Parametric insurance for Papua New Guinea telecommunications infrastructure against earthquake risk

By

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Abstract

A bespoke product to provide PNG Data co. with parametric insurance in the event of earthquakes damaging critical submarine fibre optic cables, key to the information and communication industries. The product uses a trigger of peak ground acceleration provided by USGS, with payouts used to repair cables swiftly.

Overview

Peril/s	Earthquake
Geography/Region	Papua New Guinea (PNG)
Years of	The insurance programme incepted in May 2024 and is a 1 year cover
Exposure covered	Event response costs to repair submarine fibre optic cable breakage, thereby minimising service disruption
Trigger type/s	Pure parametric
Trigger mechanism/s	Simple trigger (peak ground acceleration at each location above a threshold, across 100 calculation sites, based on USGS ShakeMap)
Key information	
Annual Limit	
Issuer	Pacific Catastrophe Risk Insurance Company (PCRIC)
Cedant	PNG Data Co Limited
Parties Involved	Structuring and calculation agent: Willis Towers Watson (WTW Risk analytics: Global Earthquake Model (GEM) Foundation Reporting Agency: US Geological Survey

DETAIL

Motivation

When disasters strike, the swift recovery of the lifeline communication infrastructure is critical to the lives and livelihoods of people and businesses. Traditional insurance is seldom available to protect infrastructure networks, which slows and weakens recovery efforts. To overcome this issue, parametric insurance can help State-Owned Enterprises (SOEs) quickly access funds for post-disaster response, as a complement to other disaster risk management approaches.

PNG Data Co. is a state-owned enterprise in Papua New Guinea (PNG), offering wholesale services to the information and communication industry. It is tasked with constructing, owning and operating the critical national transmission network, including the installation and oversight of submarine fibre optic cables.

Following several cable breakages in recent years due to earthquakes, PNG Data Co. has not been able to find any private sector insurer willing to offer coverage for its network. Indemnity insurance relies on post disaster damage assessment to provide payouts to policyholders. Unfortunately, the submarine nature of fibre optic cables makes it impractical to assess the level of physical damage to the cable network, and associated repair cost.

In the absence of suitable coverage from the private sector, PNG Data Co (the policyholder) approached the Pacific Catastrophe Risk Insurance Company (PCRIC, the risk carrier) to explore the possibility of creating a bespoke insurance product to meet its specific needs. PCRIC, a development insurer serving the Pacific region, worked closely with leading global advisory, broking and risk solutions company, Willis Towers Watson, and utilized data from the Global Earthquake Model foundation (GEM), to develop and deliver a unique insurance solution, highlighting the advantages of parametric insurance as a way of providing financial protection when government financing and/or traditional risk transfer mechanisms are not available.

While this parametric solution closes a major gap to help protect critical infrastructure networks that indemnity mechanisms cannot, it is not designed to cover all losses faced by the policyholder following a disaster. Rather, parametric insurance provides rapid access to liquidity to respond to immediate needs. Therefore, it does not completely substitute the need for traditional insurance aimed at funding reconstruction/repair costs.

The insurance coverage taken out will help protect PNG Data Co. from the financial impact of earthquake damage, providing funds for rapid response to damages from triggering events, and ultimately helping to ensure any break in their vital services is minimised. While disbursement activities are at the discretion of the policyholder based on needs and priorities, payouts can be used for example to rapidly mobilise and deploy additional equipment and staff in the affected areas (e.g. deploying ships, purchasing fuel to reach damaged sites, paying for staff overtime, etc.).

The rapid response by PNG Data Co. will ensure faster access to telecommunication services which are crucial in a time of crisis to coordinate relief and recovery efforts. This contributes to boost PNG's disaster resilience, demonstrating the value of effective risk management for critical infrastructure.

Figure 1: PNG Data Co. installing a fibre optic cable, off the coast of Papua New Guinea (source: https://www.pngdataco.com/)

Description of the Coverage

The geographic areas in scope of the insurance policy corresponds to the submarine fibre optic cable network managed by PNG Data Co. (Figure 2).
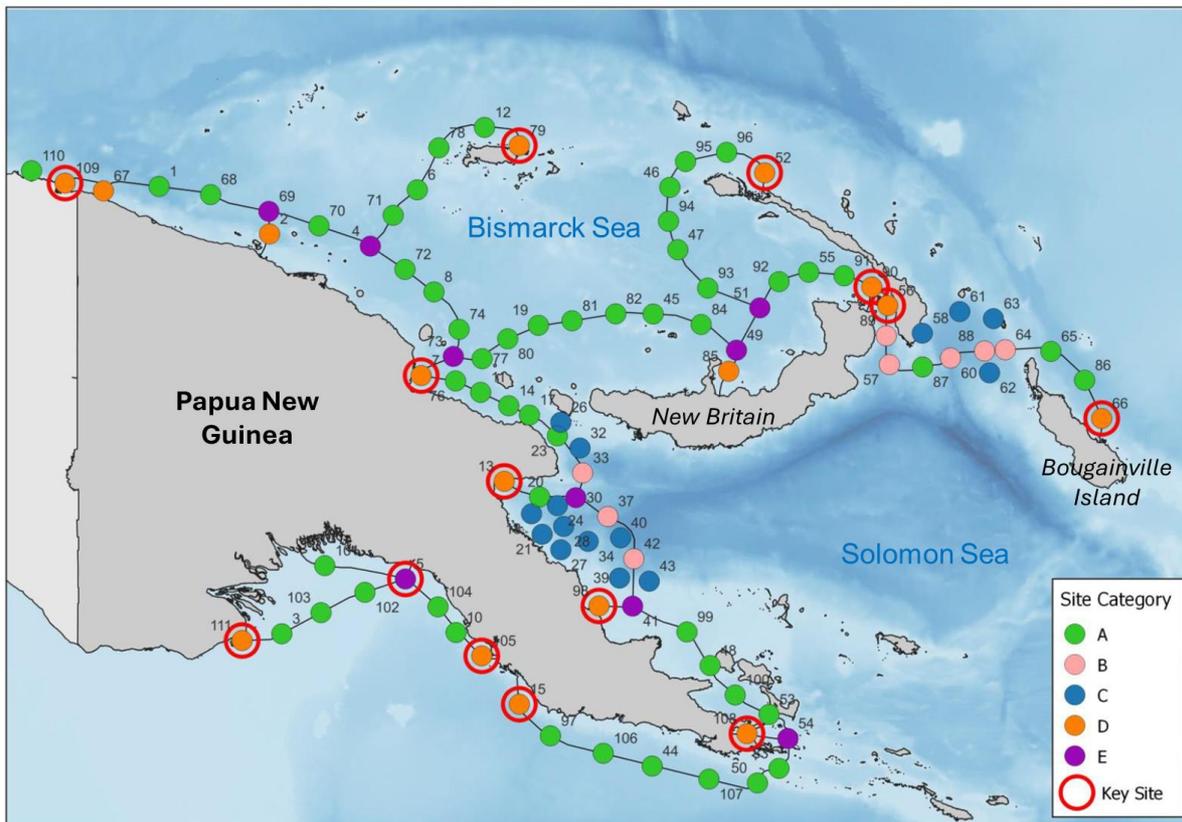

Figure 2: Calculation sites (discs colour-coded for each site type); key sites have red disks.

Following an earthquake event impacting the network, the level of ground-shaking at each calculation site is derived from the USGS ShakeMap[1].

The policy uses different site types, associated with different thresholds to 'trigger':
- A. Shallow water sites, where direct ground shaking is likely to be the main breakage mechanism.
- B. Deep water sites where potential debris flow (e.g. submarine landslides) increases the likelihood of breakage.
- C. Sites that are not on the network but correspond to potential debris flow sources which could damage the network cables following ground shaking.
- D. Sites with near-shore cable landing points which are likely to have higher vulnerability.
- E. Sites at cable junctions.

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[1] https://earthquake.usgs.gov/data/shakemap/

The selected ground-shaking trigger threshold for each site category is indicated in Table 1.

Trigger Thresholds (indicative MMI equivalent for information only)				
Category A	Category B	Category C	Category D	Category E
PGA 0.23g	PGA 0.18g	PGA 0.13g	PGA 0.13g	PGA 0.18g
~MMI 7.1	~MMI 6.7	~MMI 6.2	~MMI 6.2	~MMI 6.7

Table 1: Ground-shaking threshold (pga) for each calculation site category

The payout amount (% of cover limit) under the policy is determined by the number of calculation sites that meet their respective ground-shaking trigger (see "Payout" section below).

Testing the adequacy of ground-shaking as a proxy for damage to the cable network required empirical data, including historical records of earthquakes and their associated impact (e.g. location, extent of damage and cost of repair). The adequacy of the threshold selection was also improved by assessing the nature of the cable network and any variability in its vulnerability to earthquake shaking considering the different site types above. Such vulnerability was assessed using empirical observations from recent events as reported by the policyholder.

To design a policy in line with PNG Data Co's requirements in terms of coverage limit, premium and payout frequency (attachment point, probable maximum losses, expected losses), historical earthquake shaking was captured using USGS ShakeMaps, which are available for the past 118 years as well as in real time for current events. These maps provide shaking intensity (Peak Ground Acceleration, pga) footprints which enable sampling of the estimated shaking intensity at any point on the ground (including seafloor).

Due to the relatively short historical record (228 events in 118 years), a stochastic analysis was required to better evaluate potential ground shaking intensity at each site over a very long period of time. GEM developed a stochastic seismic hazard profile for each of the 100 calculation sites described in Figure 1, simulating 100,000 years of earthquake events and associated peak ground acceleration, using the platform Openquake. The hazard input model used for the analysis consisted of the model developed by Ghasemi et al. [2020][2]. However, given that the results provided by the United Stated Geological Survey (USGS) ShakeMap system are used for the calculation process to trigger payouts, GEM replaced the original ground motion models in each geological region as proposed by Ghasemi et al. [2020] with the corresponding ones selected by the USGS. This modification ensures a better consistency between the ground-motion values computed in this analysis and the hypothetical values that will be produced by future earthquakes occurring within the covered region as reported by USGS. Overall, the Stochastic Event Set contains 1,308,657 events.

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[2] Ghasemi, P. Cummins, and G. et al. Weatherill. Seismotectonic model and probabilistic seismic hazard assessment for papua new guinea. Bulletin of Earthquake Engineering, 18:6571–6605, 2020.

Then, Willis Towers Watson used this stochastic event set to identify which combination of site triggers and pay-out amounts best proxied the empirical data, while also resulting in an expected loss which would lead to an "acceptable" premium amount for the coverage required.

Payouts were validated using historical stress testing. As indicated above, the ground-shaking historical record includes 228 events in 118 years (from 1906 to 2023). This excludes 48 lower magnitude events which did not have a ShakeMap but were not believed to be able to cause damage, at any sampling site. Detailed damage reports from the policyholder were available for three recent earthquakes (06th May 2019, magnitude Mw 7.2; 17th July 2020, Mw 7.0; and 10th September 2022, Mw 7.6), including geographic coordinates of multiple breakage points at 8 different sites. These were compared with associated ground-shaking. A sensitivity analysis was conducted due to the scarcity of data to ensure that ground-shaking triggers and associated payouts are within reasonable ranges.

Finally, false positive and false negative payouts were also assessed by comparing stochastic losses with historical theoretical payouts over 118 years, to ensure that basis risk remains acceptable.

Payout

As mentioned above, the payout structure under the policy is determined by the number of calculation sites that meet their respective ground-shaking trigger (Table 1). For every event, 1 or more sites could be triggered. Events that are only affecting a few sites are likely to be less impactful and cost less in repairs. As such, the structure corresponds to the following:

a. When 2 sites surpass their PGA threshold, then a 10% pay-out is made
b. When 5 sites surpass their PGA threshold, then a 40% pay-out is made
c. When 8 sites surpass their PGA threshold, then a 70% pay-out is made
d. When 12 sites surpass their PGA threshold, then a 100% pay-out is made

Also, a 1 site threshold was designed for a few 'key sites'. These are sites of critical importance to PNG Data Co, such as cable junctions or landing sites, and trigger a 10% pay-out if threshold is exceeded at only this site. The number of sites needed to trigger a payout was agreed between the policyholder and the risk carrier and determined using sensitivity testing to ensure that payouts meet the policyholder needs while premium remains affordable.

This type of mechanism allows for the payout to be calculated very quickly after a qualifying event, as there is no damage assessment process. PCRIC can therefore provide a payout within two weeks of the occurrence of a qualifying earthquake event.

The insurance policy incepted on 6 May 2024. Since, WTW and PCRIC have been continually monitoring for possible eligible events. There have been several low-level earthquake events for which the calculation procedure has been run, although after five months of the policy being in-force, no earthquake events have seen ground-shaking that has been severe enough for a payout. However, the experience has shown that the calculation process is robust and functioning as expected.