rebuilding of private and public infrastructure. When public infrastructure is not insured, the reconstruction of the economy can be delayed for a long time, witness the Haiti earthquake.

New trends of cooperation in dealing with NatCats: Out of the number of examples of new types of private—public "cooperation", we cite two of different nature in the following sections: resilient communities which are a win-win situation for all, and liability claims which shift the responsibilities for NatCats and their impact on the private sector.

7. Resilient communities

The objectives of resilient communities are manifold:

- Crop insurance schemes guarantee higher food security, which creates more resilient societies—food shortages inevitably lead to the risks of famine and higher prices of staple food, which can lead to riots and even threaten governments.
- Higher risk awareness in the urban populations prepares people for an emergency. The historic district of Ichitera-Kototoi in Tokyo, with a high number of wooden houses, has been identified as a major fire risk in case of earthquake. The local government works with the population to open new escape routes, reduce fire risk and create rain water tanks.

- The 2010 initiative of the Australian Insurance Association linked individuals, local governments and insurance companies to develop new approaches to mitigate the impacts of floods and wildfires, for instance, on settlements and towns.
- Scientists and governments team up to develop EWS for major NatCats which will become publicly available.

8. Liability claims

Liability claims, initiated by government offices, legal experts or courts, linking natural catastrophes with economic actors and ultimately their insurance companies. Liability claims increasingly try to construct a link between nature and anthropogenic factors.

The case studies

Topic I

Floods

Over the past 20 years, the frequency of floods has radically increased from roughly 10 in 1950 to around 200-250 in 2010, making the overflow of a large amount of water onto normally dry land the most frequently occurring natural disaster (WMO, 2009). Consequently, the number of people affected and the amount of economic and financial loss has increased. Worldwide 178 million people were affected in 2010 with an estimated economic loss of US\$40bn in the peak years of 1998 and 2010 (WMO 2004). Given their increasing impacts and frequency, floods merit a more in-depth investigation into how to better prevent losses and protect those affected by them.

Since floods are high-impact events, it is difficult for insurers to predict how much capital should be reserved in order to pay out annual losses from floods. However, floods repeatedly occur in the same place. Targeting those affected locations with effective risk management and risk reduction activities can reduce the frequency of flooding events and their economic impact.

Implementing risk management practices can be challenging. It involves the coordination and cooperation of multiple actors transnationally, nationally, regionally and locally before, during and after times of crisis. Given the complexity of coordination and substantial risk posed by floods, the following cases present various flood risk public–private cooperation initiatives and their associated challenges, strategies and successes. In the first case study, Robert Muir-Wood presents the history of flood risk management, identifying at which point various countries began investing in flood risk management measures. He warns of the dangers of providing insurance in places where comprehensive flood risk mitigation measures have not been implemented. The second case addresses the U.S. government's direct provision of flood insurance and certain solvency issues associated with non-risk-based pricing in high-risk areas. Christophe Courbage *et al.* elaborate on the 2011 Thai floods' disruption of supply chains and the consequences of increased risk exposure. The fourth case study explores risk governance strategies in The Netherlands, where a possible public–private partnership was discussed but ultimately failed to take hold with the result that flood insurance is unavailable.

These cases are only a few of the multitude of flood risk management strategies. Some other similar initiatives of interest are:

 An important component of The Federated State of Micronesia's Strategic Development Plan is the "Pacific Adaptation to Climate Change Project", which requires all infrastructure to be climate-proofed. For more information see http://www.sprep.org/att/IRC/eCOPIES/Pacific_Region/27.pdf

- The Crop-Credit Insurance Guarantee Program for Small and Marginal Farmers (SEAF) in Brazil for which farmers must apply risk reduction methods and technology in order for the risk transfer to be valid. A similar approach is taken by the agricultural insurance scheme in Sudan. For more information see http://www.ruralfinance.org/fileadmin/templates/rflc/documents/Government_Support _pdf.pdf
- The Flood Index (ENSO) insurance in Peru provides business interruption insurance and also educates farmers on risk reduction efforts, such as clearing drainage systems, http://www.agriskmanagementforum.org/doc/enso-business-interruptionindex-insurance-catastrophic-flooding-piura-peru
- Flooding in 2008 in Lomé, Togo was exacerbated by illegal sand mining, which is simultaneously causing migration that leads to densely populated zones and causes land subsidence. The floods destroyed technical systems essential to Lomé's communications hub, further affecting neighbouring countries, particularly those that are landlocked, like Burkina Faso, http://books.google.ch/books?id=-Ucges8GbC0C&pg=PT199&lpg=PT199&dq=Flooding+in+Lom%C3%A9+Togo&sourc e=bl&ots=1CBr1905bx&sig=aUTTLIOcOFcQhePMUBs3o1ywZZI&hl=en&sa=X&ei=yx GJUJmZDtSN4gSxyIGIBg&sgi=2&ved=0CDkQ6AEwBQ
- The Pasig River in the Philippines is one of the country's main waterways but was also subject to encroachment and waste disposal until 1993 when the "Save the Marikina Project" was launched. This project aims to rehabilitate the river and surrounding areas into recreational zones. For more information please visit http://www.gfdrr.org/gfdrr/sites/gfdrr.org/files/urbanfloods/pdf/Cities%20and%20Floodi ng%20Guidebook.pdf
- The City of New York's "Plant a Million Trees" program is a public-private partnership that was launched in 2009 to plant a million trees and ensure that land and forests upstate are protected from development to preserve the city's reservoirs and water supply,

http://www.lloyds.com/~/media/Lloyds/Reports/Emerging%20Risk%20Reports/Natura 1%20Catastrophes%20in%20the%20US.pdf

Case study 1

Tracking flood risk mitigation implementation:

The out-of-phase pattern of rapid economic development in floodplains and the growth of the flood risk management culture

Author: Robert Muir-Wood, Chief Research Officer, Risk Management Solutions, Ltd.

Executive summary

While long-established towns and villages located themselves on higher ground to avoid all but the rarest floods, when countries embark on a phase of rapid economic development, they typically build in floodplains. Land owners and developers discover that the price of agricultural land can be rapidly inflated when there is permission to build. Inevitably, sooner or later, floods return and once these floods prove sufficiently catastrophic, the level of risk may be viewed as unsustainable, leading to a shift in public investment into flood mitigation measures. These out-of-phase patterns of private "rapid exposure development" followed by publically funded "improved flood risk management" can be traced through the history of a number of countries, for each of which it is possible to identify a date for the "pivotal point", generally linked to the occurrence of one or more catastrophic floods, when the investment priorities shifted. Over the past 50 years, in developed countries, public and private insurance schemes have been established to provide financial protection for residual flood risks once other mitigation measures have been put in place. However, in Thailand in 2011, flood insurance was provided to industrial and commercial properties before the emergence of a proper flood risk management culture, thereby leaving global insurers and reinsurers with calamitous levels of loss. Insurers offering coverage in developing countries will therefore need to pay much greater attention to identifying how the state of flood risk management affects flood risk accumulations.

Case description—introduction

For many countries that have been through a phase of rapid economic development, one can find a characteristic pattern in the evolution of their flood risk exposure and flood risk management. Based on the experience and memory of previous flooding events, older towns and cities are generally sited so as to avoid locations expected to be flooded. (For regions subject to conflict, the risk of flooding may have been managed alongside other risks associated with the prospect of the town or city coming under armed attack.) Where a town's economic function is principally related to a river crossing or port then the growth of the city will have had to accommodate the potential for flooding.

In a period of rapid economic development, private investors tend to build in flat floodplains both because such land has not been previously developed and will be relatively cheap to acquire, but increasingly because modern, industrial, commercial and retail facilities require level floors for production lines, distribution systems and accessways. Even the concept of "flood risk" is very different for land used for agriculture, where floods at certain times of year may be welcomed because of their role in sustaining crop productivity. While the expansion of exposure in floodplains inevitably raises the level of flood risk in a territory, it takes the occurrence of actual flood events before this risk becomes recognised. If these floods are sufficiently catastrophic in disrupting livelihoods and the economy, arguments will be made to divert resources into significant public investments in flood risk mitigation.

One of the earliest examples of this out-of-phase pattern of development in floodplains, followed by the emergence of a flood risk management culture, comes from The Netherlands.

Analysis

1) The Netherlands

Before 1000 AD, in the low-lying coastal floodplain of the southern North Sea and around the Rhine delta, the inhabitants lived on dwelling mounds, piled up to lie above the height of extreme tides. By the 10th century, with a population of what is now The Netherlands estimated as 300,000 people, the first dykes were constructed and within 400 years ringed all significant areas of land above spring tide, allowing animals to graze and people to live in the protected wetlands. The expansion of habitable land encouraged a significant increase in the population exposed to catastrophic floods (Borger and Ligtendag, 1998). The weak sea dykes broke in a series of major storm surge floods through the stormy 13th and 14th centuries (in particular in 1212, 1219, 1287, and 1362), flooding enormous areas (often permanently) and causing more than 200,000 fatalities, reflecting an estimated lifetime mortality rate from flood for those living in the region in excess of 5 per cent (assuming a 30 year average lifespan; Gottschalk, 1971, 1975, 1977).

To adapt to this increased flood risk, major improvements in the technology of dyke construction and drainage engineering began in the 15th century. As the country became richer and the population increased (to an estimated 950,000 by 1500 and 1.9 million by 1700), it became an imperative not only to provide better levels of protection but also to reclaim land from the sea and from the encroaching lakes, and to expand food production (Hoeksma, 2006). Examples of the technological innovations included: the development of windmills for pumping and methods to lift water at least 4m whether by running windmills in series or through the use of the wind-powered Archimedes screw.

Equally important was the availability of capital to be invested in joint stock companies with the sole purpose of land reclamation. In 1607, a company was formed to reclaim the 72km² Beemster Lake north of Amsterdam (twelve times larger than any previous reclamation). A 50km canal and dyke ring were excavated, a total of 50 windmills installed, which after five years pumped dry the Beemster polder, 3-4m below surrounding countryside, and which, within 30 years, had been settled by 200 farmhouses and 2,000 people.

Since the major investment in raising and strengthening flood defences in the 17th century, there was only one major flood in 1717 (when 14,000 people drowned), since which time the total flood mortality has been around 1,000 per century, (with two notable floods in 1825 and 1953), equivalent to a lifetime flood mortality rate (assuming a 50-year average lifetime) of around 0.01 per cent: 500 times lower than that of the Middle Ages (Van Baars and Van Kempen, 2009). This change reflects increased protection rather than any reduction in storminess. Since 1953 the flood risk has been further reduced, by at least another one or two orders of magnitude.

The date of the "pivotal point", from when the overall level of flood risk began to fall (based on metrics such as the average annualised number of people drowned, houses flooded or land lost) as a result of the investment in a strong flood risk management culture, is probably around 1500. Through the late medieval period, risk was rising because of an increase in the population and the number of buildings in the coastal floodplains, as well as rising levels of hazard from long-term delta subsidence (and potentially also an increase in the number or strength of extreme storm surges at this period). This transition period was then followed by several centuries during which there was a long term reduction in the level of risk, achieved through building stronger dykes to protect the floodplains.

As the land of The Netherlands has continued to subside, and as flood defences suffer depredations without ongoing maintenance, inevitably there have been periods of history when risk has been rising (as through the 1940s) before a renewed round of investment, in particular in the aftermath of a catastrophic flood (as in 1953). After 1953, with a principal focus on reducing the risk of marine storm surges, river flood risk was neglected until a scare

in 1995 refocused attention and investment. Risk levels are currently considered to be increasing again through sea level rise and land subsidence (Bouwer and Vellinga, 2007).

The risk management culture in The Netherlands predates even the late 17th century concept of property insurance (and in particular, the post-1960 development of property insurance for floods). Reflecting this heritage, today one cannot purchase flood insurance in The Netherlands. This is based on the argument that the availability of insurance might take the pressure off the government investing in engineering solutions to sustain the level of flood risk below official national targets. (The absence of flood insurance also serves to create the impression that there is no flood risk.) However, as recently as 1995, the potential for floods caused by the failure of river dykes required whole towns to be evacuated for fear of the consequences of defence breaches.

2) Japan

A comparable pattern of out-of-phase exposure growth in floodplains, followed by the development of a mature flood risk management culture, can also be found in Japan.

Away from the coastal plains, the landscape of Japan is mountainous, but almost entirely undeveloped, so that towns and cities cluster around the edge of the surrounding lowlands. Through the middle of the 20th century, Japan underwent rapid economic growth and industrialisation. The expansion of cities and the development of industrial parks, inevitably meant more exposure accumulated in both coastal and fluvial floodplains. Today 49 per cent of the population and 75 per cent of the total property are located on former river and coastal floodplains that together cover about 14 per cent of the land area (Sato, 2006). Some of the highest rates of economic growth were experienced through the late 1940s and 1950s and during this period there was a dramatic increase in the exposure at risk from flooding. The annual number of flooded properties in Japan was around 200,000 properties flooded each year through the late 1930s, rising to an average of around 300,000 properties flooded each year in the 1950s. More than one million properties were flooded in the worst single year in 1953.



Fig 1: Annual number of buildings flooded by typhoons in Japan: 1927-1996

In 1959, the Isewan storm surge flood overwhelmed the coastal defences and inundated large areas around the city of Nagoya. More than 5,000 people drowned. This event shocked attitudes in Japan and government policy on flood risk management. In the 1960 "Disaster Measures Basic Law" a considerable diversion of national resources was identified to support risk reduction. In 1961, around 8 per cent of the national budget (about 1.5 per cent of GDP) was allocated to disaster risk reduction activities. This proportion declined slowly over time, even as the monetary amounts continued to rise. Disaster management activities still consumed about 4.5 per cent of the national budget (and 0.5 per cent of GDP) by the late 1980s, by which time this represented an annual budget of around 4 trillion yen (circa US\$40bn).

Among a range of outcomes across a range of perils, this investment had a significant impact on reducing national flood risk. The concentration of most of the exposure at risk of flooding in large towns and cities meant that it was possible to achieve significant reductions in flood risk through building-engineered flood defences. By the late 1980s, the annual number of properties flooded in Japan had fallen to around 30,000: a reduction by a factor of around 10 relative to the number of annual flooded properties in the 1950s.

Insurance against typhoon was first introduced in Japan in 1984, after the flood risk from typhoon had been largely brought under control. The homeowners' policies for typhoon were designed to refund a component of the associated flood losses (in a series of steps, which ultimately cover about two thirds of the damage cost of a flood). Private insurance was therefore an important component of the overall publically funded flood risk management culture. While hard flood reduction measures (as with flood defences or flood alleviation schemes) could significantly reduce the level of flood loss, they could not completely eliminate it.

Lessons learned

Developing economies in Southeast Asia

Since the early 1990s, a number of countries in Southeast Asia, including Malaysia, Thailand, Indonesia, The Philippines and Vietnam have experienced rapid economic growth. This growth has been manifest in the rapid expansion of urban footprints, and in the development of large industrial parks. Deforestation and urbanisation have further increased the rate of runoff increasing the local hazard from flooding. Major floods have resulted, as for example in Jakarta in 1996, 2002 and the worst of the past century, in Feb. 2007; in Manila in September 2009, 2011 and 2012 and, most notoriously for insurers, in central Thailand in autumn 2011.

Industrial parks in Thailand are developed and managed by the Industrial Estate Authority of Thailand founded in 1972, answering to the Ministry of Industry. As of October 2010, the Industrial Estate Authority had established 42 industrial estates in 15 provinces. Those in the central region of the country north of Bangkok were founded from the late 1980s through to 2003. The parks themselves were established by the private sector and are 60–70 per cent allocated to factories. The Industrial Estate Authority set out to provide all the necessary infrastructure for these facilities, which was claimed to include "flood protection" but without any specification about the return period to which protection was provided.

In the headlong rush for development, investments are focused where they can bring the fastest return, as in developing infrastructure to support new industries and in building industrial plants. Developers in these areas are generally unaware of the risks, or may believe that the government has taken care of the problem. Investments in flood risk management, such as building higher flood defences, do not appear to have any immediate return. However all this can change in the aftermath of a catastrophic flood, when

demonstrable investments in flood prevention may be necessary to convince major corporations to sustain their investment in the region.

In the last two decades, rapid expansion of industrial facilities, shopping malls, etc. into floodplains has also been very prevalent in many developed countries. However, in developed countries there are pre-existing institutions focused around the mapping and mitigation of flood risk, and as a result many floodplain developments will already have gained flood protection. Risk modelling for flood insurance is also becoming well established so that the insurer should have a good understanding of the potential for flood losses.

Following the prolonged flooding of autumn 2011, the Thai government announced significant investment in flood defences to protect the central Thailand industrial parks. Developing all these defences to a sufficient standard is likely to take several years, and significant challenges will remain around operating these facilities in future floods. During a month or longer period of high river levels, even if the facilities themselves can be kept flood free, it will be a significant challenge to sustain sewage disposal, access for workers, as well as deliveries and pick-ups of manufactured goods.

The government in Indonesia has also identified US\$250m in 2011 for the Public Works Ministry to dredge over the next four years three key rivers running through the capital Jakarta. While it is not clear that this represents a dramatic shift in the level of flood risk management it is clearly a step in the right direction.

The novel feature of the 2011 situation in Thailand is that a significant proportion of the industrial estate exposure was insured. Typically, flood insurance is only introduced in a country with an advanced flood risk management culture. The situation in Thailand was a direct consequence of globalisation, in that while the owners of these manufacturing facilities were based in developed countries (principally Japan), with a strong flood risk management culture, they had exported their operations to low-wage developing countries with a poor flood risk management culture. Globally insurance is expanding faster than strong flood risk management. Corporate policies are offering protection for facilities in countries without any appreciation of the underlying risks. This has itself been driven by a belief among international re/insurers that diversification is a virtue in spreading risk, irrespective of whether the actual level of risk is known or modelled.

After the proposed future investment in improved flood defences in Thailand, the level of residual flood risk in the industrial parks in the centre of the country should be insurable. However there will still remain a great concentration of manufacturing facilities within each industrial park as well as multiple industrial parks located in a single river floodplain. The industrial development policies that encouraged the development of these industry clusters are antithetical to the underlying principles of diversification that define insurance.

The role of flood catastrophe loss modelling in this situation should be to identify the locations at greatest risk as well as highlight concentrations of flood exposure before the occurrence of a catastrophic flood.

Conclusion

Economic development typically leads to a significant expansion of the exposure at risk of flooding, as new building becomes concentrated in previously undeveloped locations in floodplains. This phase of development typically lasts until one or more catastrophic floods occurs which, to prevent people abandoning the new settlements or industries, then leads to a corresponding phase of investment in flood risk reduction.

In considering the level of flood risk in different countries it is therefore useful to understand where the country or region is situated on this out-of-phase path of development and flood risk management. The Netherlands has been involved in active flood risk management since

around 1500. In the U.S. a significant phase of investment in flood risk reduction followed catastrophic floods in the 1920s and 1930s. In Japan major investments in flood risk management began around 1960. It is believed that the pivotal point in China was passed around the year 2000 with significantly increased levels of investment in flood risk reduction. In many developing countries, the pivotal point that marks the beginning of major investment in flood risk reduction lies somewhere in the future.

A consequence of the behaviour discussed in this paper is that trends in international economic or insured flood losses cannot readily be used as potential indicators of increased flooding related to climate change. Countries embarked on rapid development tend to locate much new exposure in floodplains, and hence an increase in flood losses may be a signal of rapid economic development. In the second phase of major investment in improved flood risk management, flood losses will become reduced through better defences and flood control, as has been the case in Japan where the average number of properties flooded reduced by a factor of 10 from 1960 to 1990. The strong signals related to expanded exposure to risk and improved flood risk management are likely to dominate all other flood signals related to climate change, in particular where such trends cannot be detected independently from observations of extreme river flows.

Case study 2

U.S. National Flood Insurance Program (NFIP)

Written by Meghan Orie, Researcher, The Geneva Association

Based on: Lloyd's *Managing the Escalating Risks of Natural Catastrophes in the United States* and Michel-Kerjan, E. (2010) "Catastrophe Economics: The National Flood Insurance Program", *Journal of Economic Perspectives* 24(4):165–186

Executive summary

The U.S. government runs a national flood insurance programme, supplementing it with U.S. Treasury loans and *ex post* catastrophe funds, because for various reasons the market for private flood insurance is small in the U.S. The programme offers risk-based premiums for newer properties but subsidises a large number of older high-risk properties, rendering the programme grossly indebted. In addition, the low pricing of insurance undermined the incentive to mitigate risk and instead encouraged repetitive development in the vulnerable areas it covers.

Case description

The National Flood Insurance Program (NFIP) was created by the U.S. Congress in 1968 to provide flood insurance protection associated with hurricanes, tropical storms and heavy rain when flood insurance was considered to be an undesirable line of business.⁴ For this, NFIP produces floodplain maps, designating risk in different flood zones and sets deductibles and premiums. In return, property owners in participating local communities are eligible to buy NFIP insurance. It is optional for local community members; however, prospective property owners are legally obliged by federally-regulated mortgage lenders to purchase NFIP insurance when taking out a loan to buy property in Special Flood Hazard Areas (SFHAs) (GAO, 2007). Programme participants are also supposed to commit to sound floodplain management and related disaster mitigation measures, such as ensuring that buildings adhere to specific building codes. Implementing these measures is overseen by NFIP's Community Response System (CSR) and should lower the risk the buildings are exposed to, thus qualifying members for lower premiums.

The NFIP engages in a public–private partnership called the Write-Your-Own Program with roughly 90 property and casualty (P&C) insurance companies who write and service NFIP insurance policies in their own name but bear none of the risk. NFIP benefits from private insurers' marketing and distribution channels while member insurers of the WYO receive an "expense allowance".⁵

As of March 2011, approximately 5.6 million properties were insured by the NFIP. The programme, "...is designed to be financially self-supporting, or close to it, most of the time, but cannot handle extreme financial catastrophes by itself" (Michel-Kerjan, 2010). From a claims-paying perspective, the programme has been relatively successful. In fact, until 2006, NFIP paid out almost 95 per cent of its claims from Hurricane Katrina. It was not until a number of other natural catastrophes occurred that same year that it had to it take out an US\$18.6bn loan from the U.S. Treasury, an act it was designed to do in cases of extreme

⁴ The programme was originally intended to be supplemented by private insurance and today there are some supplementary private insurance options.

⁵ The members of the WYO Program receive in total roughly one third of premiums or 50 per cent of loading costs as an "expense allowance", according to Michel-Kerjan (2010). For instance, for servicing and selling policies to farmers under the national crop insurance programme, insurers receive 24 per cent of unsubsidised premiums.

natural catastrophe. For the natural catastrophes occurring after Hurricane Katrina, it is unlikely that it will be able to pay out all claims.

Despite its capacity for the most part to consistently pay out claims, the programme is not adequately funded because the premium rates have not covered the government's exposure and it has relied on *ex post* funding mechanisms to cover catastrophic losses (GAO, 2007). *Ex post* funding mechanisms seem to be generally less efficient and effective than *ex ante* funding mechanisms. The NFIP faces certain challenges that have exacerbated its reliance on *ex post* funding and which have made the programme insolvent in cases of extreme natural catastrophes, including issues of moral hazard, lack of insurance penetration, floodplain management and relatively unmonitored administrative costs. NFIP has been running a deficit since 1968, as it has been rolling over expenses year after year.

In June 2012, the Biggert-Waters Flood Insurance Reform Act was passed. This piece of legislation renewed and fiscally reformed the programme, as will be discussed later. It is still too early to determine the reform's outcome.

Analysis—subsidising high-risk properties?

Since its establishment, the programme has campaigned to expand the number of policyholders it covers. Homes built after the creation of flood maps to an approved building code in floodplains pay what NFIP considers actuarially sound premiums, or premiums that are "sufficient on average to cover the total flood claims and administrative costs for those policies based on the agency's maps and its estimates of the frequency of different size floods" (Congressional Budget Office, 2009).

However, NFIP must legally offer reduced premium rates for homes that were built in floodplains prior to the creation of Flood Insurance Rate Maps (FIRM). Subsidised policies comprise roughly one quarter of NFIP policies. Even with somewhat higher premiums, these participating members still only pay roughly 40 per cent of the risk-based rate. Originally rates were subsidised in order to attract policyholders with the hope that ultimately as the housing stock turned over, fewer policies would be subsidised, but this process is taking longer than expected. According to Derrig and Tennyson as cited in Sandink *et al.* (2010), this price interference has forced some insurance companies out of the market while others have failed.

First, many of NFIP policyholders profit from a lack of risk-based pricing. Risk-based pricing would provide disincentives to build or rebuild in high-risk or vulnerable areas. Without it, moral hazard is encouraged,⁶ leading to repetitive losses. An estimated 25--30 per cent of claims paid are for repetitive losses on homes that are most prone to flooding. Repeat claims on underpriced premiums create large liabilities for the taxpayer. Attempts to provide incentives to mitigate risk through the CSR programme have been relatively unsuccessful mainly due to communities' lack of understanding of insurance. As a result, Congress has been attempting to mitigate these repetitive losses, particularly in vulnerable areas, by acquiring the properties, re-locating property owners or demolishing flood-prone structures, turning the properties into open space, though it is still too early to determine whether this programme is successful.

Second, policyholders with properties located both within and outside SFHAs are surrendering their policies after short periods of time. For these ex-policyholders, the government may experience political pressure post catastrophe to rely upon its *ex post* funds to cover damage instead of relying on NFIP. For SFHAs, mortgage lenders—who are legally supposed to ensure that policyholders in SFHAs own NFIP policies—are losing track of them as the accounts are transferred to capital markets. The oversight mechanism is faltering. Thus policyholders who live in SFHAs are able to surrender their policies instead of repeatedly renewing them as they are supposed to. Generally, most policyholders surrender

⁶ Moral hazard is the effect of having insurance on one's behaviour. Having insurance changes the costs of misfortune and therefore, people may make less of an effort to avoid misfortune.

their policies after only two to four years. According to Michel-Kerjan *et al.* (2012), they see insurance as an investment and, if after a certain period it does not pay off, then they opt out of the policy, meaning that they misunderstand the function of insurance. Other reasons could be that policyholders choose to use their budget for other purposes or have a disincentive to purchase insurance because the federal government's provision of *ex post* funds covers property damage after a flood.

In addition, NFIP tends not to transfer risks into international capital markets through reinsurance. Public finances may have to carry debt into the future. NFIP owes the U.S. Treasury roughly US\$1bn per year and US\$17.8bn in total. It is in great need of financial reform (United States Government Accountability Office, 2007).

Third, floodplain management plans are often not enforced or are out of date. Out-of-date maps mean that policyholders in higher-risk zones may not be paying accurate risk-based prices nor are proper mitigation measures being implemented, exposing older buildings to high levels of risk (Burby, 2001). Updating floodplain maps is politically undesirable since it means expanding the higher-risk zones, which could decrease the value of people's property and require them to pay higher premiums. This further contributes to the NFIP's deficit.

Last, an issue affecting the solvency of NFIP is the administrative cost affecting the WYO Program. A 20–30 per cent loading cost is normal for insurers who take on the risk of the premiums they sell, but NFIP's insurance members do not bear risks. FEMA does not have the information it needs to determine whether WYO payments are reasonable and the amount of profit to the WYOs that are included in its payments. According to the United States Government Accountability Office (GAO) (2009), "Considering actual expense information would provide transparency and accountability over payments to the WYOs."

To address these solvency issues and pay back its US\$18bn debt, the Biggert-Waters Flood Insurance Reform Act was passed in June 2012. Among the changes, NFIP will phase out subsidies on properties with repetitive losses and cap annual premium increases at 20 per cent—10 per cent more than last year's cap. Second, it importantly establishes a technical mapping advisory council to modernise the floodplain maps, and therefore can re-zone areas so that premiums more closely reflect the area's risk. Third, it will include minimum deductibles for flood claims. Fourth, the legislation allows FEMA to purchase reinsurance, further transferring risk into the capital markets (Widmer, 2012). Last, the WYO Program will remain unchanged.

Though these alterations do not address NFIP's administrative issues, they do facilitate diversified risk and actuarially sound premiums. Risk-based premiums and the requirement for a minimum deductible should provide disincentives for moral hazard and discourage repetitive losses. Ultimately, these reforms should make the programme fiscally sound. The Congressional Budget Office (CBO) claims that they would "reduce NFIP's need to borrow by \$380 million between 2012 and 2014 and result in a net income increase of \$4.7 billion by 2012" (Widmer, 2012). However, they may not be sufficient for NFIP to pay back its debt to the U.S. Treasury.

Lessons learned

- Frequently updating flood maps will allow NFIP to charge better risk-based premiums.
- Lowering subsidies over time could encourage more policyholders to move or engage in risk mitigation measures.
- It is essential for the government to raise awareness of the importance of insurance and to explain how it works.
- Transferring risk, whether through reinsurance or natural catastrophe bonds is a solution to the centralisation of risk.
- NFIP could oversee mortgage lenders to ensure that Special Flood Hazard Area (SHFA) properties have flood insurance.
- NFIP could offer flood insurance under longer-term contracts, or multi-year flood insurance contracts (Michel-Kerjan, 2010).

 Raising insurance premiums may be politically difficult but necessary to achieve more actuarially sound premiums.

Conclusion

This case illustrates the financial difficulties of a public programme that is not based on riskbased premiums but also the challenges of providing a service to a public that knows little of how the system of insurance functions. NFIP has underpriced a large portion of its contracts by subsidising higher-risk and less risk-mitigated properties and operating with out-of-date floodplain maps. These policies encourage moral hazard and repetitive losses which further jeopardise NFIP's ability to pay for catastrophe-caused losses without relying on tax payments or *ex post* emergency funds. This structure has also crowded out more recent private initiatives, though the U.S. government will soon study whether private insurance could take over the flood insurance market.

Part of the programme's difficulty is that the public lacks understanding of how insurance works and the incentives or obligations to accept reforms and continuously participate in the programme. Updating flood maps has been resisted by the public because expanding high risk or vulnerable areas can lower property prices and increase flood premiums. In addition, local policies have been surrendered and the Community Response System (CSR), a programme that incentivises disaster mitigation measures, has been unsuccessful because the public sees little of their value. It is thus important to raise awareness of insurance's worth and the importance of investing in risk mitigation measures.

The U.S. government's enactment of the Biggert-Waters Flood Insurance Reform Act supports the notion that risk-based pricing is the most efficient and effective way to rate insurance risks, cover the cost of losses and protect policyholders from future losses. These changes should render the programme more fiscally sound, but it is too soon to tell whether the reforms will allow NFIP to repay its debt from 2008.

Case study 3

The 2011 Thai floods

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Executive summary

The 2011 Thai Floods caused major damages and economic losses primarily in housing, tourism, agriculture and manufacturing. Private industry had inadvertently exacerbated manufacturing disruptions by grouping large manufacturing centres far from one another. This combined with a lack of risk mitigation measures changed insurers' assessment of Thailand's risk exposure. Increased risk exposure is changing the insurance market in Thailand and leading the government to supplement its disaster risk measures with weather-index crop insurance and a public–private catastrophe fund.

Case description

Beginning in July 2011, the combination of the remnants of tropical depression Haima and tropical Storm Nok-ten led to severe flooding in 65 of Thailand's 77 provinces, mostly in the Mekong and Chao Phraya basins (AFP, 2011), and led to major manufacturing disruptions by the end of October. As of 1 December 2011, the total economic damages and losses of the Thai floods, according to the World Bank, were THB1,425bn (US\$45.7bn). Manufacturing suffered the most significant losses, followed by tourism, housing and agriculture.

Analysis—vulnerable technical systems

Though Thailand has perennially experienced yearly flooding, insurers had assessed it as at low risk for natural catastrophe until 2011. Thailand's risk exposure changed mainly due to nascent economic development⁷ and its subsequent consequences: urbanisation due to population growth, large-scale industrial agriculture and the construction of industrial estates. These activities changed economic land use patterns, damaging ecosystems that can mitigate the effects of a natural catastrophe.

Japanese companies had been moving their operations into Thailand to avoid the strong yen for some time. They built their industrial complexes in paddy fields in the central plains, as they were ideal for the construction of large production buildings but prone to flooding, exacerbating flood risk. Industry there has heavily pumped groundwater, causing land subsidence.⁸ The 2011 floods, then, inundated industry, interrupting all business activity and leaving the industrial complexes flooded by 1–3.5 metres of water, leading to environmental pollution.

Increased economic development also leads to increased losses. Manufacturing losses of at least THB1,007bn (approximately US\$32bn) occurred not only because of the damage to factories but also because of the large scale of disruption in manufacturing operations caused by the flood. According to the Labour Ministry more than 14,000 businesses had to close nationwide due to flooding and seven major industrial estates in the central region were damaged. These supply chain disruptions greatly increased the profits lost globally. Car

⁷ Thailand is a middle-income country that enjoyed solid growth, averaging more than four per cent a year from 2000 to 2007. However, its stable growth has been recently marked by political turmoil and the Thai floods.

⁸ Land subsidence is the gradual sinking or caving in of soil in areas that have flat, low-lying topography and in the presence of a thick soft clay layer at the ground surface, like Thailand's central region (Phien-wej *et al.*, 2006). This sinking typically puts these areas at greater risk for floods.

manufacturers, electronics manufacturers and farmers were mainly affected (Courbage *et al.*, 2012).

These private sector industries had disregarded the lessons of risk management, increasing their economic vulnerability. The global manufacturing supply chain, for example, ignores the relationship between economy of scale and dis-economy of risk: the smaller the number of larger plants, the higher is the risk of interruptions; the bigger the distances between the members of the supply chain and the smaller the stocks, the higher is the risk of supply chain interruptions. According to Courbage *et al.* (2012):

"The 2011 Thai floods increased the awareness of many multinational companies to the vulnerabilities of supply chains that they have perfected for years to make them more efficient in order to lower costs... But business interruption at, or even the resulting bankruptcy of, suppliers may have no direct financial repercussions on the global manufacturers themselves. The increased awareness does then not lead to changes, primarily because increasing inventory even by a small amount to avoid supply shortages can cost large companies millions of dollars."

While the Thai government had disaster risk reduction plans, it failed to fund and effectuate them effectively. According to many experts, this results from political instability—including a powerful and politically engaged military—social polarisation and public mismanagement (Montlake, 2012), revealing problems in general and issues in disaster risk reduction governance (Thai Travel News, 2011). Among many complaints, were that the government failed to act on early weather warnings, had faulty storm tracking computers, poor flood protection organisation, and poor flood fortifications (Guy Carpenter, 2011).

The impact to the insurance industry—insured losses and flood insurance

Flooding in Thailand set a new loss record, making it not only the country's most expensive catastrophe to date, but also the world's most expensive flood disaster. According to Standard and Poor's (2012), estimates for the Thai floods currently concur with an insurance market loss range of US\$16bn to US\$18bn. Of these losses it expects 10 to 15 per cent to be retained by the domestic market, 65 to 70 per cent by Japanese joint ventures or local subsidiaries and parent company branches in Thailand and up to 20 per cent by regional operations of international insurers. However, calculating the true cost of the floods could take years in terms of working out the lost business to Thailand. Indeed, there are many difficulties and much uncertainty in accurately estimating income lost to production shutdowns, and incurred costs due to supply chain disruptions and damage to property and equipment. In addition, loss adjustors only had limited access to sites beginning in mid-December.

Less than one per cent of households in Thailand have insurance coverage for floods. Mandatory household insurance only covers fire but the owner can buy additional protection for floods for only 0.02 per cent of the sum insured, according to the General Insurance Association (GIA). Due to this marginal penetration of flood insurance for residential properties, the losses came almost entirely from manufacturing and supply chains. Most commercial properties such as factories have industrial all-risk (IAR) policies with flood cover, with almost 100 per cent of the sum covered. Production or business interruption cover is separate from industrial all-risk policies. The majority of the multinational firms in Thailand either buy coverage from foreign insurers or self-insure through captive insurance operations. Japanese insurers write most of the commercial property/casualty business in Thailand. As the primary carriers make significant use of reinsurance, the net impact to the Japanese insurers on a risk basis is not expected to be significant unless the event limit might be breached (A.M. Best, 2012).

Property insurance cover in Thailand is shrinking fast in the wake of the country's severe floods and reinsurers are pulling back on underwriting in Thailand. French state-backed insurer Caisse Centrale de Rassurance S.A. announced that it has quit underwriting in

Thailand, as well as in New Zealand and Australia, as a result of several natural disasters. In 2012, flood coverage will be separated from IAR policies (A.M. Best, 2012).

Some even predict that multinational reinsurers will more than double premiums for flood and all-risk policies while capping flood coverage. Primary insurers have started imposing flood coverage sub-limits, with some covering a mere 20 per cent of the amount insured, and rate hikes of up to 30 per cent as insurers now consider Thailand a high-catastrophe-risk country contrary to what it used to be.

Public—private catastrophe-risk fund

Due to concerns about the insurance industry's ability to absorb another hit in the future and to make affordable coverage for natural catastrophes, the Office of Insurance Commission (OIC) recently planned to set up a THB50bn (US\$1.6bn) catastrophe fund to provide insurance coverage for floods, windstorms and earthquakes. This risk-sharing scheme between the Thai government and the Thai non-life insurance sector will offer protection for households, small and medium enterprises and industrial factories. The fund will provide cover for the three main natural catastrophes to which Thailand is exposed, floods, wind storms and earthquakes. This catastrophe fund will act as a primary reinsurer and the fund will purchase a reinsurance programme to enhance capacity. Under the fund, catastrophe losses between THB30bn and THB500bn would be reinsured by foreign reinsurance companies, according to the OIC. Insurance companies will be responsible for cover of losses up to THB2bn. The government would take over losses between THB2bn and THB30bn through the catastrophe fund. The government-backed catastrophe fund will be run by an independent committee. The catastrophe fund may struggle to secure that level of reinsurance coverage in the current market at a reasonable cost as rates for Thai exposures have risen after the floods. This may lead the government to explore the use of the alternative risk transfer and capital markets to provide this funding either through some sort of risk pooling or even instruments such as catastrophe bonds (Artemis, 2012).

Initially, the catastrophe fund would be sub-limited to THB100,000 per household; 20 per cent of the sum insured with a limit of THB5m per small and medium enterprise; and 10 per cent of the sum insured with a limit of THB50m per industrial company.

Crop insurance

Many farmers were impacted by the devastating 2011 floods and very few had crop insurance. Actually crop insurance has only recently become available in Thailand. It was implemented locally in the 2009–2010 cultivation season, and was offered to farmers nationwide for the first time in 2011 (Bangkok Post, 2012). This insurance is jointly implemented by the Bank for Agriculture and Agricultural Cooperatives (BAAC) and the General Insurance Association, and thus far covers, in a limited capacity, seasonal rice crops only. Premiums are subsidised by the government and collected by the BAAC, which acts as an intermediary and forwards the premium to private insurance companies. The plan charges a low premium of THB129.47 per rai (1,600 m²), putting premium income at THB130m but with a payout as high as THB400m last year. With such low premium income, few insurers have joined the programme. Faced with this limited insurance capacity, the BAAC is proposing a crop insurance fund to provide higher risk cover from natural disasters. The fund should begin with at least THB5bn (US\$164m) in its coffers, providing protection for valued crops like rice, maize and tapioca. The new fund could compensate farmers at full cost, such as THB5,000 a rai for rice farmers, and more for orchard growers. A possibility, as proposed by The BAAC could be to merge the crop insurance scheme with the government catastrophe fund.

Another form of insurance for agricultural risk that has been available since 2010 in Thailand is weather index insurance. This insurance product is designed to provide insurance payments when weather variables (like temperature or rainfall) reach certain predetermined levels. Japanese property insurance firm Sompo Japan in cooperation with the Japan Bank

for International Cooperation (JBIC), currently offers such insurance to rice farmers in Khon Kaen province in northeast Thailand, as part of its climate change adaptation initiative. The development of weather index insurance requires highly reliable long-term meteorological data. Khon Kaen Province has relatively precise meteorological weather stations, making it a suitable target for product development. So far, the product was quite successful with 6,000 applications received for the first four month of 2011 (Sompo Japan, 2011).

Lessons learned

- Alternative risk transfer and capital markets can provide funding through risk pooling and catastrophe bonds depending on the availability of affordable reinsurance.
- Weather-index insurance for crops can be effectively used as a part of climate change adaptation initiatives
- The government can enhance risk awareness:
 - implementing strict zoning and building code standards and providing subsidies for mitigation practices undertaken,
 - o investing in public protection infrastructure,
 - facilitating communication and coordination *ex ante* and *ex post* in disaster risk reduction initiatives, and
 - promoting early warning systems.

Conclusion

As Robert Muir-Wood discussed in the first case study, Thailand's out-of-phase patterns of development have benefitted from the exportation of manufacturing from developed countries with a strong risk management culture to low-wage developing countries where the flood risk management culture is weaker. However, the absence of urban planning combined with the rapid growth of industrial estates created new vulnerabilities with high potential losses. The 2011 Thai floods exposed these vulnerabilities and caused substantial economic damages and losses. With globalisation these losses are no longer limited geographically.

Globalisation has also made technical systems increasingly vulnerable. One of the underlying problems is that economy of scale goes hand in hand with dis-economy of risk. The challenge is to connect better with existing bodies of knowledge and to develop tools to predict hazards caused by technical systems with the aim of reducing future economic and insured losses. Claims could include global business interruption in just-in-time manufacturing chains caused by natural catastrophe losses or subsequent power cuts. The Tohoku earthquake and tsunami and more recently the Thailand floods caused the shortages of electronic components and car parts in manufacturing plants in North America and Europe after 11 March 2011 and exemplify this vulnerability.

Given the severity of the floods, the Thai government seems to be under pressure to simultaneously invest in risk mitigation measures (thereby reaching its "pivot point") while attempting to facilitate risk-transfer mechanisms like a public–private catastrophe risk fund and weather-index crop insurance, and issuing catastrophe bonds. That said, it is too early to determine whether the financial or physical measures taken by the Thai government will be effective.

Case study 4

De-polderising⁹ The Netherlands

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Executive summary

The government-implemented "Room for the River" Programme (*Ruim te voor de rivier*) flood proofed buildings in order to protect specific zones against the risk of river flooding. The government's strategy is to invest in flood prevention measures and to compensate loss with *ex post* catastrophe funds as for historic reasons, flood insurance is unavailable in The Netherlands. The "Room for the River" Programme is a part of a broader paradigm shift in flood protection measures from a technocratic, top-down process to the "greening of water management". This inclusive process focuses on restoring the water system to a more natural state.

Case description

Sixty per cent of The Netherlands is at or below sea level; two-thirds of Dutch people live in flood-prone areas; and 70 per cent of Dutch GDP is produced in areas that are at risk of flooding (Jones-Bos, 2011). The government has for decades adapted to these circumstances with a "delta works programme", by building ever higher dykes or levees and consequently turning floodplains into "polders", or by draining entire bays (such as the Zuidersee), and converting them into land. This newly dried land was then developed, for the most part, into farmland. While these dykes protected flood-affected areas, they also simultaneously left them more vulnerable. When the waters did breach the dykes, they caused devastating losses in life and wealth, such as the 1953 floods. According to Swiss Re, flood protection on the coast is very good, as the dykes are designed to withstand events with return periods of 4,000 to 10,000 years. However, areas along the river required more protection (Swiss Re, 1998).

The government decided to change its flood-mitigation strategies after the country experienced a series of dyke-breaching floods in the 1990s and when the government was confronted with the limitations of its evacuation capacities after observing the shortcomings in the U.S. during Hurricane Katrina.

In 2005, the government began a \in 2.2bn "Room for the River Programme", which effectively "de-polderised" the country by deepening riverbeds, moving dykes inward and allowing the plains to be potentially flooded at 39 locations along the Meuse, Rhine, IJssel and Waal rivers. It paid market value to the farmers who had settled on the polders to either move elsewhere or compensated them to raise their farms by moving them onto a mound or "terp". Nevertheless, the government is aware that waters could still breach the dykes, and is mitigating the consequences of a flood at these locations. For example, the city of Rotterdam has built a 10,000-cubic-metre-tank into a new, underground car park. The tank is large enough to catch 25 per cent of the water from a "once-in-a-century flood" (*The Economist*, 2012).

Analysis—protection without insurance

After a major flood in 1953, the Dutch Association of Insurers legally forbade its members from insuring flood damages caused by the failure of flood defences because they were

⁹ The Dutch word "polder" means dry land created by enclosing floodplains (or shallow waters) with dykes. Thus "depolderising" the land translates to removing or lowering the surrounding dykes and turning land back into floodplains.

concerned about business continuity (Jongejan and Barrieu, 2008). This debate was reopened after the devastating floods in the 1990s. After the dykes were breached, and due to the lack of flood insurance available, the federal government was pressured to pass the Calamities Compensation Act (1998) under which the government serves as a backstop for catastrophe insurance by providing a government compensation fund (*ex post* funds) that pays ad hoc compensation for loss or damage which cannot be (commercially) insured up to a maximum of \in 450m per year and only under certain circumstances (Paklina, 2003). Despite limited and inconsistent coverage, this public compensation is crowding out the private market.

Also in the 1990s, the Council of State, the Dutch supreme administrative court, advised against establishing a public-private partnership with the Dutch Association of Insurers because the Dutch government is responsible for the "habitability of the land". If the government were no longer to pay for natural disasters, it would deny its responsibility for events that threaten national interests (Jongejan and Barrieu, 2008). It was not until 2006 that a committee was installed to evaluate the government's framework for handling uninsured losses. It recommended that the government consider private sector solutions for floods, which the Dutch government pursued because it had become increasingly reluctant to provide this ad hoc compensation and was attempting to stimulate the development of new private insurance arrangements to alleviate budget pressures.¹⁰ Until 2010, discussions took place between the government and the insurance industry about engaging in a public-private partnership, where insurance would cover a certain limited amount of an extreme loss and the government would cover the rest. However, these discussions stopped in 2010 due to the economic crisis. Such a scheme would likely have been compulsory and it would have increased the insurance premium people had to pay in the short-term, putting downward pressure on people's income (Botzen, Interview).¹¹

The debate about who should provide flood loss compensation in The Netherlands touches upon a political decision whether risk transfer mechanisms should be privatised, as governments tend to be responsible for risk reduction mechanisms, whereas insurance can provide knowledge on these measures, provide proper risk assessment and allocation mechanisms, speed up loss adjustment services and provides effective incentives to reduce risk exposure (Monti, 2011).¹²

The "Room for the Rivers Programme"

The best alternative solution for the Dutch government was for them to focus on flood protection. The Room for the Rivers Programme is one flood protection strategy among many, ensuring that primary flood defences meet their statutory safety standards and reduce the extreme water levels (10–40 cm) to lower the probability of a breach of primary flood defences¹³ with the cooperation of 17 partners including the provinces, municipalities, water boards and Rijkswaterstaat. Ultimately the Minister of Transport, Public Works and Water Management bears the overall responsibility for the programme to create safer and more attractive river regions. The programme is thus the result of a paradigm shift in thinking about flood protection from a technocratic, top-down process towards the "greening of water management", an inclusive process that focuses on restoring the water system to a more natural state and "living with water" rather than attempting to control it. This shift started in the 1980s and 1990s (Huitema and Meijerink, 2009).

¹⁰ Botzen and van den Bergh, 2008; Jongejan and Barrieu, 2008; Collins, 2009; Bouwer *et al.*, 2007.

¹¹ In any case, costs are currently paid indirectly via taxes if the government compensates damages.

¹² For more information see the WMO's excellent piece "Risk Sharing in Flood Management: A Tool for Integrated Flood Management".

¹³ Even though the government compensation scheme lowered a group of survey participants' willingness to buy insurance, there was still a large number who wanted to buy private flood insurance because they realised the uncertainty of being paid out after a catastrophe (Botzen and van den Bergh, 2012).

While Dutch citizens are highly aware of flood risks, they may feel a false sense of security because of the extensive protective works in The Netherlands, which could encourage risky behaviour. Establishing an inclusive process for creating the programme raised awareness of the value of flood protection. Citizens were consulted multiple times at different stages of project development. For example, the Fourth Memorandum on water management was created in an open planning process with 3,000 participants, a major change from the earlier engineering discussions (van der Brugge et al., 2005). And while the national authorities set safety frameworks, regional and local branches of government elaborated on it with residents' input and then projects were ultimately approved by the state secretary of Infrastructure and the Environment. This is a key new development because local levels of government can make spatial adjustments more palatable for people and demonstrate the value of the spatial changes (Stam and Severign, 2012).¹⁴ Brouwer and van Ek's (2004) costbenefit analysis demonstrated that traditional flood control policy is the most cost-effective option, particularly given that dyke infrastructure is already in place. However, land use changes and floodplain restoration "can be justified economically in the long run (next 100 years) if, besides the expected value of the damage avoided, the additional non-priced socioeconomic and environmental benefits associated measures are also taken into account."¹⁵ In sum, the Room for the River Programme has the added value of encouraging public awareness of water system dynamics and resilience, capturing stakeholder interest, and increasing environmental values.¹⁶

Supplementing these programmes are two policies "Retain, Store, Drain" and "Living With Water." They encourage neighbourhoods to retain water where it falls, build floodable parks and legally require certain houses to use cisterns. Living With Water requires that urban planners and water managers create communities wherein water is a cherished asset and not something to fear. In addition, the locations chosen to be de-polderised were mainly rural farmland and were mandated not to be further developed.

The Room for the River Programme directorate (PDR) ensures that the national and regional levels share information and stay in contact. It also monitors the budget and guides the processes. This keeps the programme on track and facilitates communication between different levels of government (Stam and Severijn, 2012).¹⁷ In addition, EU initiatives like FloodResilienCity (FRC) and Adaptive Land Use for Flood Alleviation (ALFA) facilitate better information-sharing for flood protection between European cities. The Dutch government also works with neighbouring countries to make shared rivers safer.

Programme controversy

Despite this more open and participatory process, there are still some criticism of and resistance to the programme.¹⁸ Indeed, negotiations for demolishing houses were difficult in Nijmegen, but the local population was able to participate by designing how to use the waterfront area, putting in floating restaurants and a Marina (ClimateWise, 2012). According to Huitema and Meijerink (2009), the new ideas for river management have not completely supplanted the "old" ways of managing the rivers. Though nature development is formally part of the design task, stringent safety regulations and a low budget may constrain advancement of the "greening of water management." But it is nonetheless a laudatory process that was, in very basic terms, hard won through individual initiatives and coalitions, pursued by various actors and that the government ultimately accepted and is implementing with strict standards the provision of national security for its people.

¹⁴ Personal Communication on 7 June 2012.

¹⁵ For the long-term horizon, "certain assumptions were made on cost benefit analysis and the valuation of the flow of costs and benefits in time through the applied discount rate" (Brouwer and van Ek, 2004). Assumptions are also made on the area's economic development and value of protected assets.

¹⁶ The cost benefit analysis shows the same if the environmental benefits are monetised

¹⁷ *Ibid.*

¹⁸ See Wolsink"(2005).

Programme disadvantages: a role for the private sector

The government discussions in the 1990s on public–private partnerships demonstrate that insurance could play a greater role in Dutch flood risk transfer and in some aspects of risk evaluation. The disadvantages to excluding insurance from risk mitigation strategies are:

- When the system does fail, damages are substantial and *may* be partially compensated by the government, as "determination of the extent of the compensation provided, lies with the government that is in office when the disaster takes place. Therefore, these decisions are influenced by political will and public pressure" (Botzen and van den Bergh, 2008).
- Though the Room for the Rivers Programme increases environmental values, this may not translate into preventative action. Basing a compensation system on risk-based premiums would incentivise individuals to engage in less risky behaviour and risk mitigation measures, such as flood-proofing or retrofitting homes.
- Like the NFIP, risk spreading is not optimal. With a government compensation programme, all risks are born by the Dutch government (taxpayers) and are not hedged on (international) insurance markets.

Given the challenges of low-probability, high-loss events like floods, the government would likely need to establish a public-private partnership with insurers in order to encourage them to offer flood coverage. If the government were to do so, it seems most suitable for it to reinsure industry coverage. In fact, during the post 1990s floods, this was the proposed form of partnership discussed by the government and the insurance industry. Such an arrangement would ensure that the government would still ultimately remain responsible for the habitability of the land while shifting some of the financial responsibilities to the private sector as well as benefitting from insurance's operational capacities, efficacy and expertise.

Lessons learned

- The government has a strong role to play in risk reduction. Governments and citizens should decide to what extent insurance should play a role in risk transfer and reduction.
- Advantages to having private insurance are that insurance is contractually bound to pay its obligations, whereas government post-catastrophe payouts may be determined by politics.
- Insurance could contribute by spreading risk internationally, while government-run programmes may not.

Conclusions

The Dutch have a long history of managing the risk of floods (see Robert Muir-Wood's case study) and the Room for the Rivers Programme demonstrates the iterative nature of flood risk management. New dyke breaches require reassessing strategy and flood protection structures. After the floods in the 1990s, the Dutch government attempted to take regulatory and legislative actions to further mitigate flood risks by setting up a public–private partnership with insurers. When this attempt was foiled by the 2008 financial crisis, a new strategy was pursued.

The Dutch government launched the Room for the Rivers Programme for which it ensured that primary flood defences meet their statutory standards and reduce water levels, but also shifted flood protection thinking from a technocratic, top-down process to an inclusive process of "greening water management" which has the added value of raising awareness of water system dynamics and resilience.

The Dutch government has taken a proactive approach in order to limit damages in the case of a natural catastrophe. It effectively translates policy into programmes; ensures that all levels of government communicate about policy measures and coordinates flood planning with neighbouring countries, and importantly, it invests in the programmes to prevent future losses. In fact, the Dutch have developed an industry of promoting their water-management strategy. However, insurance still could play a larger role in risk reduction and risk transfer by providing valuable and effective services, including claims payment management, technical know-how, risk transfer services and disincentives to engage in risky behaviour.

Topic II

Earthquakes and natural perils

Earthquakes¹⁹ may be the most destructive natural disaster in terms of loss of life and property damage. Roughly 10,000 people die annually in earthquakes mainly due to building collapse, with earthquake economic losses reaching a record high of more than US\$226bn in 2011 (Swiss Re, 2012). These damages can be compounded by secondary hazards—like aftershocks, mudslides, fires and tsunamis—that can enlarge the affected area. For example, the 2003 tsunami triggered by the Sumatra earthquake caused havoc and a large number of causalities in distant Ceylon and other regions. It is, then, reasonable to consider earthquakes and natural perils in tandem.

While earthquake-affected zones are well known, an earthquake's timing, force²⁰ and area affected are difficult to anticipate. As is the case for floods, these uncertainties make it difficult for insurers to predict adequate capital reserves. Thus, it is important to target at-risk areas with effective risk management and risk mitigation measures to contain damages and prevent untimely deaths.

While no risk can ever be completely mitigated, earthquake risk and losses depend greatly on man-made factors such as population density, emergency preparedness and building codes. As seismologists like to say, "Earthquakes don't kill people, buildings do." If we compare the outcomes of two major earthquakes in 1988/89, we will see that the death toll of 62 people for California's World Series Earthquake, with a magnitude of 6.9, was far less than that of an earthquake of a similar magnitude in Armenia. There, the death toll numbered 25,000. The main difference between these two outcomes is building codes. While California updated and enforced building codes, Armenia lacked earthquake-proof buildings in 1989 (Nelson, 2011). Depending on these factors and the efficacy of recovery efforts, earthquakes can devastate an affected region's built environment and infrastructure over long periods of time, slowing economic recovery from the quake. The quality of life of the affected population can thus still be diminished long after the event, as the 2010 earthquake in Haiti demonstrates.

Earthquakes have an immense capacity for destruction, but strong earthquake risk management can mitigate damages and loss of life suffered and, for this reason, deserves further investigation. Earthquake risk management practices and recovery efforts benefit greatly from public and private coordination as the following cases show. Masaaki Nagamura describes the successful coordination of government and private sector recovery efforts after the 2011 Tohoku earthquake and tsunami. The second and third cases address California Earthquake Insurance and the Norwegian Perils Pool. These deal more broadly with issues of solvency and compulsory or quasi-compulsory insurance schemes.

There are a number of other interesting and valuable earthquake risk mitigation strategies that this report was unable to include. Some other examples are:

• In 2009, the Government of Mexico sponsored a US\$290m, multi-peril catastrophe bond under the World Bank's MultiCat Programme. This bond allows governments to further transfer risks from natural perils into the capital markets. For more information, please visit

¹⁹ At their most basic, earthquakes are the violent shaking of the ground resulting from movement within the earth's crust or volcanic action.

²⁰ The severity of an earthquake is measured by a magnitude rating based on the strength and duration of their seismic waves. A rating of 3-5 indicates a light earthquake, 5-7 is considered moderate or strong, 7-8 is serious and 8 and above is severe.

http://www.oecd-

ilibrary.org/docserver/download/fulltext/5kgcjf7wkvhb.pdf?expires=1351169254&id=id &accname=guest&checksum=B92C0CEE84D127BB264BBBECC5F17C2F

- The Turkish Catastrophe Insurance Pool (TCIP) was launched in 2000 as a result of the Marmara earthquake. It is a legally mandated pool that has a mandatory purchase requirement for residential buildings in municipalities, http://info.worldbank.org/etools/docs/library/114715/istanbul03/docs/istanbul03/11yazi ci3-n%5B1%5D.pdf
- New Zealand's primary provider of earthquake insurance is the Earthquake Commission (EQC), a Crown Entity that is owned by the government—though subject to public sector finance and reporting rules—and controlled by a board of commissioners. The government guarantees that EQC will meet all its obligations and EQC entirely administers the fund, processes claims, organises reinsurance and funds research while insurers aid in collecting premiums,

http://www.oecd.org/daf/financialmarketsinsuranceandpensions/insurance/high-levelroundtableonthefinancialmanagementofearthquakes.htm

 The French Natural Disaster Compensation Scheme (CAT NAT) operates on principles of solidarity. Primary insurers are legally obliged to include natural perils coverage as a mandatory extension to fire insurance. It is voluntary to purchase and has high uptake. Moral hazard is mitigated by requiring insureds to retain a portion of the risk by paying a statutory deductible. Compensation is triggered by an interministerial declaration. More information on this scheme is available at http://www.oecd.org/daf/financialmarketsinsuranceandpensions/insurance/highlevelroundtableonthefinancialmanagementofearthquakes.htm

Case study 5

Tohoku earthquake and tsunami

Author: Masaaki Nagamura, Division Head, Corporate Social Responsibility, Tokio Marine and Nichido Fire Company.

Executive summary

As a result of the 1964 Niigata earthquake, the Japanese Diet implemented the Residential Earthquake Insurance system, a public–private partnership between the Japanese Government and insurance industry. Instead of indemnity-type coverage, the System provides post-disaster financial relief. This arrangement allows it to avoid administrative congestion during a disaster. The system proved its efficacy during the Tohoku earthquake in 2011 and greatly contributed to the recovery process.

Case description—the development and evolution of the Earthquake Insurance System

In Japan, earthquakes had long been considered uninsurable because of the difficulty of applying the law of large numbers, the overwhelming scale of economic consequences they generate and the concern for adverse selection, a situation where the programme becomes unsustainable due to a heavy risk concentration in seismically active zones.

However, in 1964, shortly after the Niigata earthquake, the Japanese Diet voted to revise the existing insurance business law to consider the establishment of an earthquake insurance system. Based on the extensive study and series of debates that followed, the Earthquake Insurance Act was enacted on 1 June 1966, and the Residential Earthquake Insurance system was launched the same day. The system offered coverage for earthquake, tsunami and volcanic eruption perils.

The primary objective of the Act is "to contribute to the stabilization of the lives of the affected people." Unlike typical non-life insurance policies, the system was not designed to offer indemnity-type coverage, but instead, prioritised the function of post-disaster financial relief to the affected residential property owners. One of the major reasons behind not adopting traditional indemnity-type coverage is the overwhelming number of claims an insurance company accepts in a catastrophic event. Indemnity-type coverage requires a thorough appraisal process for both the insured and the insurer to mutually agree on the amount payable. While the process works reasonably well under normal circumstances, it creates serious administrative congestion in an emergency situation, where tens of thousands of policyholders demand an immediate response. Other than the administrative considerations, there were financial aspects which had to be kept in mind. Even with governmental support, the programme needed to begin by offering partial coverage in order to contain the exposure, while keeping the premium level affordable for property owners.

From the initial stages of discussion, the concept of "no-loss and no-profit" had been in place. Since the system is intended to fulfil public policy objectives, profit margin is not factored in the insurance rate-making.

The Residential Earthquake Insurance system incorporated a number of features to cope with the concerns raised during the drafting stage. Firstly, it was agreed to have the government function as a reinsurer, to prevent private insurers from bearing excessive financial burden. The total limit of liability was set for the entire programme to restrict the collective financial responsibility of the government and the private sector. In order to distinguish the government's liability from the general account budget, a special purpose account was created. Secondly, the scope of coverage was set to focus on residential properties, to abide by the Act's intent to serve the affected people. Thirdly, to counter the concern on adverse selection, the drafters came to the conclusion that earthquake coverage
should not be sold stand-alone, but as a rider to a comprehensive property policy. Offering the earthquake coverage as a rider also helps minimise the solicitation cost. To raise public awareness of the earthquake coverage, the insurance industry has implemented a practice to confirm a policyholder's refusal to purchase the coverage in case the applicant is not interested in it. This practice is especially important in Japan where resultant fire following an earthquake is excluded in standard residential property insurance policies.

In the system, the Government of Japan functions as a reinsurer. Primary insurers cede 100 per cent of the written Earthquake Insurance exposure to Japan Earthquake Reinsurance Co., Ltd. (JER), a special purpose reinsurance company managed by the leading Japanese non-life insurance companies, which retains a portion of the risk and retrocede the remainder to the member companies and the government. The total payment limit from a single event has evolved over the years, and currently stands at JPY6.2tn (US\$7.95bn), an amount considered sufficient to withstand a catastrophic event affecting the metropolitan Tokyo area. Burden sharing between the government and the private sector is defined under the relevant ordinances of the Earthquake Insurance Law. Based on the April 2012 revision, the public-private liability split is set in the following three layers depending on the scale of loss:

- the first loss up to JPY104bn (US\$1.33bn): 100 per cent covered by the private sector,
- the second layer in excess of JPY104bn up to JPY691bn (US\$8.86bn): 50/50 per cent split between public and private sectors,
- the top layer in excess of JPY691bn up to JPY6.2tn (US\$79.52bn): approximately 98.4 per cent public versus approx. 1.6 per cent private.

In case of a loss, primary insurers take care of claims handling and payments, which in turn are compensated by the government through JER, pursuant to the above-mentioned criteria.

As a mandatory practice, the Earthquake Insurance premium, net of operational expenses, is reserved separately by both the private insurer and the government, under a special account. Investment income arising from premiums is also subject to the same requirement. On behalf of the primary carriers, JER functions as the integrated manager of the reserve. After the launch, the programme underwent numerous revisions to respond to changes in consumer expectations. It resulted in an increase in the types of policies in which an earthquake coverage rider can be included, the relaxation of the requirements for policyholders to purchase the rider, an increase in the limits on both individual coverage and the entire programme, an improvement in the compensation scheme, and the revision of applicable premium rates. Notable revisions were made in 1980 and 1987 when payment methods to cover half loss and partial loss respectively were introduced. Those alterations responded to the needs of subdivided payment patterns.

The devastating earthquake that struck the port city of Kobe in January 1995 ignited another round of debate on the system, which matured in the substantial increase of coverage limits (from JPY10m (US\$128,250) to JPY50m (US\$641,293) for buildings, from JPY5m (US\$61,425) to JPY10m (US\$128,250) for contents). The coverage issue aside, the earthquake revealed that the public was not well-informed about the system, with 9.0 per cent penetration ratio. (The figure increased to 23.7 per cent by the 2011 Tohoku earthquake.) This prompted the industry to better publicise the programme. As part of the effort to attract more clients, the Earthquake Insurance premium became subject to income tax deduction beginning in the 2006 fiscal year. The General Insurance Association of Japan (GIAJ) has been running advertising campaigns in the hope of capturing public attention. Even though the programme runs on the no-loss and no-profit principle, primary insurers find enormous value in selling the coverage, since it solidifies their relationships with their customers.

Case description—how earthquake insurance responded to 11 March

Then on 11 March 2011, a magnitude 9.0 earthquake hit Japan's Tohoku region, which was followed by unusually strong tsunamis. The total insured loss is estimated at JPY3tn

(US\$38.46bn), which is currently the world's second most costly insurance loss since 1970. Of this loss, the Earthquake Insurance system will pay out an estimated JPY1.2tn (US\$15.4bn). In order to expedite the payment process, insurance companies sent supporting staff to the affected areas while opening extra toll-free call centres. Meanwhile, member companies of the GIAJ made collaborative efforts to streamline the claims adjustment process by utilising aerial photos to designate the total loss area, adopting a simplified claims assessment standard, and agreeing to a common definition in adjusting tsunami claims. The collective action enabled the industry to settle over 90 per cent of the reported claims in the first three months after the event. Even with the high percentage of settlements, the industry continues its efforts to reach out to policyholders who may have suffered but have yet to recognise valid coverage under their policies.

The swift payment of Earthquake Insurance was among the first to reach the disaster stricken area. According to the survey on the economic effects of the Earthquake Insurance conducted by GIAJ, more than 80 per cent of the respondents used the insurance money to either reconstruct damaged structures or purchase furniture or living appliances.

While contributing to the economic recovery of the Tohoku Region, it should be noted that no insurance company ran into financial distress after the event. This is largely attributable to the Earthquake Insurance system in place.

The 11 March event raised the public's awareness of the system, and the number of applicants has increased by more than 10 per cent over the previous year. With the surge in the Earthquake Insurance exposure, the total programme limit has been increased from JPY5.5tn (US\$70.54bn) to JPY 6.2tn (US\$79.52bn) as of April 2012.

Lessons learned

The key to quickly settling Earthquake Insurance claims was the simplicity in payment methods. Considering the number of claims reports expected from a catastrophic event, the simpler the reports are, the easier it is to enable clear-cut settlements. However, it is also true that policyholders who had claims substantially larger than partial loss designation yet short of half loss may end up receiving substantially less than his/her expectation. There are ongoing discussions on the pros and cons of introducing an extra layer of payment.

It may also be worth mentioning that the Earthquake Insurance system functioned as a platform from which the market players could work out industry-wide collaborative efforts to expedite claims payments.

From the financial perspective, no single player ran into insolvency despite the unprecedented size of the claims. It proves the effectiveness of the Earthquake Insurance system, which involves the Government of Japan as a reinsurer. The burden sharing between the government and the private sector is determined depending on the significance of loss. Furthermore, private insurance companies are mandated to reserve 100 per cent of the risks assumed under Earthquake Insurance from which the insurance payments are made, thus leaving no negative impacts on the participating insurers' bottom line.

The way the Japanese insurance industry withstood the 11 March event is indicative of an effective public–private partnership in the context of disaster risk resilience. The absence of the Earthquake Insurance system could have left many affected citizens uninsured, while primary insurance players would have been unable to write earthquake coverage due to the likely shortage in reinsurance capacity.

Conclusion

While it is necessary to continue in our efforts to further stabilise the system, the existing Japanese Earthquake Insurance programme has proved effective in its response to the 11 March earthquake and tsunami. It is crucially important that the system's effectiveness is shared with the policymakers to ensure a sustainable undertaking.

In light of the increasing intensity and frequency of natural disasters in many parts of the globe, including the emerging economies, the system in Japan could be referred to as a living example of how the public and private sectors make the most of each other's capability to withstand a natural threat. There are still some shortcomings that need to be rectified, which calls for close cooperation among the parties involved.

The Geneva Association will organise a seminar jointly with Tokio Marine & Nichido Fire Insurance Company, to discuss the events of 11 March 2011 and the lessons learned. Experts from academia, policymaking, industry and insurance interested in attending should contact Walter R. Stahel at walter_stahel@genevaassociaiotn.org

Case study 6

California Earthquake Authority (CEA)

Written by: Meghan Orie, Researcher, The Geneva Association Based on: Lloyd's *Managing the Escalating Risks of Natural Catastrophes in the United States*

Executive summary

After the Northridge earthquake in 1994, insurers pulled out of the market leaving a void. This lack of earthquake insurance created a need for innovative solutions and opened the opportunity for a publicly-administered, privately-funded insurance scheme that today is solvent with high amounts of capital but low penetration.

Case description

Before the Northridge earthquake, policymakers and insurance companies had underestimated California's risk exposure to earthquakes. This underestimation and the substantial damages caused by the Northridge earthquake caused residential earthquake insurers to become overexposed. Consequently, insurance companies severely restricted or stopped writing earthquake coverage, as another significant earthquake would have quickly exhausted their claims-paying resources.

As a result, the California Earthquake Authority (CEA) was created in 1996 to fill this gap. CEA "natural perils" policies are sold through private insurance companies. The law requires insurers that sell residential property insurance in California to offer earthquake coverage to their policyholders as an optional extension. The natural perils portion of the policyholder's premium is then channelled into a government administered pool for which the CEA is legally required to buy reinsurance.

The policy offered is a "basic policy", covering only dwellings and excluding non-essential structures like pools or patios. The policy covers the repair of earthquake damage, ensures that new construction conforms to current building codes, replaces personal property and provides for living expenses while a home is being rebuilt.

By law, the agency receives no money out of the state budget nor is allowed to go bankrupt. Should it no longer be able to pay claims, they will be prorated or provided in instalments to policyholders. That said, the CEA claims that insolvency is unlikely. It is financially sound with an A- rating (excellent) from A.M. Best. It has over US\$9bn in claims-paying capacity, which comes from earthquake insurance premiums, contributions from and assessments on participating insurance companies, borrowed funds, reinsurance and the return on invested funds. It is able to maximise this growth with a federal income tax exemption. This status lets it set premiums at a lower rate than they would be able to otherwise.

Analysis

This public–private cooperation makes insurance available for extreme risks that would not often be insurable for a broad public at an actuarially sound price. In fact, the CEA's main mitigation strategy is to create risk awareness through risk delineation and financial incentives. Risk-based pricing and a cost-effective structure allow the CEA to do that, remain solvent and offer relatively affordable premiums.

The CEA provides financial incentives for risk mitigation and is implementing policies for adaptation, enhancing financial solvability and decreasing the costs of catastrophe insurance in the long term. For example, it recently adopted a building code for retrofitting existing structures to withstand earthquakes and is trying to develop a financial incentive rebate programme that would cover a portion of retrofit costs. The programme acts as a double incentive to buy the insurance and to install retrofits, thereby lowering the insured's premium. According to Paudel *et al.* (2012), premiums can also be kept more affordable in public–

private partnerships like the CEA by using the insurance sector to sell and administer insurance policies and process claims. To further keep premium prices down, partnerships in the U.S. keep the fees provided to insurers low.

This demonstrates that a public–private partnership can be effective and efficient when run with actuarially sound methods. In a case like this, the programme may benefit from tax exemption or government reinsurance to make premiums for disaster coverage more affordable while benefitting from insurance's expertise. That said, the programme may still suffer from certain pitfalls. Despite being widely available, the CEA has only a 12 per cent penetration rate. Swiss Re has said, "California's current level of earthquake insurance is insufficient for a region with such high seismic risk, high accumulation of property and high economic activity" (Swiss Re, 2012). The state is consequently attempting to double the current number of insureds in the next five years. A large pool of insureds and high market penetration can facilitate risk spreading and may reduce costs.

Even though the CEA's premium costs are reduced by many factors, it is legally required to purchase reinsurance, the costs of which are included in the premium, increasing its cost. Too many people may still consider the premiums to be too expensive for broad penetration. In fact, experts identify expensive premiums as a factor contributing to low market penetration in California. To lower the premiums, the CEA is lobbying Washington DC Alberto Monti identifies another demand-side problem, namely, that most people may underestimate, ignore or forget the extensive losses that can be caused by earthquakes so that even reasonably priced catastrophe insurance coverage may be perceived by prospective policy holders as too expensive (Monti, 2011). Another reason could be a problem of moral hazard. If individuals or businesses assume that the state of California will reimburse them for their losses from an earthquake, then they have a disincentive to buy earthquake insurance, an occurrence that Browne and Hoyte refer to as a "charity hazard" (Browne and Hoyte, 2000). This low market-penetration rate is the reason why the state may, under political pressure, provide government relief after a disaster to compensate uninsured damage.²¹ In this sense, the state of California has similar problems to the NFIP. Despite offering ex ante disaster programmes, both governments can rely on ex post funds because of a lack of policy uptake.

It is difficult to know why people are not buying CEA offered insurance; however according to Paudel *et al.* (2012), the problem of low penetration could be resolved if the government were to establish and enforce strict mandatory purchase requirements. This is a more paternalistic strategy, as it assumes that the government should dictate what insurance people have. And, depending on enforcement mechanisms and how the insurance is distributed, it may not necessarily be effective, as we saw with NFIP's limited mandatory purchase requirement. A wider mandatory purchase requirement seems unlikely or is likely to be unpopular, if the benefits of the insurance are not effectively communicated to the general public.

Lessons learned

- Private insurance contributes to the scheme by selling and administering policies and by the knowledge and expertise in managing risk.
- Federal income tax exemptions can contribute to making premiums more affordable.
- Raising awareness about the value of insurance is essential for the CEA to achieve further market penetration.
- Implementing programmes that rebate retrofit costs for buildings in order to reduce policyholder premiums can encourage purchase of insurance.

²¹ The CEA website stresses the limits of government disaster-relief programmes to encourage the purchase of earthquake coverage (CEA, 2012)

Conclusion

Natural catastrophes with a high severity and low frequency, such as earthquakes in urban areas, can stretch the traditional insurance industry to its limit with regard to underwriting (premiums) and financial reserves. Alternative risk transfer products may have been less vulnerable: the Northridge earthquake of 1994 and its substantial damages caused residential insurers to become overexposed and led many insurers to exit the market. A dearth of insurance resulted in the establishment of the CEA, a cooperation between private and public actors allows higher resilience at actuarially sound prices. The private sector is mandated to offer coverage, administers and processes claims, while the public sector provides risk-based incentives to lower premiums, further transfers risks to international capital markets and provides the legal status and conditions for more "affordable" premiums. These factors keep the programme solvent.

Despite these benefits, CEA has a low penetration rate, and California is subsequently grossly underinsured given its earthquake exposure, and levels of property and economic activity. Low uptake is most likely caused by the perception that premiums are too expensive; underestimating (or forgetting) earthquake risks; and the assumption that either the government or family will financially support re-construction. These challenges are relevant for determining the level of compulsion in insurance and will reflect varying policy objectives and market conditions. The CEA has an obligatory offer of catastrophe insurance, but as stated, this has the disadvantage of low penetration rate. Requiring the mandatory purchase of catastrophe insurance could solve this penetration problem, though this obligation limits autonomy and could be unpopular without clear communication of insurance's benefits to the public. The third option, a mandatory inclusion of catastrophe coverage in basic property insurance policies is explored in the next case study.

Case study 7

Norwegian Natural Perils Pool (NNPP)

Written by: Meghan Orie, Researcher, The Geneva Association Based on: Lloyd's *Managing the Escalating Risks of Natural Catastrophes in the United States*

Executive summary

The NNPP is a publicly-mandated, private insurance pool that is characterised by high solvency, high amounts of accumulated capital reserves and high penetration rates. This Norwegian solution is based on a mandatory inclusion of natural catastrophe coverage in all basic property insurance policies.

Case description

The activity of the NNPP is authorised by the Act on Natural Damage Insurance No. 70, passed in 1989; by Law No. 98 in 2004 and by Rules for the Norwegian Natural Perils Pool, which was established by Royal Decree in 1979 and had subsequent amendments added by the Ministry of Justice. Among the natural catastrophes covered are losses caused by earthquake, landslide, storm, flood and volcanic eruption.

Insurance companies who cover fire risks in Norway must by law be members of NNPP (Norsk Naturskadepool, 2012). Since 1996, member companies have been allowed to reinsure a part of the programme that is equal to their share of the pool (Norsk Naturskadepool, 2009).²²

Natural catastrophe perils are legally required to be included in all fire policies unless those perils are covered by another form of insurance. To ensure wide diffusion of policies, legally, mortgage lenders must require the purchase of fire policies for a property in order to issue a loan.

NNPP is managed by representative member insurers and administered by a separate office in the Norwegian Financial Association (NFA). At the end of 2010, the pool had 85 member companies. NNPP acts as a distribution pool, meaning that participating companies keep direct contact with their policyholders, and as an equaliser, by spreading losses in the market (smoothing available funds over geographically diverse regions). It also makes reinsurance arrangements and handles damage compensation among its members.

The premium is adjusted annually on the basis of a proposal by the NNPP after approval by authorities (Van Schoubroeck, 1997).

Damages covered are distributed between the member companies in proportion to the company's portfolio of fire insurance. The total loss NNPP can compensate per occurrence was limited to NOK1,800m in 1994. If the damage exceeds the limit, then NNPP will proportionally reduce the compensation (Van Schoubroeck, 1997). Currently the Norwegian Natural Perils Pool is solvent.

Analysis

Historically, the government helped those affected by natural perils events with earmarked funds, tax relief and help from the armed forces. This changed in 1918, when a Norwegian insurance company began offering voluntary coverage for damages to buildings caused by natural disasters. However, this was an unprofitable endeavour because only those living in areas exposed to natural perils bought insurance cover.

²² Norwegian Financial Services Association handles the administration and daily management of the NNPP.

In 1938, the government systemised compensation by creating a national fund, and in 1961 it finally established a natural damage scheme with the Act on Natural Damage. To determine whether natural perils coverage could be offered through insurance, in 1971 a committee was appointed. The committee found that "...both with regard to the owner of the damaged property and also from a social point of view, the best solution would be to compensate damages caused by natural disasters through insurance" (Norsk Naturskadepool, 2009).

In Norway natural perils coverage is considered to be a fundamental right of citizens and is based on principles of solidarity and mutualisation: NNPP insurers and insureds share losses and risks rather than insurers paying for their particular claims, and insureds for their particular risks.

NNPP is only involved in "compensating damage to goods that are excluded from coverage pursuant to the law" (Van Schoubroeck 1997). Insurers offer a private solution in the NNPP but one which is heavily regulated by the government. They proportionally share both risk and compensation responsibilities, meaning there is a "solidarisation of loss" (Van Schoubroeck, 1997). And the programme benefits from insurer's technical expertise, marketing capabilities and claims payout processes. Indeed, the system functions efficiently, according to Van Schoubroek (1997). However, NNPP membership may make competition more difficult for start-up companies because their competitors have already been well established, aided by their pool membership (Haug, 2012).

Furthermore, NNPP encourages citizens to pursue private options by refusing to compensate damage if it is already covered by private insurance or if it had been possible to take out insurance against the damage by means of common types of insurance. These policies thus limit the government's exposure to losses from natural catastrophes.

In the case of the insured, those at greater risk of catastrophe are ultimately subsidised by those at lesser risk because NNPP does not distinguish the premium rate between geographical zones, class of risk or type of property. Premiums are priced at a rate of 0.07 per thousand of the sum insured in the fire policy. However, premium rates are stipulated by the Pool Board, a group of eight insurance company representatives, which takes into account that the total premiums shall—over time—correspond to the NNPP's and the individual company's amount of loss and damage plus administrative expenses (Norsk Naturskadepool, 2009). The premiums are thus actuarially sound even if they are not strictly risk based, that is to say calculated based on an insured's risk profile. Because the NNPP covers many risks, it can be difficult to accurately price individual policies. Given that Norway is not overly exposed to one risk in particular, the programme is able to cross-subsidise.²³

To overcome one of the major difficulties of non-risk-based pricing—moral hazard—the Norwegian government has implemented certain policies to discourage such behaviour and encourage risk mitigation. These include incentives for retrofitting buildings and the right to reduce or waive indemnity if damage is caused by weak construction in relation to the item's anticipated stress exposure, by poor maintenance or supervision; or in cases where the claimant can be blamed for failing to prevent the damage or to limit its extent (Norsk Naturskadepool, 2009). Judgement is made on a case-by-case basis by a loss adjustor.

There are, however, still challenges to raising awareness of risk without risk-based pricing. It has been stated that flood risks are being poorly communicated to Norwegian society, and are poorly understood by government decision-makers (Krasovskaia *et al.* 2009). For society, the government's solution to avoiding repetitive losses is legislation. Municipal governments may forbid people from building or repeat building in certain high-risk areas. To facilitate government identification of high-risk areas, there is currently a public debate occurring about the possibility of exchanging loss data between insurers and the government

²³ In other words, those at less risk of certain natural catastrophes occurring subsidise those who are at a greater risk.

so that the government may better identify high-risk areas. An agreement has yet to be established for this possible partnership (Haug, 2012).

Last, the case of NNPP demonstrates the benefits of mandatory inclusion of catastrophe coverage in basic property insurance policies. To assure broad policy uptake, mortgage lenders are legally obliged to require that property owners purchase fire insurance, and therefore natural perils coverage, in order to issue a mortgage.²⁴ This system seems to be relatively popular and successful in Norway as the penetration rate for natural perils coverage is high (Lloyd's, 2011). This high penetration rate has facilitated risk spreading and may have reduced premium costs.

Today, the NNPP is solvent and ensures its continued solvency by collecting sufficient premium income to build reserves to be able to cover expected losses for the long-term future, reducing the risk of the mismatch between the size of annual premiums and the size of annual expected losses. It also buys reinsurance on the international market, further transferring risk. In 2011, the amount of claims was greater than premiums received, serving as a reminder of the value of the pool (Haug, 2012).

Lessons learned

- Attaching natural perils insurance to already existing insurance policies has allowed the Norwegian government to provide adequate cover at reasonable premiums.
- Private insurance contributes to the scheme by selling and administering policies and by the knowledge and expertise in managing risk.
- Actuarially sound premiums ensure the solvency of the programme.
- Risk-based pricing could help reduce moral hazard.

Conclusion

After historically relying on *ex post* disaster relief for natural perils, the Norwegian government reconsidered its risk management strategy from the 1920s to 70s and ultimately decided on a public–private partnership with insurers. The private sector is mandated to offer coverage and administer and process claims, while the public sector manages the pool, makes reinsurance arrangements and equalises losses. NNPP has actuarially sound though not risk-based pricing. These policy measures demonstrate NNPPs underlying principles of mutualisation and solidarity, which reflect the government's values as a welfare state. Indeed, for NNPP the government plays a strong regulatory role which is based on principles of equitable distribution of losses and sharing of risks, while benefitting from insurance's effective claims management and technical expertise.

To ensure diffusion of NNPP policies, the government has made the inclusion of a natural perils policy mandatory in basic fire insurance policies, and permits mortgage lenders to issue loans only to those who have purchased fire insurance. This has resulted in a high penetration rate that facilitates risk spreading and reduces premium costs.

²⁴ According to Alberto Monti, linking different insurance products may distort competition because policyholders would have to choose the same company for both products; however, this is only problematic if the price, terms and conditions of the extension are *not* mandated by law (Monti, 2011). NNPP's extension, however, is mandated by law, limiting market distortions.

Topic III

Developing resilient communities

According to the World Bank, resilience is "The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to, and recover from the effects of a hazard in a timely manner, including through the preservation and restoration of its essential basic structures and functions" (Dickson *et al.*, 2012, p. 236). The term was originally coined in psychiatry, describing an individual's capability to "return to normal life" after a severe trauma.

Increased global climate risk and the increased frequency of catastrophic events pose new challenges to the resilience of global communities. Man-made acts or omissions, such as short-sighted land-use zoning policies, hamper resilience by increasing the number of untimely deaths and economic losses resulting from more frequent floods, landslides, heat waves, droughts and fires. Major components of absorbing, accommodating and recovering from these catastrophes are implementing *ex ante* risk mitigation measures and quickly reconnecting local communities to the economy post catastrophe.

Since the development of modern insurance in 14th century Italy, one of its major roles has been to develop means of resilience. Thus, it can contribute its knowledge and offer services to promote more resilient communities.

The following case studies demonstrate that, economic reconnection and *ex ante* measures can benefit from local, regional, national and international actors. In the following case study, Andreas Spiegel and David Satterthwaite describe how an international public–private coordination between, insurance, international organisations and government can work to offer necessary financial support services to protect vulnerable communities from natural catastrophes.

The ease with which private and international actors are able to offer financial and other support services is greatly dictated by government policies and regulatory frameworks. Public policy, as Swenja Surminski describes in her case study, can decisively affect which types of insurance policies are purchased in China, where agricultural weather-index insurance is common but catastrophe property insurance is not.

The insurance industry, in cooperation with many partner institutions such as governments, has substantially contributed to promoting resilient communities over the past years. Some other relevant projects are:

- Malawi's national index-based disaster insurance programme, a weather derivative crop insurance, for which the Malawi Meteorological Service's national maize yield assessment models are used to calculate the value of projected losses if rain falls less than certain benchmarks, http://www.gfdrr.org/gfdrr/sites/gfdrr.org/files/documents/DRFI_Malawi_WeatherInsur ance_Jan11.pdf and http://www2.lse.ac.uk/GranthamInstitute/publications/Policy/docs/PP_sustainable-risk-transfer-initiatives.pdf
- In Afghanistan, the "New Home, New Life" Programme has been used to promote flood and disaster risk reduction awareness by employing educational national radio dramas, http://www.gfdrr.org/gfdrr/sites/gfdrr.org/files/urbanfloods/pdf/Cities%20and%20Floodi ng%20Guidebook.pdf
- Since roughly the 14th century, Alpine communities have fostered protective forests triangles of forests adjacent to villages to protect them from natural catastrophes such as mudslides or avalanches. The group has the incentive to protect common space

for the common good rather than razing forests. Recently, the Swiss Federal Government has implemented an action plan for sustainable forest management. Please visit *http://www.slf.ch/forschung_entwicklung/lawinen/lawinenschutz/index_EN* or see the "Swiss National Forest Programme (Swiss NFP): Action Programme 2004-2015" for more information.

Case study 8

The R4 Rural Resilience Initiative—protecting livelihoods in a changing climate

Authors: Andreas Spiegel, Senior Climate Change Advisor, Director Risk Management, Swiss Re, and

David Satterthwaite, Senior Global Micro-Insurance Officer, Private Sector Department Oxfam

Executive summary

Insurance promotes risk-taking essential to economic growth and development. But how can the world's poorest communities afford it? The answer is simple: you allow them to buy insurance with an asset they have in abundance—their hard work.

This is the innovative idea that formed the basis of the R4 Rural Resilience initiative, a ground breaking new project launched by Oxfam America and the World Food Programme (WFP) with the support of Swiss Re.

R4 builds on the success of the Horn of Africa Risk Transfer for Adaptation (HARITA) project in Ethiopia. It gives poor farmers and rural households the option to pay for insurance by contributing their time and labour to local climate adaptation measures, such as crop irrigation and forestry projects. But let us explain in more detail.

Case description: building rural resilience

For the 1.3 billion subsistence farmers living on less than a dollar a day, vulnerability to weather-related shocks and climate change is a constant threat to their food security and well-being. As climate change drives an increase in the frequency and intensity of storms and droughts, the challenges faced by food-insecure communities struggling to improve their lives and livelihoods will also increase. The question of how to build rural resilience in the face of these risks is critical for addressing global poverty.

In response to this challenge, Oxfam America and the UN World Food Programme have launched the R4 Rural Resilience Initiative, R4 referring to the four risk management strategies that the initiative integrates, namely a combination of improved resource management (risk reduction), insurance (risk transfer), microcredit (prudent risk taking), and savings (risk reserves).

Swiss Re is supporting R4 as a founding sponsor and exclusive technical advisor in the field of insurance and reinsurance. For quite some time, Swiss Re has been investing in the development of innovative micro-insurance schemes, such as weather and yield index insurance products, to manage systemic risks. The company's knowledge of climate-related risk and agricultural insurance solutions play a vital role in increasing risk transfer capacity across Africa and other parts of the developing world. Swiss Re and its R4 partners aim to facilitate access to credit that will help farmers finance better-quality seeds and boost food production.

Analysis: innovating in partnership

R4 follows in the footsteps of HARITA, an innovative project that brought together a network of public and private organisations, including Ethiopian farmers, Relief Society of Tigray (REST), Nyala Insurance Share Company, Africa Insurance Company, Dedebit Credit and Savings Institution (DECSI), Mekelle University, the Government of Ethiopia, the International Research Institute for Climate and Society (IRI), Swiss Re, and Oxfam America. The project was funded by the Rockefeller Foundation and Swiss Re.

When it was launched in 2009, HARITA broke new ground in the field of rural risk management. Its central innovation was to allow Ethiopia's poorest farmers to pay for crop

insurance with their own labour. In its three years of operation in Ethiopia, HARITA delivered an impressive record, with promising results for replication. The project scaled up the number of policyholders from an initial 200 households in one village in 2009 to over 13,000 households in 43 villages in 2011—directly affecting approximately 75,000 people.

For this work programme, farmers are paying the same amount of premium through labour that one would pay to buy the product commercially, which happens in coordination with the government's work programme. In the case of Tigray Ethiopia, this programme is administered for the government by Oxfam partner, the Relief Society of Tigray (REST). Elsewhere in Ethiopia and in other countries, WFP administers work programmes. This innovation is called "insurance for work" (IFW).

The work done in "for the work" programmes are activities that reduce climate risk. Risk reduction activities promote resiliency by steadily decreasing vulnerability to disaster risks over time. Through participatory vulnerability assessments, called Participatory Capacity and Vulnerability Assessments (PCVAs), R4/HARITA farmers identify critically needed risk reduction activities for their community, like small-scale water harvesting, increasing soil moisture retention through improved agronomic practices, and other agricultural methods to improve crop production. These measures are designed to restore the fertility and hardiness of the degraded soil and its capacity to rebound after future shocks. Having identified the risk reduction strategies that can be performed on their land, farmers have the option of purchasing weather-index insurance from local insurers to address the risks that cannot be sufficiently reduced, like localised droughts that can erode farmers' coping capacities over time. This is accompanied by the project's unique IFW model whereby the poorest farmers who participate in a government-and REST-run food-for-work initiative known as the Productive Safety Net Programme (PSNP) are also able to pay for the insurance through labour. What the work farmers do to pay for insurance includes long-term risk reduction measures as mentioned above, identified through the PCVA. By allowing very vulnerable farmers to pay their premiums through risk-reducing labour, farmers benefit even when there is no payout-the risk reduction measures taken in their communities pay dividends, even during the wet years.





Safety Net Programme with R4



R4 represents a new kind of partnership, bringing public and private-sector actors together in a strategic, large-scale initiative to innovate and develop better tools to help the most vulnerable people build resilient livelihoods. R4 aims to leverage the respective strengths of its partners: Oxfam America's ability to build innovative partnerships and the WFP's global reach and extensive capacity to support government-led safety nets for the most vulnerable people. This partnership will enable thousands more poor farmers and other food-insecure households to manage weather vulnerability through an affordable, comprehensive risk management programme that builds long-term resilience.

The R4 partnership will test and develop a new set of integrated tools that extend the risk management benefits of financial services, such as insurance and credit, to the most vulnerable populations. R4 focuses on mechanisms that can be integrated into social protection systems, including productive safety nets, so that the results can be applied at a much larger scale by governments and international organisations. For example, insurance for work—a key part of the R4 approach and an innovative food assistance tool—can help expand access to insurance for those who could otherwise not afford it. Beyond its use in agriculture, this model could also strengthen labour-based safety nets, reducing costs for governments and protecting beneficiaries from the disruptions caused by climate disasters.

By combining the lessons from HARITA with the reach of the WFP, R4 will continue to test and scale up this innovative approach in Ethiopia, Senegal and two other countries in the next five years. R4 also constitutes a first step toward developing a sustainable insurance market for poor people, an essential factor in ensuring farmers' livelihoods and food security over the long term.

Expanding the reach of R4

The R4 Rural Resilience Initiative strives to empower half a million food-insecure people to improve their lives and livelihoods in the next five years. The overriding strategic objective of the Rural Resilience Initiative is to achieve long-term impacts well beyond the initial programme. This will be accomplished by building a sustainable commercial market for risk management and strengthening government support for rural resilience.

Still in its early stages, the programme is supported by subsidies from government and aid organisations to finance the "insurance for work" option. This is so because subsidies are the only way to establish an insurance scheme in the poorest regions of the world, and public-private partnerships play a key role in implementing such a scheme. The expectation, however, is that after a few years people will be able to cover the premium cost themselves if economic growth has increased.

Risk diversification is crucial to ensure that insurance becomes a commercially viable option in the long term. The R4 country pilots, starting with the first expansion from Ethiopia to Senegal, play an important role in making this happen. By enlarging the participating risk community and spreading risk across multiple projects, R4 promises to develop the scale needed to strengthen community resilience in additional parts of Africa and indeed elsewhere.





In Senegal, programme implementation will begin in 2013. The R4 Senegal team, which includes members of Oxfam America and the WFP with technical support from Swiss Re, is now in the planning and assessment phase. During the joint planning phase, the team will look closely at a number of measurements that will help identify areas of improvement and future opportunities for expansion. These include relative food security, areas of high climate variability, population reliance on subsistence agriculture, suitable population density, and political stability of the region. Other factors for consideration are the availability of suitable crop insurance products, existence of adequate infrastructure, and access to appropriate distribution channels.

Overview of assessment and national planning:

To ensure local ownership of the R4 process and strengthen community-level engagement, the R4 team will produce quarterly progress reports in close cooperation with national and local partners. Assessments will focus on four key areas:

- National-level analysis and preliminary selection: this incorporates geographical selection of possible R4 regions within Senegal and initial engagement of national partners.
- 2. Detailed regional/local analysis and mapping: this includes detailed understanding of local conditions (infrastructure, livelihoods, markets, local capacity, rainfall, etc.), and validation of findings in consultation with regional/local authorities and partners.
- Community assessment and identification: this includes community-based seasonal livelihoods assessment/mapping and market and value chain mapping, engagement of communities with regional/local authorities, and partners.
- 4. R4 programme design: this includes tailoring R4 tools to the Senegal context (technical design of community disaster risk reduction activities, design of risk transfer solution, and development of livelihoods and credit package).



Conclusion

R4 represents a new kind of partnership that addresses the question of how the world's poorest and most vulnerable communities can benefit from insurance. The main innovation behind R4—borrowed from HARITA—is the option for participants to pay for their premiums by contributing their labour. This model shows how creative risk management approaches can be both effective and affordable. But it also underscores the critical importance of bringing together public and private sector actors in a strategic, large-scale initiative to turn a ground-breaking idea into reality. Beyond the difference these projects make in helping local communities adapt to climate change, they also make a lot of economic sense and offer long-term business potential to investors and private sector participants.

By wedding HARITA's participatory model with the WFP's global reach, R4 promises to build the momentum needed to promote climate adaptation measures on a larger scale. This will enable thousands more poor farmers and food-insecure households to manage weather vulnerability through an affordable, comprehensive, risk management programme that builds long-term resilience and helps secure livelihoods.

Case study 9

Natural catastrophe insurance in China: policy and regulatory drivers for the agricultural and the property sectors

Author: Swenja Surminski, Senior Research Fellow Centre for Climate Change Economics and Policy, London School of Economics and Political Science

Executive summary

This case study looks at the role of public policy and regulatory drivers for agricultural insurance and property catastrophe insurance in China, on a comparative basis, and in the light of current and estimated impacts of climate change on the agricultural and non-agricultural/ urban economies.

In this case study we compare the governance arrangements of two different disaster risks in China: crop damage in the agricultural sector and property damage to individuals and small and medium enterprises. The starting point of our analysis is the difference in utilisation of insurance to manage these risks. Our research discusses possible explanations for this difference and the potential for changes by investigating the public policy environment, regulatory set-ups and the likely implications of climate change. We identify public policy and insurance regulation as the key governance drivers for natural disaster insurance in China.

Case description: the insurance dimension

China is exposed to a range of natural hazards such as earthquakes and typhoons, causing large-scale human tragedy and significant economic losses. Some of the meteorological hazards such as floods and droughts are expected to grow in intensity and frequency due to climate change, while at the same time exposure levels are also increasing, mainly driven by economic growth and rapid urbanisation.

The country became the world's second largest economy in 2010 and is increasingly playing an important role in the global economy. Almost 1.5 percentage points of the projected growth of 4-4.5 per cent of the world economy in 2011-12 is accounted for by China. Nonetheless, in terms of GDP per capita and economic structure, China remains a middle income developing country (OECD, 2011). It is widely predicted that amongst other emerging markets China will experience the largest growth in insurance penetration and premium volume (Ranger and Williamson, 2011). But despite these economic growth trends, the provision of catastrophe insurance is still underdeveloped: while agricultural catastrophe insurance cover is available and supported by government policy, there is only limited catastrophe insurance outside the agriculture sector. Organisations such as the World Bank, the Asian Development Bank and private companies have developed risk assessments and models that could contribute to the first steps of setting up a national catastrophe insurance system in China. While a range of proposals and suggestions for catastrophe insurance schemes have been discussed recently by the government, no progress has been made in terms of implementation. In contrast, the agriculture sector has seen a range of reforms of the provision of catastrophe insurance, with strong political support and significant subsidies being paid to encourage take-up amongst the rural population. How can these differences in the use of insurance for risk governance be explained?

Although several studies (Feyen *et al.*, 2011; Enz, 2000; Zheng *et al.*, 2008, 2009) have found that one of the most significant historic drivers of non-life insurance demand in emerging economies is income per capita, this alone cannot wholly explain the long-term evolution of insurance penetration at a country level. Exploring the range of demand drivers in the light of expected climate change, Ranger and Surminski (2011) conclude that "the most significant influence on growth is likely to come through firstly, public policy and regulatory responses to climate change and secondly, new opportunities related to GHG

mitigation and adaptation policies." This case study looks at the policy and regulatory drivers of catastrophe insurance in China and explores why catastrophe risk transfer has been introduced in the agriculture sector, but not for general property risks in China. The analysis concludes with an assessment of the potential role of climate change for the provision of catastrophe insurance in China.

Analysis: comparison of natural catastrophe insurance for crops and property in China

The starting point of our analysis is a comparison of the governance arrangements of two different natural disaster risks in China: crop damage in the agricultural sector and property damage to individuals. The first observation is the difference in the utilisation of insurance to manage these risks: while coverage of natural disaster risks under agricultural insurance, is relatively common and has been available for some time, there is very limited natural disaster insurance available outside the agricultural sector. We base our analysis on findings from the recently published "ClimateWise Compendium of disaster risk transfer initiatives in the developing world ", (ClimateWise, 2011). This database contains five entries for China: two proposed, but not yet implemented schemes for property insurance, and three existing schemes for agriculture.²⁵ By comparing the key characteristics of the two areas we can look for explanations for these differences in governance approach.

While the People's Insurance Company of China was established in 1949, the provision of domestic property insurance in China was virtually non-existent until the 1980s due to restrictions in private ownership of property. Agricultural insurance in China started in 1982 with the introduction of both livestock and crop insurance. There have been two main phases to the programme; each of them characterised by different operational models and different degrees of success. The first phase took place from 1982 to 2002, when policies were developed and underwritten by the state-owned PICC (People's Insurance Company of China). Insurance was extended into rural areas through local government, and was operated as a social welfare mechanism to protect farmers against natural disasters. During this period, underwriting results were poor (total premiums gradually declined from US\$98m in 1992 to US\$40m by 2002), and PICC reduced its involvement in the lead-up to its partial privatisation (Mahul and Stutley, 2010). The second phase started in 2003. It is characterised by the introduction of new agricultural insurance programmes as part of an overall policy to boost agricultural production. A major component of the cover is insurance against weatherrelated catastrophic events, supported by a considerable level of government subsidisation. In 2007, six Chinese provinces were chosen to participate in a new agriculture insurance trial, which was then extended to 25 provinces and autonomous regions (Wang et al., 2011). The most common form of crop insurance is Multi-peril Crop Insurance (MPCI), which acts as a loss-of-yield guarantee against a variety of climatic perils (drought, flood and sometimes diseases) and receives subsidies from the central and provincial government (Mahul and Stutley, 2010). The government is significantly involved in the agricultural insurance programme, its most important inputs being the provision of premium subsidies (shared between the central and the provincial governments), reinsurance of last resort by some of the provincial governments in the event that reinsurance limits are exceeded, and provision of support by government technical agencies in tasks such as loss assessments. There are no public sector agricultural insurers in China, and the market is dominated by domestic insurers and increasingly by international reinsurers that provide layers of stop-loss cover for specific lines of crops or livestock (Mahul and Stutley, 2010). Underwriting results have tended to be positive on the whole, mainly due to the large degree of geographic diversification (Wong, 2011).

Property catastrophe insurance in China has a much shorter history compared to the agriculture sector and is not widely available. Efforts to provide this type of cover has been on earthquake risks. After some cover becoming available in the late 1980s, loss

²⁵ See Annex for more details.

experiences and concerns about rising risk levels led to earthquake risks being excluded from most property policies. In late 2003, the China Earthquake Administration, with the support of the China Insurance Regulatory Commission (CIRC) and a number of other government ministries, pushed for a national earthquake insurance pool. Although the proposal passed through the State Council, it did not successfully win the endorsement of all relevant agencies due to unclear funding arrangements. The 2008 Wenchuan earthquake contributed to reinforcing the trend of limiting and excluding cover (Wang et al., 2009). On the other hand, a number of separate pilot studies of government-based flood insurance schemes have been undertaken since 1992 in China (Wang et al., 2009). The nationwide penetration rate of earthquake insurance is very low at around 3 per cent (Wang et al., 2009); and that relating to earthquakes, typhoons and floods stands below 5 per cent (Swiss Re, 2006). As a result, even when economic losses from catastrophes are high, insured losses tend to be quite low. For example, the flooding of the Huaihe and Yangtze rivers in 2007 caused an estimated US\$1.7bn in economic loss. Insurance claims, however, only reached US\$90m which amounts to only 6 per cent of the total loss. During the recent Wenchuan earthquake, the total payout made by the insurance industry reached around US\$147m by the end of August 2008, being equivalent to much less than 1 per cent of the total amount of losses (Lloyd's, 2007).

Table 1 provides a summary of the key characteristics of natural catastrophe insurance in the agriculture and property sector in China.

	NatCat insurance Agriculture	NatCat insurance Property
Current status	Available since 1982	Very limited availability to private individuals and small and medium enterprises; several unsuccessful pilot schemes; some cover available to commercial insurance clients as part of their insurance package; several proposals discussed by government and industry over last decade to increase penetration and offer broader coverage, have not been implemented yet.
Who + what is insured?	Individual farmers, cooperatives, agro- businesses, covering crop and livestock losses.	Proposed for individual home owners and small and medium enterprises; covering residential homes and private assets.
Who is insuring?	Initially operated by the state-owned Peoples Insurance Company of China as a social welfare mechanism; as part of market liberalisation efforts now provided by private domestic insurers with growing foreign involvement via reinsurance.	Proposals range from private insurance provision, state schemes and insurance pools—with varying degrees of public/private involvement.
Size of the scheme	Premium volume in 2010: US\$2bn (in 2003: US\$58m)—no overall exposure estimates.	Mixed exposure estimates—70 per cent of land area at risk; average annual property damage from NatCat: US\$15bn.
Key challenges	Lack of risk data; lack of reinsurance; highly dependent on government subsidies; provision of cover for small- scale farming operations.	Underdeveloped domestic insurance market, with small-scale companies not being able to offer catastrophe cover; lack of risk data; lack of industry risk analysis.

Table 1: Summary of the key characteristics of the two natural catastrophe (NatCat) insurance areas

Regulatory approach	Under agricultural law, not under insurance law.	Proposed under insurance law; China Insurance Regulatory Commission (CIRC) is leading efforts to develop new regulatory system.
Political support	 High—government regularly confirms importance of agricultural insurance as a core part of its agricultural development policy. The most important inputs from Government are: premium subsidies, support from government technical agencies (e.g. in loss assessment), government reinsurance as a last resort, financial assistance for new provincial agricultural insurers, and no premium tax for agricultural insurance. 	Mixed—official support, but delay in implementation indicates lack of commitment. In late 2003, the China Earthquake Administration, with the support of CIRC and a number of other government ministries, pushed for a national earthquake insurance pool. Although the proposal passed through the State Council, it did not successfully win the endorsement of all relevant agencies because of lack of funding. The CIRC's current 12 th five-year plan includes the creation of a national natural disaster risk transfer programme as well as the improvement of loss models and underlying data.
Climate change link	National Adaptation plan refers to insurance—concerns about growing drought and flood risks; public announcements on climate risks are made with references to insurance.	Main discussion focused on earthquake risks so far. General concerns about rising risk levels are a key challenge. Climate change is seen as a potential aggregator of risks.

Lessons learned: public policy, regulation and climate change as drivers of risk governance arrangements?

While a range of factors such as demand and supply, risk culture and risk perception all play a part in the selection of a risk governance approach, we focus our analysis on three core areas, deemed to be most relevant in the context of NatCat insurance: the public policy environment, regulatory set-ups and the likely implications of climate change for both areas.

Public policy drivers: public policy is widely credited with creating growth impulses for insurance in emerging markets (see for example Hussels *et al.*, 2005). The most obvious form of influence is via insurance regulation (see point 2). But "public policies not linked with insurance can also remove constraints and provide the building blocks for increasing demand by, for example, encouraging investment in insurable assets (such as property, through property rights), facilitating a stable economic environment, enhancing financial literacy and risk awareness, building human capacity (including professional actuarial education), the dissemination of risk information, enhancing capital markets, creating stable and effective legislative regimes and consumer protection" (Ranger and Surminski, 2011).

In China the two sectors considered show different degrees of public policy relevance. Support for agriculture and for the rural population has been a constant key public policy driver in China, with insurance seen as an instrument to fit in with these wider rural policy plans. The protection of private property and compensation for damages caused by natural disasters is part of China's overall disaster risk strategy, but it does not appear to be directly linked to such a constant key public policy driver. While there are policy signals that indicate support for insurance

solutions—often after an event—these are insufficiently strong enough to trigger implementation. In the context of risk governance it is important to recognise the two dimensions of insurance: it can be considered as a public policy instrument supporting the achievement of policy goals such as social security, health and safety, and particularly in the context of agricultural insurance—food security. At the same time, insurance can take the form of privately sold financial products, ranging from pet-insurance to business interruption cover and private home insurance, signalling a private choice rather than a public tool.

Interestingly, in the case of agriculture, insurance is seen as an effective way to achieve overall public policy aims, while there is no such driver for the property sector. In China the growing trend of urbanisation could have implications for these policy drivers. A gradual and on-going change in the quality of the Chinese labour force has entailed its reallocation away from (low-productivity) agriculture towards services and manufacturing, leading to a rapid urbanization and concentration of economic activity in urban areas (Herd *et al.*, 2011). In 2010, the industry sector accounted for 48.6 per cent of total GDP and the services sector for 40.5 per cent on total GDP (Economy Watch, 2010). Today, 600 million urban Chinese constitute 44 per cent of the country's population (Kamal-Chaoui *et al.*, 2009), and China's urban areas now generate over 60 per cent of GDP (World Bank, 2011). These trends lead to increased exposure and higher risk accumulation in urban areas, which might trigger more public policy support for new risk governance arrangements for the property sector.

 Regulation and market set-up: in China the overall rule-setting in terms of law and regulation remains with the government (provincial and national) for both considered sectors. Most insurance types are governed by insurance law, which has a clear commercial focus on insurance. This would also apply to the proposed property insurance schemes. But agriculture insurance is not formally regulated via insurance law and is in fact mainly based on agriculture law, which contains key references to the role of state.

The rapid growth in agriculture insurance has led to calls for a law to standardise and to protect the activities of the stakeholders in the agriculture insurance area, and there appear to be public plans to create a new set of rules and codes for agriculture insurance. The analysis also highlights different degrees of private and public involvement in agriculture and property insurance. On a general level, the overall trend of greater liberalisation of the Chinese economy has implications for the insurance sector. While the government continues to play a dominant role in agricultural insurance, there is a growing involvement of private sector players. An interesting aspect in this context is the question of who governs entrance to the market and who sets the terms and conditions of products as well as the price? The decision over entrance to the market rests to a large degree with the government, in the form of regulation. At the same time, there is also the decision by the private insurer to apply for a licence, enter a market and provide a certain product.

There is evidence that in both risk areas, the private sector is concerned about rising risk levels and a lack of risk information. In fact some agriculture insurers ceased their underwriting in response to high claims levels. This highlights the relevance of commercial viability, which governs the private sector's decision-making. For the property sector, the proposals for pools and new insurance schemes appear to have backing from private sector players—but the optimal balance between public and private involvement seems unclear. Similar to the agriculture risks there are concerns about rising risk levels and cost effectiveness for private sector players. There is evidence that insurance regulation can be influenced by changing risk levels: "for example: where concerns about Government exposure to reconstruction costs after a

disaster or social protection against loss have led to changes in the conditions for insurance, such as market liberalisation, tax incentives or subsidies for insurance, mandatory insurance lines, the introduction of public insurance or investing in pilot programmes and improvements in risk data." (Ranger and Surminski, 2011)

• The role of climate change: risk governance arrangements can be impacted by changing risk levels—for example due to socio-economic factors, demographic change, changes in risk perception or climate change. For China, there is evidence of the implications of recent loss events on demand, supply and public support for insurance, but these impulses are often short-lived, fading with the memory of specific events. This is evident in the context of earthquake risks, but also for climatic hazards, such as floods While there is uncertainty about the size and type of impacts from a changing climate, studies expect more extreme events, with consequences for both property and agriculture (for example, Daily *et al.* .2009).

Economic development is mainly concentrated in the densely populated eastern coastal regions, which are particularly exposed to the potential effects of sea level rise and extreme weather events such as typhoons. The greatest exposure is in the southeast provinces of Guangdong, Fujian and Zhejiang, which frequently find themselves in the path of typhoons (Munich Re, 2010). It is estimated that the sea level along the Chinese coast will continue to rise and that the frequency of typhoon and storm surge will increase (National Development and Reform Commission, People's Republic of China, 2007), with an associated potential for significant losses affecting these thriving economic centres. Despite the fact that the relative magnitude of these impacts is still under debate, there is general consensus that China's agriculture sector will be affected significantly and that the impact on agricultural production and prices is likely to be particularly important, with associated implications for both domestic and international markets.

Economic studies show that climate change will affect not only agricultural production, but also agricultural prices, trade and food self-sufficiency in China (Wang *et al.*, 2010). Agriculture is in fact one of the sectors most affected by natural hazards, and climate-related hazards such as droughts, floods, low temperature stress, and hail are responsible for 71 per cent of the losses caused by natural hazards annually in China (Huang *et al.*, 2005). There are currently no studies that have shown empirically that climate change has already begun to affect insurance demand. But theory and evidence from existing insurance markets suggests that a "riskier and more uncertain world would be associated with an increase in insurance demand, at least until some local threshold were reached where the affordability of insurance or the insurability of risk were threatened" (Ranger and Surminski, 2011). The influence of climate change on insurance provision will be multifaceted, complex and regionally variable.

In China there are signals for changes in public policy towards insurance in response to concerns about climate change. China's National Climate Adaptation refers to insurance as a tool to increase China's climate resilience. While this could lead to a greater political recognition of insurance as one of the many tools needed, it is difficult to predict the overall direction of these trends: will it coincide with market liberalisation and lead to a greater role for the private sector? In the wake of rising risk levels the public sector role is likely to remain important because of the affordability / availability challenge of insurance cover—which means that the private sector alone is unlikely to provide the solutions.

Conclusion

Climate change is already impacting insurance in the form of policy commitments to insurance by the government in their national adaptation strategy. While there is a trend towards greater private sector engagement, the challenges of affordability and availability of private insurance cover make it unlikely that the private sector will provide the solution on its own. While our case study has focused on the risk governance drivers, it is important to recognise the effectiveness of any of the proposed risk governance approaches. The benefits of risk transfer are widely recognised, but at the same time it is necessary to reflect on design and structure of those instruments—history has shown that risk transfer is not a silver bullet for catastrophe risk management. Its effective contribution rather depends on an effective and holistic risk-management framework.

Topic IV

Liability litigation as a tool for disaster remediation and deterrence—a tale of two sharply differing outcomes

We live in a compensation culture. The assumptions that injuries must receive financial healing and that available assets bearing even the most remote connection to the injury must be made to pay are embedded in the developed world and becoming a tenet of the responsibilities of the developed to the developing world. These principles are admirably humanitarian but raise significant issues of wise social policy and long-term sustainability.

It was not always thus. Responsibility and compensation for injuries was not contemplated for the 12,000 or so years of human existence, arising only 300 years ago out of the Industrial Revolution. Compensation as a significant economic and sociological event has emerged only in the past 50 years. It operates today through tort liability principles in the private sector and regulatory requirements in the public sector.

But with injuries of mass scale growing in frequency and severity as a result of changing climate conditions, environmental hazards and the effect of new technologies and products, there are signs that other mechanisms will be added to the tools of compensation. These case studies explore the emergence of applications of criminal law as a means of motivating or facilitating compensation.

Some other cases of interest are:

- Six Italian scientists were found guilty of manslaughter and sentenced to six years in prison for having provided "inaccurate, incomplete and contradictory" information on the danger of the 2009 deadly earthquake in L'Aquila, Italy. For more information, please visit http://www.bbc.co.uk/news/world-europe-20025626.
- Swiss billionaire and sustainability pioneer, Stephan Schmidheiny, was sentenced to 16 years in prison in Italy for partial responsibility of asbestos-related deaths at his former company, Eternit AG, even though he was responsible for ending Eternit's use of asbestos before it was legally banned, *http://www.bloomberg.com/news/2012-02-13/sustainability-pioneer-sentenced-to-prison-over-asbestos.html*

Case study 10

The Bhopal environmental disaster

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Executive summary

A 1984 explosion at a chemical facility operated by Union Carbide in Bhopal India resulted in toxic waste emissions that killed or severely injured thousands of residents in a widespread area. Litigation instituted by the Indian government and other parties in that country and in the U.S. resulted in a final settlement by Union Carbide of US\$450m, although it was never clear whether the cause of the explosion involved any negligent behaviour by the company. When Union Carbide was acquired by Dow Chemical in 2000, reputational pressure generated a further reparations contribution by Dow of several hundred millions more, providing total funds of more than US\$750m for victim compensation.

Case description

Worldwide attention to the Bhopal disaster was immediate and intense, with inevitable tensions between the Indian government and Union Carbide. The company was presumed to be at fault, and vengeance as well as compensation was demanded. The CEO of Union Carbide denied fault by the company but went immediately to the site to take personal control of the clean-up and response. On arrival he was arrested and jailed for an extended period of time. The elements were in place for a massive and long-term conflict that could have delayed the recovery of compensation for decades and involved international political and legal disputes.

However, within a few months nearly all of the principal parties were focused on developing solutions that would speed substantial funds to aid the victims, all of them in a deeply impoverished area.

- The company began to distribute aid almost immediately.
- The Indian government sought to have the litigation conducted in Indian courts with governmental oversight.
- Opportunist groups and legal interests more concerned with self-gain than victim compensation brought suit in the U.S. courts, where excessive recoveries and contingent legal fee awards are an incentive in all such events. But the U.S. judiciary ruled that the issues should be tried in India.
- Within a few years, settlement was reached between the company and the victims in the amount of US\$450m, a settlement that was approved by the Indian government as fair and final.
- When Dow acquired Union Carbide in 2000, it had no technical legal exposure, but knew that the proliferating recognition of expanding hardship from the 1984 event would likely generate reputational pressure. That occurred with the assistance of NGOs and produced a further settlement believed to be in excess of US\$300m.
- While tragic conditions continue for the Indian population, over US\$750m has been recovered for the victims.
- It is widely believed that the Bhopal experience has enhanced the safety record of the chemical-power-generating industry worldwide.

Case study 11

The Ecuador rainforest oil exploration claim

Author: Richard H. Murray, Special Advisor and Chairman of the Liability Regimes Programme, The Geneva Association

Executive summary

Exploration for oil in the Ecuadorian rainforests during the 1970s and 1980s jointly by Texaco and the national oil company of Ecuador, Petroecuador, is claimed to have left insufficiently cleaned conditions at the drilling sites and allegedly polluted local water sources. After Texaco was acquired by Chevron in 2001, a class action suit was filed in Ecuador on behalf of 30,000 indigenous Indians. That suit resulted in a 2011 judgment against Chevron for more than US\$18bn. That judgment is on appeal in Ecuador, but is also the subject of multiple lawsuits involving efforts to recover from Chevron in multiple countries. An appeal from the collection litigation is pending before an international tribunal in The Hague.

Case description

When the joint government-owned and Texaco drilling operations were shut down in the 1990s, a clean-up operation was conducted by both parties. That effort resulted in a formal determination by the Ecuadorian Government that the clean-up was satisfactory with a final release of responsibility.

At the time of that release, the Ecuadorian government had tested water supplies in the region and found no contamination.

But this did not deter a consortium of Ecuadorian and U.S. attorneys from convincing 40 of the indigenous Indians to "sign" an agreement to act as lead plaintiffs in a class action against Chevron. The signatures were by thumbprint. That began a tangled web of litigation that is far from completion, and after 12 years in the courts has yet to provide any victim compensation. But there have been numerous widely publicised and bizarre developments along the way.

- The class action attorneys sought recovery of US\$60bn for their 30,000 "clients" in the Ecuadorian legal system widely believed to be vulnerable to corruption.
- There is significant evidence that the expert opinion supporting the damage claim, and the trial judge's decision, were both written by the claimants' attorneys.
- This assertion of legal fraud by Chevron might be discounted as advocacy. However, the claimants' attorneys were so brazenly proud of their ability to bribe and intimidate the court that they had a film crew videotape their planning and executing of the fraud. Those tapes and other evidence have been publicly disclosed.
- The result of these actions was the entry of a judgment in 2011 by the trial court in Ecuador, awarding the claimants US\$18.1bn. That judgment is now on appeal to the Ecuador Supreme Court.
- Without waiting for the decision on appeal, claimants' counsel filed suits in many countries, including the U.S. and most recently Canada, seeking to collect the judgment by seizing Chevron's assets and operations in those countries.
- The collection litigation is far more expensive for claimants counsel than the manipulation of the trial court. To finance these costs, they had their 40 representative clients enter into a litigation funding agreement with a specialist funding organisation in the U.S. The 86-page agreement is also signed by thumbprint. It provides for a scaled sharing of any ultimate recoveries for Chevron, divided between the funding company and the claimants.
- If the 30,000 claimants receive approximately the same total recovery as the Bhopal victims, all of the amount will be consumed by the funders and the attorneys, with virtually no benefits paid to the claimants.

Case 10 and 11—analysis: a tale of two differing outcomes

Liability litigation as a means of compensating the victims of mass suffering can be a useful tool for remediation and a beneficent motivator for others to take maximum precautions to avoid other disasters. The Bhopal case is an illustration of salutary effects of responsible use of the litigation tool.

Liability litigation can also be a formidable obstacle to victim recoveries and, in the Chevron situation, it can become the disaster that creates disincentives for responsible business operations in the future. If the truth and the facts have nothing to do with the outcome of a claim, why bother with best safety practices in the future.

What are the differentiating characteristics that make these two cases such powerful demonstrations of the helpful or harmful role that liability litigation can play?

First, in nearly all cases of mass disasters, the interests of one or more sovereign governments are invoked. The potential for intergovernmental conflicts are high, and multinational litigation is a fuse that can ignite those conflicts.

In Bhopal, the Indian government is to be commended for quickly recognising that it had to behave calmly to cope with the national anger and to focus on achieving a fair and speedy recovery for the victims. The Indian government established an unwritten but clearly understood form of public–private partnership with Union Carbide. This is clearly a non-traditional public–private sector relationship, but it is essential if the interests of the victims are to be the paramount objective of all key parties. Bhopal should be a lesson studied by all governments for coping with future mass disasters.

The Ecuadorian government was part of the Chevron problem and an obstacle to its solution. If one assumes that the 30,000 citizens affected had some right of recovery (an amount clearly less than was appropriate for the millions of Bhopal victims) the government has done nothing to help achieve that goal. It has also done much to create obstacles, beginning with the failure to enforce its own settlement agreement and release with Texaco. Tolerating lawlessness in its judiciary is not just added governance, but it is an obstacle to the management and resolution of mass disaster challenges. The failure to prevent the use and abuse of its citizens by third-party greed is worse, especially when played out so visibly on the world stage.

Second, adult behaviour and responsibility must also dominate the actions of lawyers and the judiciary. It was of vital importance in Bhopal that the U.S. Courts refused to allow the case to proceed there. Multiple jurisdictions handling the same vast claim is nearly always a recipe for chaos. It is equally important that the controlling legal system and the participating attorneys place their clients' interests above personal gain. There is no single formula for how to do this, and ethics rules are of little help in the midst of disaster recovery. Maturity of understanding and quality of character are required. Those conditions prevailed in Bhopal but seem totally absent in the Chevron situation.

Third, the economic motivations must be aligned with the responsible behaviours desired. There is little public data about the economics of the Bhopal resolution process, but it worked well.

Cases 10 and 11—lessons learned: a tale of two differing outcomes

There are three perverse economic incentives that have made the Chevron litigation into a disaster of mass proportions.

- Tolerance for judicial corruption is a self-evident perversity of economic motivation.
- The class action contingent fee system, as applied in the US and now beginning to spread globally, is not intrinsically perverse. But its tolerance for excessive attorney rewards and the absence of regulation that protects the interests of powerless clients are noxious diseases that must be contained from exploiting the victims of mass disasters.

 Litigation funding practices are a new phenomenon, arising primarily in this century. Litigation funding may well have a useful role to play in assuring access to justice. But the very recent practices of investments in litigation that are seen in the Chevron situation are abominations for disaster relief and for future disaster avoidance motivations. To perceive the problem, one need only contemplate how claimants counsel explained the terms and effect of the eighty-six-page funding agreement to their illiterate clients.

Conclusions

Private–public cooperation helps in solving post disaster conflicts; with the new issue that the judiciary system is a third party in this case.

Lack of integrity and corruption can multiply the difficulties encountered that 'punish' the victims a second time.

Bibliography

Topic I: Floods

- WMO (2004) Risk Sharing in Flood Management, Geneva: WMO, from http://www.apfm.info/pdf/ifm_tools/Tools_Risk_Sharing_in_FM.pdf
- WMO (2009) Risk Sharing in Flood Management: A Tool for Integrated Flood Management, Geneva: WMO.

Case study 1: Tracking flood risk mitigation implementation

- Borger, G.J. and Ligtendag, W.A. (1998) "The role of water in the development of The Netherlands—a historical perspective", *Journal of Coastal Conservation*, 4: 109-114.
- Bouwer, L.M. and Vellinga, P. (2007) "On the Flood Risk in the Netherlands", Advances in Natural and Technological Hazard Research, 25: 469–484
- Gottschalk, M. K. E. (1971) Stormvloeden en rivieroverstromingen in Nederland. Deel I: De periode voor 1400, Assen: Van Gorcum.
- Gottschalk, M. K. E. (1975) Stromvloeden en rivieroverstormingen in Nederland. Deel II: De periode 1400–1600, Assen: Van Gorcum.
- Gottschalk, M. K. E. (1977) Stormvloeden en rivieroverstromingen in Nederland. Deel III: De periode 1600–1700, Assen: Van Gorcum.
- Hoeksma, R.J. (2006) *Designed for Dry feet: Food Protection and Land Reclamation in the Netherlands*, Reston, VA, U.S.: American Society of Civil Engineers, p. 155.
- Lambert, A. M. (1971) The Making of the Dutch Landscape: An Historical Geography of the Netherlands, London: Seminar Press Ltd, p. 225.
- Sato, T. (2006) "Fundamental Characteristics of Flood Risk in Japan's Urban Areas", in S. Ikeda, T. Fukuzono and T. Sato (eds) *A better integrated management of disaster risks: Toward resilient society to emerging disaster risks in mega-cities*, Tokyo: TERRAPUB and NIED, pp. 23-40, from http://www.terrapub.co.ip/e-library/nied/pdf/023.pdf
- Van Baars, S. and Van Kempen, I.M. (2009) *The Causes and Mechanisms of Historical Dike Failures in the Netherlands*, Delft: European Water Association (EWA), from *http://www.dwa.de/portale/ewa/ewa.nsf/C125723B0047EC38/8428F628AB57BECFC 125766C003024B6/\$FILE/Historical%20Dike%20Failures.pdf*

Case study 2: U.S. National Flood Insurance Program (NFIP)

- Burby, R. (2001) "Flood Insurance and Floodplain Management: The US Experience", *Environmental Hazards*, 3(3):111-122.
- CBO (2009) The National Flood Insurance Program: Factors Affecting Actuarial Soundness, Washington, DC: CBO.
- GAO (2007) Natural Disasters: Public Policy Options for Changing the Federal Role in Natural Catastrophe Insurance, Washington, DC: GAO, from http://www.gao.gov/new.items/d087.pdf
- GAO (2009) Flood Insurance: Opportunities Exist to Improve Oversight of the Write-Your-Own Program, Washington DC: GAO, from http://www.gao.gov/assets/300/294277.pdf
- Lloyd's (2011) Managing the Escalating Risks of Natural Catastrophes in the United States, London: Lloyd's, from http://www.lloyds.com/~/media/Lloyds/Reports/Emergingper

cent20Riskper cent20Reports/7549per cent20Lloydsper cent20Naturalper cent20Catastrophesper cent20inper cent20theper cent20USper cent20V5a.pdf

- Michel-Kerjan, E. (2010) "Catastrophe Economics: The National Flood Insurance Program", Journal of Economic Perspectives, 24(4): 165-186.
- Michel-Kerjan, E., Lemoyne de Forges, S. and Kunreuther, H. (2012) "Policy Tenure under the U.S. National Flood Insurance Program (NFIP)", *Risk Analysis*, 32(4): 644–658, from

http://opim.wharton.upenn.edu/risk/library/J2011RA_PolicyTenureNFIP_EMK.pdf

- National Flood Insurance Progam (2012) "What is Floodplain Management?", from http://www.fema.gov/national-flood-insurance-program-1
- Paudel, Y. (2012) "A Comparative Study of Public-Private Catastrophe Insurance Systems: Lessons from Current Practices", *The Geneva Papers on Risk and Insurance Issues* and Practice, 37(2): 257-285.
- Property and Casualty Insurers Association of America (2011) *True Market-Risk Rates for Flood Insurance,* PCI White Paper Series, Des Plaines, IL: Property Casualty Insurers Association of America, from *http://www.pciaa.net/web/sitehome.nsf/lcpublic/304/\$file/NFIP_White_Paper_June20 11.pdf*
- Sandink, D., Kovacs, P., Oulahen, G. and McGillivray, G. (2010) *Making Flood Insurable for Canadian Homeowners*, Discussion Paper, Zurich: Swiss Re, from *http://www.iclr.org/images/Making_Flood_Insurable_for_Canada.pdf*

Widmer, L. (2012) "What to Know About the New Flood Insurance Program", *MyNewMarkets*, from *http://www.mynewmarkets.com/articles/181049/what-to-know-about-the-new-floodinsurance-program*

Case study 3: The 2011 Thai floods

- AFP (2011) "Thai floods death toll tops 800", from http://www.thaivisa.com/forum/topic/522783-thai-floods-death-toll-tops-800/
- A.M. Best (2012) "Flood Losses Prompt Key Changes in Thai Insurance Industry", Best's Briefing, 9 February, from http://www.ambest.com/press/021001thaifloodbriefing.pdf
- Artemis (2012) "Thailand to establish a catastrophe insurance fund", from http://www.artemis.bm/blog/2012/01/17/thailand-to-establish-catastrophe-insurancefund/
- Bangkok Post (2011) "Bangkok 'safe' from river flooding", from http://www.bangkokpost.com/news/local/257670/bangkok-afe-from-river-flooding
- Courbage, C., Orie, M. and Stahel, W. (2012) "2011 Thai floods and insurance" in C. Courbage and W. Stahel (eds) *Extreme events and insurance: 2011 annus horribilis: The Geneva Reports*, Geneva: The Geneva Association, p. 124, from *http://genevaassociation.org/PDF/Geneva_Reports/GA-2012-Geneva_report*[5].pdf
- Guy Carpenter (2011) "Cat-I Bulletin: Floods in Thailand", 3 November, from *http://www.guycarp.com/portalapp/publicsite/catdocument.pdf?instratreportid=2077* (last accessed June 2012).
- Montlake, S. (2012) "Thailand's Flood Relief Party Meets Tide of Complaints", Forbes, from http://www.forbes.com/sites/simonmontlake/2012/02/09/thailands-flood-relief-partymeets-tide-of-complaints/

- Phien-wej, N., Giao, P.H. and Nutalaya P. (2006) "Land subsidence in Bangkok, Thailand", *Engineering Geology*, 82(1): 187-201, from *http://www.sciencedirect.com/science/article/pii/S0013795205002693*
- Robinson, G. (2012) "Floods unsettle Thai insurance industry", *The Financial Times*, from http://www.ft.com/intl/cms/s/0/0e9b9dec-62b3-11e1-9245-00144feabdc0.html
- Sompo Japan (2011) "Sales area expansion of Weather Index Insurance", from http://www.sompo-japan.co.jp/english/about/csr/topics/20110222_2.html
- Standard and Poors (2012) Thai Floods Dampen Asian Insurers' Earnings And Capitalization, from http://www.alacrastore.com/research/s-and-p-credit-research-Thai_Floods_Dampen_Asian_Insurers_Earnings_And_Capitalization-946587
- *Thai Travel News* (2011) "Thailand Floods: Experts say government failed to prepare for floods", from *http://www.thaitravelnews.net/politics/thailand-floods-experts-government-failed-prepare-floods/* (last accessed June 2012).
- The Nation (2011) "Major Dams Over Capacity", from http://www.nationmultimedia.com/new/national/Major-dams-over-capacity-30166650.html

Case study 4: De-polderising the Netherlands

Botzen, W.J.W. (2012) Telephone interview. 1 June.

- Botzen, W.J.W. and van den Bergh, J.C.J.M. (2008) "Insurance Against Climate Change and Flooding in the Netherlands: Present, Future, and Comparison with Other Countries", *Risk Analysis*, 28(2): 413-425.
- Botzen, W.J.W. and van den Bergh, J.C.J.M. (2012) "Monetary valuation of insurance against flood risk under climate change", *International Economic Review*, 53(3): 1005-1025.
- Bouwer, L.M., Huitma, D. and Aerts, J. (2007) *Adaptive flood management: the role of insurance and compensation in Europe*, paper presented at the Amsterdam Conference on the Human Dimensions of Global Environmental Change, 24-26 May.
- Brouwer, R. and van Ek, R. (2004) "Integrated ecological, economic and social impact assessment of alternative flood control policies in the Netherlands", *Ecological Economics*, 50: 1-21.
- ClimateWire (2012) "How the Dutch Make 'Room for the River' by Redesigning Cities", Scientific American, from http://www.scientificamerican.com/article.cfm?id=how-thedutch-make-room-for-the-river
- Collins, S. (2009) "Flood losses in European countries often covered by state programs", Business Insurance, from http://www.businessinsurance.com/article/20090531/ISSUE03/305319995#
- Huitema, D. and Meijerink, S. (2009) "Policy dynamics in Dutch water management: analysing the contribution of policy entrepreneurs to policy change", in D. Huitema and S. Meijerink (eds) *Water Policy Entrepreneurs*, Cheltenham Glos, U.K.: Edward Elgar Publishing.
- Jones-Bos, R. (2011) "As the Mississippi floods, follow the Dutch Model", *The Washington Post,* from *http://www.washingtonpost.com/opinions*
- Jongejan, R. (2012) E-mail interview. 3 June.
- Jongejan, R. and Barrieu, P. (2008) "Insuring Large-Scale Floods in the Netherlands", *The Geneva Papers on Risk and Insurance Issues and Practice*, 33: 250-268, from *http://genevaassociation.org/PDF/Geneva_papers_on_Risk_and_Insurance/GA2008* _GP33(2)_Jongejan&Barrieu.pdf

- Monti, A. (2011) High-Level Roundtable on the Financial Management of Earthquakes, Paris: OECD.
- Paklina, N. (2003) Flood Insurance, Paris: OECD www.oecd.org/dataoecd/51/9/18074763.pdf
- Room for the River (2012) Room for the River, a safer and more attractive rivers region, from http://www.ruimtevoorderivier.nl/media/19174/factsheet_uk.pdf
- Stam, J.M. and Severijn, S. (2012) Telephone interview. 7 June.
- Swiss Re (1998) Floods—an insurable risk? A market survey, Zurich: Swiss Re.
- The Economist (2012) "Counting the cost of calamities", from http://www.economist.com/node/21542755
- Van der Brugge, R., Rotmans, J. and Loorbach, D. (2005) "The transition in Dutch water management", Regional Environmental Change, 5: 164-76.
- WMO (2004)Risk Sharing Flood Management, Geneva: WMO. in http://www.apfm.info/pdf/ifm_tools/Tools_Risk_Sharing_in_FM.pdf
- WMO (2009) Cities and Flooding: Part 1, Geneva: WMO.
- Wolsink, M. (2005) "River basin approach and integrated water management: Governance pitfalls for the Dutch Space-Water-Adjustment Management Principle", Geoforum, 37(4): 2-15.

Topic II: Earthquakes and natural perils

- Natural Geographic (2012) Earthquakes, from http://environment.nationalgeographic.com/environment/natural-disasters/earthquakeprofile/
- Nelson, S. (2011) Earthquake Hazards and Risks, Lecture Notes EENS 2040, New Orleans, LA: Tulane University, from http://www.tulane.edu/~sanelson/geol204/eqhazards&risks.htm

Case study 5: Tohoku earthquake and tsunami

Case study 6: California Earthquake Authority (CEA)

- Browne, M. J. and Hoyt, R.E. (2000) "The Demand for Flood Insurance: Empirical Evidence", Journal of Risk and Uncertainty, 20(3): 291–306.
- CEA (2012) History, from http://www.earthquakeauthority.com/index.aspx?id=7&pid=1
- Lloyd's (2011) Managing the Escalating Risks of Natural Catastrophes in the United States, London: Lloyd's, from http://www.lloyds.com/~/media/Lloyds/Reports/Emergingper cent20Riskper cent20Reports/7549per cent20Llovdsper cent20Naturalper cent20Catastrophesper cent20inper cent20theper cent20USper cent20V5a.pdf
- Monti, A. (2011) High-Level Roundtable on the Financial Management of Earthquakes, Paris: OECD.
- OECD (2008) Financial Management of Large-Scale Catastrophes No. 12, from http://books.google.ch/books?id=Lwtz5bntNYC&pg=PA87&dq=Norwegian+Perils+Pool&hl=en&sa=X&ei=XM7iT7WEG4TEtAb Ots3ABg&ved=0CDoQ6AEwAA#v=onepage&g=Norwegian%20Perils%20Pool&f=fals e
- Paudel, Y., Botzen, W.J.W. and Aerts, J.C.J.H. (2012) "A Comparative Study of Public-Private Catastrophe Insurance Systems: Lessons from Current Practices", The Geneva Papers on Risk and Insurance Issues and Practice, 37(2): 257-285.

- Surminski, K and Oramas-Dorta, D. (2011) Building effective and sustainable risk transfer initiatives in low- and middle-income economies: what can we learn from existing insurance schemes, London: Centre for Climate Change Economics and Policy and Grantham Resarch Institute on Climate Change and the Environment.
- Swiss Re (2012) Lessons from Recent Major Earthquakes, Zurich: Swiss Re, from http://www.preventionweb.net/english/professional/publications/v.php?id=24710
- The Geneva Association (2011) *Tackling Climate Risk: An Insurance Contribution to the COP Discussions*, Geneva: The Geneva Association, from *http://genevaassociation.org/PDF/BookandMonographs/GA2011-Tackling_Climate_Risk.pdf*

Case study 7: Norwegian Natural Perils Pool (NNPP)

Consorcio de Compensación de Seguros (2008) "Norway", in *Natural Catastrophes: A Diversity of Insurance Coverage*, Madrid: Consorcio de Compensación de Seguros pp. 121-28, from

http://consorseguros2.tirea.es/textos/datos/pdf/extra/naturalCatastrophes.pdf

- Erikson, R., Hansen, E., Ringen, S. and Uusitalo, H. (1987) *The Scandinavian Model: Welfare States and Welfare Research*, from *http://books.google.ch/books?hl=de&lr=&id=fDbzBfzThusC&oi=fnd&pg=PP11&dq=No rwegian+Social+Model&ots=a6Do88heN9&sig=osG18MrvGT9zKBX4Bx7J3IYBS3M# v=onepage&q=Norwegianper cent20Socialper cent20Model&f=false*
- Haug, T. (2012) Telephone interview. 2 July.
- Krasovskaia, I., Gottschalk, L., Sælthun, N. and Berg H. (2009) "Perception of the risk of flooding: the case of the 1995 flood in Norway", *Hydrological Sciences Journal*, 46(6): 855-868, from *http://www.tandfonline.com/doi/abs/10.1080/02626660109492881*
- Lloyd's (2011) Managing the Escalating Risks of Natural Catastrophes in the United States, London: Lloyd's, from http://www.lloyds.com/~/media/Lloyds/Reports/Emergingper cent20Riskper cent20Reports/7549per cent20Lloydsper cent20Naturalper cent20Catastrophesper cent20inper cent20theper cent20USper cent20V5a.pdf
- Monti, A. (2011) *High-Level Roundtable on the Financial Management of Earthquakes*, Paris: OECD.
- Næss, L.O., Bang, G., Eriksen, S. and Vevatne, J. (2005) "Institutional adaptation to climate change: Flood responses at the municipal level in Norway", *ScienceDirect*, 15(2): 125–138.
- Norsk Naturskadepool (2009) *History, organization and principle of operation of NNPP*, presented at Conference for NNPP's reinsurers in Oslo 16th to 18th June 2009, from *http://www.naturskade.no/en/main/information/conference-for-nnpps-reinsurers-in-oslo-16th-to-18th-june-2009/*
- Norsk Naturskadepool (2012) What is the Norwegian Perils Pool?, from http://www.naturskade.no/en/main/membership-pages1/members/1-what-is-thenorwegian-natural-perils-pool/
- OECD (2008) Financial Management of Large-Scale Catastrophes No. 12, from http://books.google.ch/books?id=Lwtz5bntNYC&pg=PA87&dq=Norwegian+Perils+Pool&hl=en&sa=X&ei=XM7iT7WEG4TEtAb Ots3ABg&ved=0CDoQ6AEwAA#v=onepage&q=Norwegianper cent20Perilsper cent20Pool&f=false
- The Geneva Association (2011) Tackling Climate Risk: An Insurance Contribution to the COP Discussions, Geneva: The Geneva Association, from

http://genevaassociation.org/PDF/BookandMonographs/GA2011-Tackling_Climate_Risk.pdf

Van Schoubroek, C. (1997) "Legislation and Practice Concerning Natural Disasters and Insurance in a Number of European Countries", *The Geneva Papers on Risk and Insurance Issues and Practice*, 22(83): 238-267, from *http://www.genevaassociation.org/PDF/Geneva_papers_on_Risk_and_Insurance/GA* 1997_GP22(83)-Schoubroeck.pdf

Topic III: Developing resilient communities

Dickson, E., Baker, J.L., Hoornweg, D. and Tiwari, A. (2012) *Urban Risk Assessments: Understanding Disaster and Climate Risk in Cities*, Washington DC: World Bank.

Case study 8: The R4 Rural Resilience Initiative—protecting livelihoods in a changing climate

Case study 9: Natural catastrophe insurance in China: policy and regulatory drivers for the agricultural and the property sectors

- AIR (2009) "Agricultural Risk and the Crop Insurance Market in China", AIRCurrents, from http://www.air-worldwide.com/Publications/AIR-Currents/Agricultural-Risk-and-the-Crop-Insurance-Market-in-China/
- ClimateWise (2011) "ClimateWise Compendium of disaster risk transfer initiatives in the developing world", from *http://www.climatewise.org.uk/climatewise-compendium/*
- Dailey, P., Huddleston, M., Brown, S. and Fasking, D. (2009) *The Financial Risks of Climate Change: Examining the financial implications of climate change using climate models and insurance catastrophe risk models*, Association of British Insurers, Research Paper No. 19, p. 108.
- Economy Watch (2010) "Economic Structure of China Chinese Economic Profile", from http://www.economywatch.com/world_economy/china/structure-of-economy.html
- Enz, R. (2000) "The S-Curve Relation Between Per-Capita Income and Insurance Penetration", *The Geneva Papers on Risk and Insurance Issues and Practice*, 25(3): 396-406, from *http://genevaassociation.org/PDF/Geneva_papers_on_Risk_and_Insurance/GA2000* __*GP25(3)_Enz.pdf*
- Feyen, E., Lester, R. and Rocha, R. (2011) What Drives the Development of the Insurance Sector? An Empirical Analysis Based on a Panel of Developed and Developing Countries, Working Paper S5572, Washington DC: World Bank.
- Herd, R., Koen, V., and van den Noord, P. (2011) *China's emergence as a market economy: achievements and challenges*, OECD contribution to the China Development Forum 20-21 March 2011, Beijing, Paris: OECD.
- Huang R.H., Zhang, Q.Y., Ruan S.G. *et al.* (2005) *Meteorological disaster forecasting and early warning in China and disaster prevention and reduction countermeasures*, Beijing: China Meteorological Press, pp. 3-22.
- Hussels, S., Ward, D. and Zurbruegg, R. (2005) "Stimulating the Demand for Insurance", *Risk Management and Insurance Review*, 8(2): 257-278, from *http://onlinelibrary.wiley.com/doi/10.1111/j.1540-6296.2005.00059.x/abstract*
- Information Office of the State Council, The People's Republic of China (2011) *China's Policies and Actions for Addressing Climate Change*, Beijing: Information Office of the State Council.

- Kamal-Chaoui, L., Leman, E. and Rufei, Z. (2009) *Urban Trends and Policy in China*, OECD Regional Development Working Papers, 2009/1, Paris: OECD.
- Lloyd's (2007) "China Avenues for Growth", Focus Asia Newsletter, Issue 3.
- Mahul, O. and Stutley, C. (2010) Government Support to Agricultural Insurance: Challenges and Options for Developing Countries, World Bank: Washington, DC.
- Munich Re (2010) *Topics Geo natural catastrophes 2009: analyses, assessments, positions,* Munich: Munich Re, p. 40.
- National Development and Reform Commission (NDRC), People's Republic of China (2007) China's National Climate Change Programme, Beijing: NDRC.
- OECD (2007) Integrated Disaster Risk Management of China, Session III: Financial Management: Role of Insurance Industry, Financial Markets and Governments. Part B: Developing Country Perspective, from http://www.oecd.org/insurance/insurance/38120232.pdf
- OECD (2011) "China", in OECD, Agricultural Policy Monitoring and Evaluation 2011: OECD Countries and Emerging Economies, Paris: OECD Publishing.
- Ranger, N. and Surminski, S. (2011) A preliminary evaluation of the impact of climate change on non-life insurance demand in the BRICS economies, Working Paper, Leeds and London: Centre for Climate Change Economics and Policy, from http://www.cccep.ac.uk/Publications/Working-papers/home.aspx
- Ranger, N. and Williamson, A. (2011) Forecasting non-life insurance demand in the BRICS economies: a preliminary evaluation of the impacts of income and climate change, Munich Re Technical Paper 11, Leeds: Centre for Climate Change Economics and Policy.
- Swiss Re (2008) Setting up sustainable agricultural insurance: the example of China, Zurich: Swiss Re.
- Wang, J., Huang, J. and Rozelle, S. (2010) "Climate Change and China's Agricultural Sector: An Overview of Impacts, Adaptation and Mitigation", ICTSD–IPC Platform on Climate Change, Agriculture and Trade, Issue Brief No.5, Geneva: International Centre for Trade and Sustainable Development and Washington DC: International Food & Agricultural Trade Policy Council.
- Wang, M. et al. (2011) "Agriculture insurance in China: History, experience, and lessons learned", International Journal of Disaster Risk Science, 2(2):10-22.
- Wang, Z., Lin, T. and Walker, G. (2009) *Earthquake Risk and Earthquake Catastrophe Insurance* for the *People's Republic of China*, Asian Development Bank Sustainable Development Working Paper Series, No. 7.
- Wong, M. (2011) "Fertile grounds in Asia's giants. Agricultural Feature", Asia Insurance Review, June 2011.
- World Bank (2007) "China: Innovations in Agricultural Insurance—Promoting Access to Agricultural Insurance for Small Farmers", Washington, DC: World Bank.
- World Bank (2008) "Catastrophe Insurance Policy for China", World Bank Good Practice Notes July, from http://siteresources.worldbank.org/CHINAEXTN/Resources/318949-1217387111415/Catastrophe_Insurance_en.pdf

World Bank (2011) "Urban Development and China", from http://go.worldbank.org/XH48514WY0

- Zheng, W., Yongdong, L. and Deng, Y. (2009) "A Comparative Study of International Insurance Markets", *The Geneva Papers on Risk and Insurance Issues and Practice*, 34 (1): 85-99, from *http://genevaassociation.org/PDF/Geneva_papers_on_Risk_and_Insurance/GA2009* _GP34(1)_Zheng.pdf
- Zheng, W., Yongdong, L. and Dickinson, G. (2008) "The Chinese Insurance Market: Estimating its Long-Term Growth and Size", *The Geneva Papers on Risk and Insurance Issues and Practice*, 33: 489-506, from *http://genevaassociation.org/PDF/Geneva_papers_on_Risk_and_Insurance/GA2008* _GP33(3)_Zheng_et_al.pdf

Topic IV: Liability litigation as a tool for disaster remediation and deterrence—a tale of two sharply differing outcomes

Case study 10: The Bhopal environmental disaster

Case study 11: The Ecuador rainforest oil exploration claim

No bibliography has been submitted for Topic IV.