Research Assessment Exercise 2020
Impact Case Study

University: City University of Hong Kong
Unit of Assessment (UoA): 10 - earth sciences (incl. oceanography, meteorology) and other physical sciences (incl. environmental science)

Title of case study: Climate, tropical cyclones and reinsuring natural catastrophes

(1) Summary of the impact

The research Professor Johnny Chan and his team at the Hong Kong City University of School of Energy and Environment are doing related to climate and tropical cyclones is critical to helping public entities, insurers and reinsurers better manage their risk and the costs associated with natural catastrophes.

(2) Underpinning research

Frequent extreme weather events, heat waves, tropical cyclones and the East Asia Winter Monsoon are among the many events that affect the Asia-Pacific region. Being able to better predict tropical cyclones and the frequency of heavy rainfall is critical for governments, public entities, insurers and reinsurers to prepare for and mitigate the associated risks. The work Professor Chan carries out annually on tropical cyclone formationand landfall provides insight into the near-term risk and the potential costs. The team's recent study of the long-term changes in tropical cyclones through 2100 highlights future changes: global warming will increase the severity of tropical cyclones. and landfalls will continue to move northward in Asia, putting cities like Shanghai and Tokyo at more risk [C]. Another result of global warming is the frequency of heavy rainfall. A recent study by Professor Chan showed that urban cities in Asia are at more risk of heavy rainfall [A,B] which underscores the need for these cities to address infrastructure improvements. Drainage systems in many megacities in the Asia-Pacific region were designed many years ago and are not adequate to accommodate the expected increases in rainfall frequency and intensity. Without appropriate design, the chance of flooding in these cities is therefore much higher than in better-prepared cities.

In some of the developing countries like the Philippines and the Pacific Islands, there is an increased interest in better managing the risk for tropical cyclones. Professor Chan is currently researching such risk to improve disaster preparedness [D]. This should allow governments to reduce the potential loss of life by evacuating areas of risk.

One of the largest insurance losses in China was from the winter storm in January 2008 which caused heavy damage to transmission and distribution lines in China. In East Asia, the occurrence and persistence of extreme cold spells are closely related to an anomalous East Asian winter monsoon. Professor Chan's team is researching the underlying physical mechanisms of cold extremes under a changing climate in order to better predict their occurrence in the future [F]. Insurers are still finding it difficult to reinsure transmission and distribution lines at an acceptable cost. Being able to better predict these events should lead to increased availability of reinsurance.

China and India along with the US are the three largest food-producing nations and also the three largest crop insurance markets in the world. Understanding the interdecadal weather patterns and their influence on weather in crop-growing regions will allow farmers and governments to minimize the impact by planting crop that are better suited for the likely climate conditions [E]. In addition to the research Professor Chan's team undertakes, they also provide a wealth of information to help insurers and reinsurers understand the risks associated with these long-term weather patterns. There are additional impacts on crops and food security due to increasing ozone concentrations across China, recently reviewed by Prof. Peter Brimblecombe, evidence that air pollution is also having an impact on agricultural output.

(3) References to the research

[A] Holst, C.C., Tam, C.-Y., Chan, J.C.L. Sensitivity of urban rainfall to anthropogenic heat flux: A numerical experiment (2016) Geophysical Research Letters, 43 (5), pp. 2240-2248.

[B] Holst, C.C., Chan, J.C.L., Tam, C.-Y. Sensitivity of precipitation statistics to urban growth in a subtropical coastal megacity cluster (2017) Journal of Environmental Sciences, 59, pp. 6-12.

[C] Lok, C.C.F., Chan, J.C.L. Simulating seasonal tropical cyclone intensities at landfall along the South China coast (2018) Climate Dynamics, 50 (7-8), pp. 2661-2672

[D] Sajjad, M., Chan, J.C.L. Risk assessment for the sustainability of coastal communities: A preliminary study (2019) Science of the Total Environment, 671, pp. 339-350.

[E] Li, X., Zhou, W., & Chen, Y. D. (2015). Assessment of regional drought trend and risk over China: a drought climate division perspective. Journal of Climate, 28(18), 7025-7037.

[F] Zhou, W., Chan, J.C.L., Chen, W., Ling, J., Pinto, J.G., Shao, Y. Synoptic-scale controls of persistent low temperature and icy weather over Southern China in January 2008 (2009) Monthly Weather Review, 137 (11), pp. 3978-3991.

(4) Details of the impact

Guy Carpenter & Company, LLC issues a range of reports that largely derive from the work from scientists in the School of Energy and Environment who form part of this UoA. These studies focus on understanding the variations driving weather phenomena in the Asia-Pacific region and to some extent around the world. "Natural catastrophes and climate risks continue to pose a significant threat to the communities, economies and ecosystems of the Asia-Pacific region, but understanding these threats is the first line of defense in providing better solutions and protections in this region and around the world," said James Nash, CEO of Asia-Pacific Region, Guy Carpenter LLC. Although the interpretation provided to Guy Carpenter LLC covers weather and climate change, it also looks at ways in which the nature of air pollution is changing in the region. These reports are disseminated to insurers and planners. They include: Aioi Nissay Dowa Insurance Co., American Agricultural Group, ANZ Lenders Mortgage Insurance Pty Ltd., BT Financial Group, Caisse Centrale de Réassurance, Catholic Church Insurance Ltd. China Property & Casualty Reinsurance Company Ltd., FERRERO, First Insurance Company Ltd., ICNZ, Insurance Australia Ltd., Mitsui Sumitomo Insurance

Company Ltd., MS&AD Insurance Group Holdings Incorporated, Nonghyup P&C, Reask, RMS, South Carolina Dept. of Insurance, Taiping Reinsurance Co. Ltd., Toa Reinsurance Co. Ltd., Westpac and Zurich Insurance Company Ltd.

In recent years influential reports include:

1. *Report 2018 Western North Pacific Basin Tropical Cyclone Predictions* gave forecasts for the season May 1 to October 31 drawing on the typical outcomes in an El Niño Southern Oscillation (ENSO) and the neutral year that follows, suggesting that the number of tropical cyclones between would be to be near- to below-normal: (i) Japan and Korea 3.7 cyclones in the season compared with 4.9 typical average over almost half a century, (ii) Eastern China and Taiwan 3.0 compared with 3.6 and (iii) South China, Vietnam and the Philippines 4.9 compared with 7.3

2. *Report on 2018-2019 Australia Tropical Cyclone Predictions* gives projections of the number of landfalling tropical cyclones for Australia over the six-month period from May 1 to October 31, 2019, which is near-average compared with the historical 1968 through 2015 average of 4.2. High accuracy forecasts are possible for all the regions except the Northern Territory, but there the frequency is relatively low. In Queensland predictions are for 1.6 and in Western Australia 2.1. These are near average and are made at a high forecast accuracy.

3. *2019 Western North Pacific Basin Tropical Cyclone Briefing*

As an indicator of use the most recent report of 2019 on North Pacific Basin tropical cyclones was downloaded by 108 unique users, of which 20 were internal and 71 were external.

Weather prediction and insurance is especially relevant given the large amount of money involved and the increasing size of claims. While some of the hazards and extreme events mentioned above are of great concern, there are also more gradual changes underway that are important to incorporate into actuarial calculations. Among these, increasing temperature is especially important. Temperature also effects both the speed of crop development, but also the rate of change in insect life cycles, essentially increasing the impact of pests that attack crops. Higher temperatures have secondary effects over time as such changes in climate lead to wider environmental change that alters the success of crop varieties in the landscape. Changing temperatures and sunshine hours give rise to increased levels of ozone and this has a critical impact lowering crop yields and affecting food security.

The research described here has had a distinct impact on the way insured risks are evaluated. In particular, the work has led to changes in the way in which premiums are estimated. The impact can be estimated in terms of its reach by that the fact that this effectively alters the way thousand premiums are estimated.

In addition to providing information to the insurance industry, Professor Chan also trained a scientist, Dr. Shirley Qin, from Guy Carpenter LLC to run the tropical cyclone prediction model. Since then, Dr. Qin has been running the model for the prediction of the number of tropical cyclone landfalls in East Asia as well as Australia on a real-time basis, and the results have been disseminated to the insurance industry. Such technology transfer is the first of its kind for tropical cyclone prediction.

More recently, work with Dr. Keith Ngan and Prof Johnny Chan in this UoA has been reported to the Hong Kong MTR Corporation Limited, which oversees the rail system. The research was undertaken following last year’s Super Typhoon, when service was interrupted

for a half-day because crews needed to remove fallen trees from the track. The MTR is using the results to prepare for their response to typhoon landfalls. The report has estimated which sections of track are at the greatest risk and allows crews to act without having to wait for detailed reconnaissance. It may even be possible to be pro-actively prune trees along sections at risk.

(5) Sources to corroborate the impact

1. *Report 2018 Western North Pacific Basin Tropical Cyclone Predictions,* Marsh and McLennan Companies.

2. *Report on 2018-2019 Australia Tropical Cyclone Predictions.* Marsh and McLennan Companies.

3. *2019 Western North Pacific Basin Tropical Cyclone Predictions.* Marsh and McLennan Companies.

4. GCCapitalIdeas, *Increasing Frequency of Extreme Weather Events in Asia Pacific* November 12, 2018.

5. GCCapitalIdeas, *2018 Asia Pacific Catastrophe Reinsurance Report,* October 29, 2018.

6. GCCapitalIdeas, *Guy Carpenter Asia-Pacific Climate Impact Centre Publishes New Annual Report*, May 20, 2014.

7. Chan, J.C.L., Ngan, K., C. K., Tang, C.K., and Chu, J. Estimation of wind speeds along exposed railway tracks, *Final Report to MTR Corporation Limited*. 2019, 25 pp.