Pacific Ocean Finance Program- Insurance

April 2020

A project for:

FFA | PROP Pacific Islands Regional Oceanscape Program

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Pacific Ocean Finance Program—Insurance

Final Report, April 2020

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Author Profile

Willis Towers Watson (WTW) is a leading global advisory, broking, and solutions company that helps clients around the world turn risk into a path for growth. As a global risk advisor and re/insurance broker with close to 200 years of experience, we have extensive expertise assessing, developing, and implementing risk management tools and risk transfer instruments to support resilient societies and economies around the world.

The authors of this report, Dr Simon Young and Jacqueline Wharton, completed the Pacific Ocean Finance Program—Insurance work during the period of February 2019 – April 2020, supported by a team of internationally recognised experts in developing novel approaches to risk management through public-private collaboration. The team has deep credentials, boasting a demonstrable track record in extending innovations in risk analytics into disaster risk management and financing for a broad range of organisations and communities who have not traditionally benefited from the coverage and solutions of the insurance industry; we have supported governments, multilateral and international institutions, regional trade associations, banks, non-governmental organisations, and others managing catastrophe risk around the world.

We have been at the forefront of innovation in the disaster risk financing space to support post-2015 development and humanitarian agendas, as well as in the climate finance space and in the emerging area of ecological finance, with ocean and coastal risk and resilience a particular focus. This report draws on deep knowledge of natural catastrophe schemes and parametric insurance innovations, as the team has been instrumental in the design and implementation of complex regional programmes such as the Pacific Catastrophe Risk Insurance Company (PCRIC) in the Pacific region, CRIFF SPC in the Caribbean and Central America—including the conceptualisation and implementation of the CCRIF Livelihood Protection Policy—and ARC Ltd in Africa. Further, following the launch of the Global Ecosystem Resilience Facility by WTW CEO John Haley in March 2018 at the World Ocean Summit, we have undertaken a programme of work focussed on risk quantification and financing applications to support the resilience of coastal ecosystems and their beneficiary communities; we are also founding members of the Ocean Risk and Resilience Ocean Alliance.

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This report has been prepared by Willis Towers Watson, drawing on inputs from a team of internationally recognised experts led by Dr Simon Young and Jacqueline Wharton.

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The project team thanks the Pacific Ocean Finance Program team, especially Dr Melissa Walsh, Riibeta Abeta, and Judy Arumae for their guidance and support. We are grateful to them and the Pacific Islands Forum Secretariat and Pacific Islands Forum Fisheries Agency for hosting regional consultations in May 2019. We thank the governments of Fiji, New Zealand, Palau, Samoa, Solomon Islands, and Vanuatu for hosting multi-stakeholder regional consultations in May and September 2019, with participation and input from government officials and technical experts. We also thank WWF-Pacific for the opportunity to present and receive feedback at their Coral Reef Rescue Initiative Regional Workshop in Suva, May 2019.

Thanks to all the stakeholders and participants who provided consultation, input, and feedback over the course of our work, including the governments of Fiji, New Zealand, Palau, Samoa, Solomon Islands, and Vanuatu, the Asian Development Bank, the Asian Development Bank Institute, CCRIF SPC, Cherelle Jackson, Conservation Finance Alliance, Conservation International, the Fiji Hotel and Tourism Association, Fiji Surf, Friends of Palau National Marine Sanctuary, GNS Science, Jodi Smith, Melanie Hopkins, the UK High Commissioner and Head of the Pacific Network, and the British High Commission, the Munich Climate Insurance Initiative, National Pacific Insurance, the Ocean Risk and Resilience Action Alliance, Ove Hoegh-Guldberg, the Pacific Catastrophe Risk Insurance Company, the Pacific Financial Inclusion Programme, Palau Conservation Society, Palau International Coral Reef Center, PAN Fund, the Reserve Bank of Fiji, the Secretariat of the Pacific Regional Environment Programme, the Nature Conservancy, Tower Insurance, the United Nations Environment Programme, and WWF.

We also thank all the experts leading and participating in each of the Pacific Ocean Finance Program workstreams and the organisers and participants of the Pacific Ocean Finance Conference on Yanuca Island, Fiji, November 2019.

Guidance, input, and review from the Pacific Ocean Finance Program Manager, Dr Melissa Walsh, and an independent peer review from Dr Scott Hook, greatly enhanced this final report.

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1. Executive Summary

Under the Pacific Ocean Finance Program, the Willis Towers Watson consulting team, in partnership with a broad range of stakeholders, has developed three insurance concepts, based on an initial risk review, to support Pacific ocean health and thereby increase the resilience of Pacific communities.

Ocean health is crucial to communities across the small island states of the Pacific Ocean. Coastal and island communities are particularly susceptible to climate pressures, and dependence on the "natural economy", both blue and green, means they are on the frontline dealing with the impacts of climate change alongside other negative anthropogenic effects on the marine environment.

Healthy oceans and coastal ecosystems provide prosperity and protection to coastal communities. Natural infrastructure, such as reefs and mangroves, protects such communities from ocean impacts by absorbing wave energy, thereby reducing coastal erosion and reducing storm wave damage and inundation. They are the hatcheries and nurseries for fish populations, which provide a key source of nutrition as well as economic activity for small islands. And they manifest as the coastal land- and sea-scapes on which tourism revenue is dependent.

1.1 Marine Ecosystems: Critical Natural Infrastructure

Our marine ecosystems, and the ocean systems that support them, are truly valuable physical assets; they may be 'free' public goods, but their maintenance is critical to sustaining their value. Like roads and bridges, natural assets can be thought of as public infrastructure, and even though they do not often feature explicitly on government asset lists or balance sheets, revenue streams, and the associated economic well-being of coastal and small-island communities, depend on their presence and continued health. Therefore, like grey infrastructure, public authorities must establish financial responsibility for the care and upkeep of natural assets, otherwise risking significant stress to the industries and financial flows that depend on their functioning.

1.2 Threats to Pacific Ocean Health

We have identified a number of major threats to ocean health across the Pacific, including extreme climatic events such as cyclones and marine heatwaves, chronic pressures such as increases in ocean temperatures, ocean acidification, rising sea levels, disease, the many ecological effects of poor fishing and land-use practices, and pollution particularly in the form of plastics. Many of these threats are directly or indirectly linked to anthropogenic greenhouse gas emissions and the resultant changing climate, and science is unanimous in finding that these threats will worsen over multiple decades even under the most ambitious GHG emissions reduction targets.

As the direct consequences of carbon pollution increase the vulnerability of coastal communities, threatening both lives and livelihoods, it is a key priority to strengthen the resilience of the ocean environment which supports them.

1.3 Project Objectives

Understanding coastal and ocean risks, and deploying financial tools, such as insurance, to help manage these risks, is a critical component of resilience-building. Our work has explored the practical application of recent innovations in the financial management of climate risk, including through three case studies presented here.

1.4 Exploring the Role of Risk Financing as a Tool for Ocean Health

Risk financing, such as insurance, builds resilience to shock events, mitigating the impacts by arranging finance, to respond and recover, in advance. Even though paying upfront for something that might not be needed often seems expensive and even unaffordable, it is often more cost-efficient than other financial mechanisms; savings are rarely sufficient to meet immediate let alone medium term need, selling assets brings long-term economic hardship, and borrowing after-the-fact is either impossible or cost prohibitive, passing the costs associated with disasters to future generations through a suffocating debt burden. Insurance pay-outs, already paid for, and guaranteed through legally binding contracts, provide funding for recovery quickly after an event. Understanding and putting a price on risk highlights the value of risk reduction, and predictability of funding allows for the development and implementation of contingency plans, guiding effective response and recovery which reduces the negative consequences of disasters to individuals, communities and countries.

1.4.1 Potential Benefits

The development and implementation of risk financing for the marine environment and ocean health objectives can deliver significant benefits, including:

- Protecting investments in the maintenance, protection, and / or conservation of marine ecosystems;
- Providing immediate liquidity for early post-event responses to threats to the marine environment from hazards such as tropical cyclones, extreme rainfall, and / or extreme ocean temperatures; and
- Incentivising stewardship of the marine environment while increasing the financial resilience of communities reliant on the blue economy.

1.4.2 Insurance Use Cases

We have identified three broad uses for insurance:

- To bring financial protection to marine ecosystems as infrastructure assets in a traditional insurance sense. Such natural assets are providing direct and indirect economic value through protecting grey assets and nurturing key economic activities such as fisheries and tourism, and insurance can backstop investment in both ongoing maintenance / conservation and post-disaster recovery / rebuilding.
- To provide economic relief in the face of disruption to economic activity due to the loss of value provision by natural assets. In insurance parlance, this type of cover is called Business Interruption, and while the concept has generally been applied to private sector entities, recent innovations such as parametric insurance, allow for broader application of these principles including to individuals as well as to regional and national governments.
- To incentivise stewardship of the marine environment and build financial resilience of communities through providing insurance as a reward and tool for bringing financial inclusion to the most vulnerable.

1.5 Insurance Concept Case Studies

For each of the use cases presented above, we have developed a practical insurance concept, concentrating on a particular geographic and project context for the detail, but with a view to enabling broader application.

Parametric Insurance for Blue Infrastructure

Parametric cyclone insurance for a segment of the Great Sea Reef in Fiji to incentivise preparedness and finance rapid response and early recovery after major cyclone shock events.

Cover for business interruption of the blue economy from carbon pollution

Parametric insurance for marine thermal shock events using a sea surface temperature index, to help mitigate the economic consequences of tourism revenue decline due to sudden natural asset degradation in Palau.

Insurance as Reward

Livelihood protection as a social benefit through parametric insurance to support fisherfolk resilience and incentivise improved fisheries management in Vanuatu.

1.6 Concept 1: Parametric Insurance for Blue Infrastructure

1.6.1 The Risks

Coral reefs are severely impacted by wave action during cyclones, and sediment, trees and other detritus cause even greater damage in the days and weeks after a storm. Reef recovery is greatly speeded and enhanced by rapid clean-up, to curtail ongoing damage. Rapid advances in the science of coral restoration and regeneration are also unlocking opportunities for longer-term recovery efforts such that active interventions over an extended period can greatly mitigate the medium to long term impacts of cyclones on coral reefs. With growing stressors from anthropogenic sources including thermal stress and pollution, reefs exposed to tropical cyclones need all the help they can get to recover rapidly, and to maintain resilience to these other stressors.

1.6.2 The Location and Context

We have identified the Great Sea Reef (GSR) as our focus for detailed risk analytics and insurance product design. GSR is the third longest continuous barrier reef system in the world, stretching over 200km offshore to the NW of the two main islands of Fiji, protecting the north coasts of Viti Levu and Vanua Levu. The provinces of Ba, Ra, Rau and Macuata are those with coastlines adjacent to GSR; together, these provinces host 40% of Fiji's population and 70% of Fiji's tourism (which translates to a quarter of national GDP). The GSR also provides the source for 80% of Fiji's offshore fishing revenue as well as hosting huge areas of inshore fisheries which underpin nutrition and livelihoods for coastal communities along the entire length of the GSR.

The GSR is focus of a major initiative led by WWF Pacific in collaboration with the Government of Fiji, which aims to bring a systems approach to effective management of the marine and terrestrial environments that impact the reef. The scoping programme is targeting a transition towards sustainable stewardship of the reef and development of the related economy. The stated programme vision is as follows: “By 2025, the Great Sea Reef and coastal ecosystems are healthy and resilient to a changing climate, supporting sustainable business, inclusive livelihoods, food security and community wellbeing.”

Within the proposed integrated reef and community resilience approach, stakeholders have identified a role for reef insurance to help to manage the major risk of cyclone impacts undermining key elements of the GSR programme, as further described below.

1.6.3 The Insurance Mechanism

Parametric insurance is a form of insurance that provides pay-outs based on the occurrence and intensity of a hazard event, as a proxy for impact and loss, rather than indemnifying against actual loss (which is the traditional insurance approach). This focus on hazard rather than loss creates a broad range of potential applications which could not be served by indemnity insurance. These include protection of assets which are public goods creating value across a broad range of actors, operability with lower data requirements than conventional insurance, and an ability to settle very rapidly, generating pay-outs within days, which can be applied immediately to arrest ongoing loss development, and underpin early—and thus more effective—recovery.

In the case of coastal natural infrastructure, this type of cover can replicate traditional risk financing for non-traditional fixed assets such as coral reefs and mangroves, providing rapid funding to respond to damaging events such as cyclones and heavy rain through:

- Rapid reef clean-up and/or mangrove replanting (funding early response that greatly increases reef recovery after cyclones and/or enables rapid mangrove restoration, which in turn incentivises planning for response);
- Medium term coral rehabilitation activities such as re-attaching broken coral fragments, introducing nursery-grown corals, and other developing techniques for reef rebuilding;
- Response activities to mitigate sub-optimal performance of waste and water infrastructure with regard to the impacts of run-off on ocean health during and after extreme climate events; and
- Payments to fisherfolk to not fish, provision of fish aggregating devices and assistance to fish offshore, or provision of other social benefit support to ease post-cyclone stress on reefs and/or mangroves.

For the Great Sea Reef case, we have selected an area of reef adjacent to the north coast of Macuata province, which is in the heart of the GSR and is a locally-protected area. This area scored the highest of any on the GSR in a study of the value of coral reefs in terms of contribution to the global survivability of coral reefs in the face of projected ocean warming and acidification due to anthropogenic climate change (the 50 Reefs study, Beyer et al., 2018), and is therefore an area of reef that can benefit more than most from rapid response to cyclone impacts.

1.6.4 Case Study

We have identified two options for parametric insurance policy design, one of which is simpler and more easily deployable (and for which we have developed full risk metrics and potential policy design and pricing) and the other of which requires a specific data source and associated risk transfer pathway, through the Pacific Catastrophe Risk Insurance Company (PCRIC), a regional public-good risk pooling facility created as an outcome of the PCRAFI project.

Option 1: Simple "cat-in-a-box" design, targeting a particular area of interest to focus premium dollars in generating pay-outs for events which have high impact on the reefs which matter to the client. Historical cyclone records (track points and intensity) are available back to 1955 in the public record, which can be used to build a view of what track and intensity characteristics correlate with impact on the segment of reef of interest. A buffer zone around the reef area can then be drawn, with increasing intensity of cyclone recorded within the buffer zone triggering progressively larger pay-out percentages including an initial trigger level and a maximum intensity at which the full coverage value is paid out.

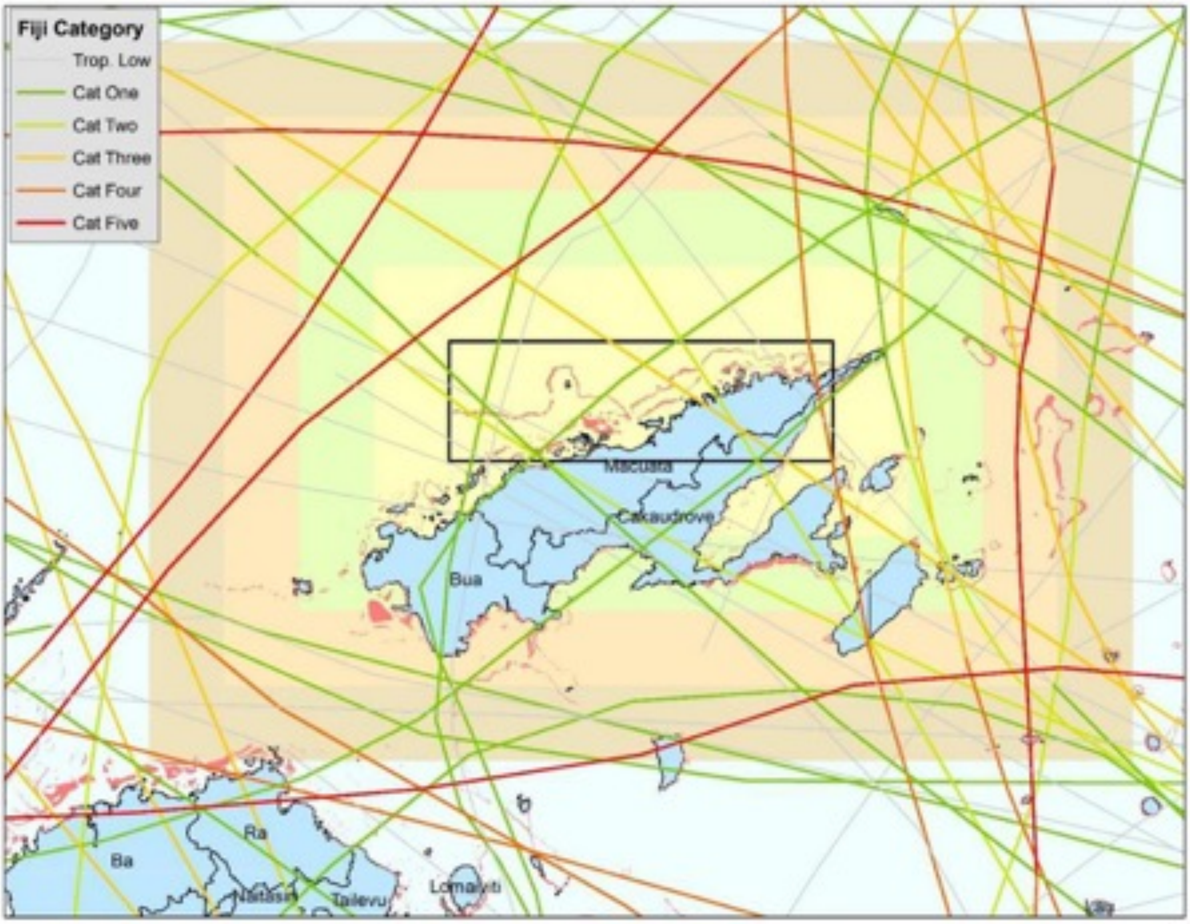

Figure 1.1 Testing historical cyclone activity within different buffer zones around the GSR offshore of Macuata province. The overall aim is to identify an area which captures storms which affect the reef but excludes storms which do not.

Category	Number of Storms in Box			
	100km	75km	50km	25km
One	12	10	7	5
Two	6	6	5	3
Three	5	4	3	2
Four	4	3	1	1

Five	5	5	3	1

Table 1.1 Historical cyclone count of different categories within different size boxes.

Based on the historical record, a box of around 50km around the defined reef zone north of Macuata province (the light green box in Figure 1.1) appears to best capture the cyclones of interest in terms of reef damage. Using the event counts in Table 1.1 and three trigger levels (and consequent pay-out rates) based on the highest category reached by a particular cyclone within the defined box, namely 30% for Category 3, 60% for Category 4 and 100% for Category 5, we estimate that a parametric insurance policy could be purchased for a little less than 10%, annually, of the policy limit (maximum pay-out amount). For example, for FJD100,000 premium, coverage could be purchased which paid out FJD300,000 for a cyclone which reached Cat 3 level within the defined box, FJD600,000 for a Cat 4 cyclone and FJD1,000,000 for a Cat 5 cyclone within the box.

Option 2: Modelled wind speed parametric, which could be underwritten by PCRIC and likely participate in the Pacific regional pool, thus benefiting from diversification of risk across the region and access to the global risk markets at scale and based on a known and trusted model. PCRIC's current tropical cyclone model, built and operated by AIR Worldwide, can provide an estimate of wind speed at a high number of points on the ground in any of the 15 Pacific islands within the model for any cyclone active within the Pacific, based on the track and intensity information provided by the regional meteorological agencies. In the case of offshore reefs, we estimate that peak wind speed in the adjacent land area (in this case Macuata province) will be a very good proxy for intensity of hazard affecting the reef. Given that data from PCRIC is not fully within the public domain, we have not fully developed the risk analytics for Option 2; however, we are confident, based on past experience, that the risk metrics will align closely with those summarised above for Option 1 so that pricing for each option will be very similar (for the same trigger thresholds and pay-out rates).

1.6.5 Pilot Transaction Characteristics

The key barriers to transaction completion for a GSR reef insurance policy relate to the source of premium and the use of pay-outs. For the former, initial support through grant funding as part of the broader GSR programme funding envelope would be highly advantageous, with sustainability of premium funding based on the shared benefits of an intact and healthy reef and mutual contributions from derived value across public and private sectors. For the latter, community engagement and organising of response strategies for post-cyclone reef clean-up and recovery enhancement can form an integral part of the GSR programme.

1.7 Concept 2: Cover for business interruption of the blue economy from carbon pollution

1.7.1 The Risks

The small islands of the Pacific are particularly susceptible to the impacts of climate change and resulting increases in ocean risk, many of the effects of which will be chronic and slow-onset, rather than acute and immediate. Coral reefs are particularly susceptible to changes in ocean temperature, and many other marine ecosystems also suffer from heat stress, some dramatically.

As sea surface temperature (SST) rises along with surface atmospheric temperatures due to the greenhouse effect, more SST peaks are high-stress events for marine ecosystems, peaks which happen seasonally and are enhanced by the El Niño Southern Oscillation (ENSO). High heat stress leads to coral bleaching and, if sufficiently severe, widespread coral mortality. Other marine species also undergo mass mortality events due to extreme heat stress. Such events not only have a devastating ecological effect, they also impact significantly on island economies dependent on tourism; reduction in tourism revenue leads to economic hardship and, ultimately, reduced resilience.

1.7.2 The Location and Context

We have identified Palau in Micronesia as an appropriate location to develop an insurance concept to help mitigate the impact of marine heat stress events on economic activity. Palau has a high profile in global climate change discussions due to its extreme vulnerability, and also in recognition of its own major investments in marine conservation over many decades. There is a very strong link in Palau between the economy (dominated by tourism and with an important fisheries component) and the health of the marine environment.

Within Palau, we have explored two potential applications of parametric insurance based on heat stress, both within the Rock Islands Southern Lagoon World Heritage Site. One targets coral bleaching, concentrating on Ngemelis Island Conservation Area (where the world-renowned Blue Corner reef is located), and the other targets jellyfish mortality within Ongeim'l Tketau, commonly known as Jellyfish Lake, a major tourist attraction.

Palau provides a strong contextual environment for implementing insurance solutions, both locally (e.g. Koror State government or national government) and regionally (e.g. through the Pacific Catastrophe Risk Insurance Company, potentially as a programme nurtured within the Pacific Island Climate Change Insurance Facility), including through the Palau Protected Areas Network (PAN) Fund.

1.7.3 The Insurance Mechanism

Palau boasts a high level of ongoing scientific study through local institutions such as the Coral Reef Research Foundation and the Palau International Coral Reef Center, which has led to very well-documented coral bleaching and Jellyfish mortality events attributed to short-term (days to weeks to a few months) peaks in SST which are, in turn, correlated with La Niña events (periods of highly negative ENSO index).

Measurements of sea surface temperature at high temporal and spatial resolution are publicly available in real time, most notably through the Coral Reef Watch (CRW) programme of the US National Oceanographic and Atmospheric Administration. Related scientific endeavours over many decades have led to an excellent record of past sea surface temperatures (although at lower resolution), and climate models resolve future changes in SST at the same resolution as the historical record, though with significant uncertainty related both to modelling uncertainty (incomplete scientific knowledge, challenges in downscaling) and to future carbon emissions, which is the dominant parameter controlling future SST forecasting.

Under the CRW programme, derivatives of satellite-based SST estimates at 5km spatial resolution and daily temporal resolution have been shown to be excellent proxies for coral bleaching events. In particular the Degree Heating Week (DHW) metric has been developed to underpin a coral bleaching warning system, with DHW reflecting both the degree of heat stress and its duration. We have therefore developed risk analytics using DHW as the index to proxy impactful events at both sites, with pay-outs triggered to address loss of revenue from tourist user fees and / or general tourist arrivals.

We have identified two significant challenges to operational testing of these concepts, though we believe that the case studies selected provide a unique opportunity to overcome these challenges, thereby unlocking a tool with great potential to support blue economy development across the Pacific. These key challenges are:

- Achieving an appropriate level of certainty around forward-looking risk analytics on SST and DHW to enable private markets to participate in risk-taking at an acceptable price; and

- Unlocking grant funds from Annex 1 / carbon-polluting countries to pay for the premiums, such that beneficiary countries can continue to build resilience even through economically damaging climate events.

1.7.4 The Case Studies

Ngemelis Island Conservation Area

This case study addressed coral bleaching, which impacts significantly, and potentially catastrophically, on reef health and therefore on the national economy, given the high tourist value of this particular site, and the overall high fisheries value of healthy reefs more broadly. The area of interest is the conservation area itself, although sea surface temperature characteristics from a 15km by 15km area (Figure 1.2) have been used to test different potential parametric index structures.

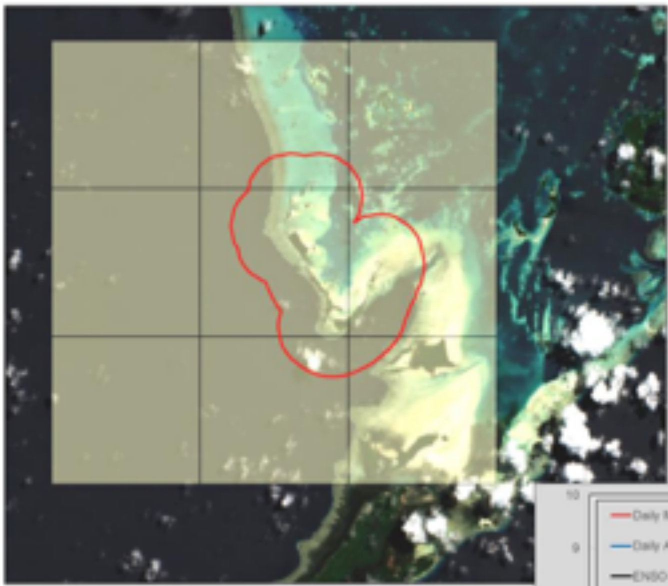

Figure 1.2 Map showing the conservation area and 5km grid cells representing the CRW data points available to act as the parametric index.

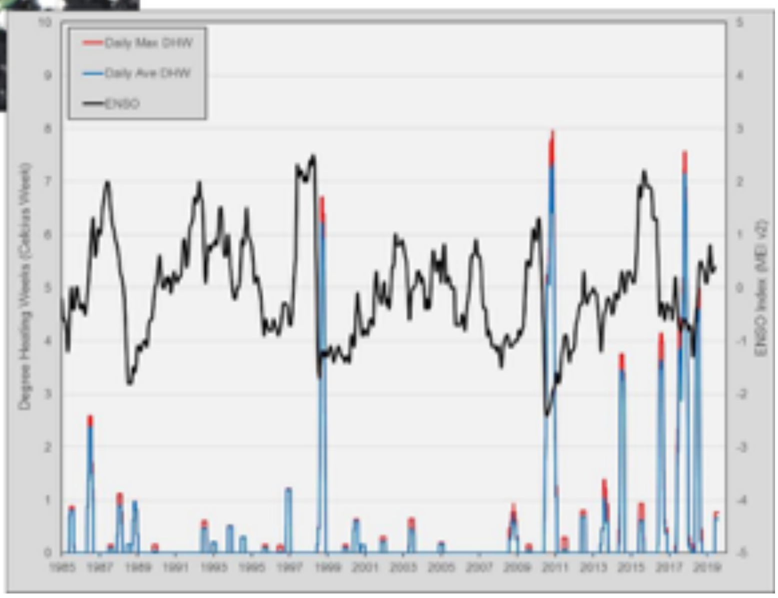

Figure 1.3 Plot of daily DHW since 1985; red is the maximum daily DHW across all 9 cells shown in Figure 1.1, blue is the average daily DHW across those cells. The MEI v2 ENSO index is shown in black; strongly negative values are La Niña events.

Figure 1.3 clearly illustrates that the major bleaching index peaks in Palau are related to minimum ENSO index numbers (peak La Niña conditions), although the low ENSO index value in 1987/88 does not correlate with a high bleaching index value, and the bleaching years from 2016 to 2018 do not contain either prolonged or a major peak of negative ENSO index.

In terms of correlation with known bleaching events, 1998, 2010 and 2016-2018 all correlate with documented bleaching episodes in Palau, indicating that DHW for Palau is a very effective proxy for coral bleaching events and that ENSO state is less effective.

Ongeim'l Tketau (Jellyfish Lake)

OIT is a marine lake with a unique ecosystem due to its isolation from the main Rock Islands Southern Lagoon. The golden jellyfish is normally present in numbers of millions, and this along with their daily cross-lake migration, makes the lake a major tourist attraction. Access to the lake is carefully controlled and includes a substantial use-fee which serves as a major revenue source for the Koror State government.

The first well-documented mass mortality event in Jellyfish Lake occurred in late-1998, when the entire jellyfish population died off over a few months. A die-off in 1987 was also known but poorly documented; others before that may well have occurred. Most recently, a die-off started in 2016 and continued through to 2018. Lake temperature and related chemical and biological changes have been found to be the likely dominant cause, although low rainfall has also been cited as a potential contributory factor.

High lake temperatures are linked directly to negative ENSO, and low rainfall is also a characteristic of La Niña conditions. While neither ENSO index, DHW, or low rainfall is a perfect proxy for jellyfish mortality events, a combination is proposed as forming the basis for parametric insurance triggering for jellyfish mortality events.

1.8 Concept 3: Insurance as Reward

1.8.1 The Risks

Fisheries play a vital role in food security for the world's population and provide livelihoods to some of the poorest and most vulnerable communities. Yet fishing is a high-risk activity, with injury and loss of life all too common. Physical risks threaten assets such as boats, and volatile catch quantity and prices create high inter-annual income variability. Destructive or damaging fishing activities also threaten the very resource these communities rely on. Supporting a resilient and sustainable fisheries sector is a key pillar for prosperity and long-term ocean health, particularly in light of the negative impacts climate change is having on livelihoods.

Incentivising small scale fisherfolk to register and install transponders on their vessels, participate in monitoring of catch volumes, and follow sustainable fishing practices, amongst other things, is a key element of implementing a sustainable fisheries policy, and provision of insurance as a reward as well as a building block to greater financial inclusion (including potentially unlocking access to credit) has the additional benefit of providing some level of security for livelihoods when disasters occur.

1.8.2 The Location and Context

We have identified Vanuatu as being a good example of where government is keen to get higher participation from subsistence fisherfolk in programmes aimed at implementation and monitoring of sustainable fishing practices. Our case study explores the provision of some basic level of livelihood protection, through parametric insurance against extreme climate events, by the government not only to reward participation in government programme(s) but also to provide a platform for expansion of insurance penetration by allowing individuals to purchase additional cover beyond that provided for free, potentially at subsidised rates up to a certain level.

In the event of a natural disaster, the government assumes great responsibility in supporting low income communities, many of which are reliant on subsistence fishing. By providing insurance and inviting the topping up of that insurance by individuals, the government is both bringing discipline to its own management of natural disaster risk (and the duties of care and contingent liabilities it holds) and enabling individuals and communities to pick up some of the risk burden themselves.

1.8.3 The Insurance Mechanism

Vanuatu is prone to many different types of extreme weather events, all of which impact on the population and their livelihoods. Most important among these for fishers and other coastal zone communities are cyclones and heavy rain events (noting that drought events are equally important for farmers but not for fishers). The livelihood protection coverage proposed in this case study uses indices of cyclone intensity (through wind speed) and rainfall amount (daily peak rainfall), measured across a geographical area consistent with the scale of data available and the distribution of land areas in Vanuatu.

An individual index for each peril is available for each geographical area (comprising individual islands with close neighbouring islands, with some subdivision for larger islands). Because the risk profile is different for each area, a mechanism in which the value of the metric (peak wind speed or 1-day rainfall) at a fixed return period is used to define pay-out triggers. This enables the pricing of the insurance product to be constant across all of the regions, ensuring equity in terms of the provision of the base coverage by the government and also greatly reducing the administrative burden for additional "blocks" of insurance purchased by individuals to top up coverage.

While the precise structure of the triggers will need to be refined via input from both the government and beneficiaries, we envisage three or four trigger levels, enabling small pay-outs for smaller events which are likely to happen relatively frequently, and progressively larger pay-outs for more intense events, such that the total coverage limit could be paid out for a single large event or for several smaller events in the same annual policy period.

This form of insurance contract allows upscaling in a straightforward manner; "blocks" of coverage can be purchased for a fixed premium, and each provides pay-outs at the same trigger levels. So, if an individual (or head of household) purchases one additional block to the one provided for free, perhaps at a subsidised rate to incentivise scaling up of protection, the pay-out will be doubled at each trigger level.

We envisage administrative processes to be embedded within the private sector, with the Pacific Catastrophe Risk Insurance Company (PCRIC, the regional sovereign insurance pool) potentially able to reinsure the primary insurance company issuing the policies, or directly insure the government for the first "block" of insurance for each individual. The process needs to be scalable and able to accommodate direct purchase of top-up coverage by individuals alongside the main government-purchased coverage.

1.8.4 The Case Study

The conceptual model for this insurance product is shown in Figure 3.1. Access to the insurance product and financial support for some base level of coverage is provided by the government (through the relevant ministry) in return for adherence to fishing policies, monitoring activities, etc. Premium is paid by the government (for the base level of coverage) and also may be paid by the individual (for additional coverage) to the insurer which underwrites the risk and issues / administers the policies. The insurer may or may not participate as a risk-taker; if not, it would need to be reinsured via PCRIC or the international markets. Each policy is attributed to a geographical area, and triggers are set such that each area has an equal probability of getting an event at a certain trigger level. Relevant data sources (PCRIC wind model for cyclone, NASA Global Precipitation Mission data for rainfall) are constantly monitored, and once a trigger threshold is met, notification is provided to clients and pay-outs are available within a few days, and can be distributed in a variety of ways (preferably linked to other financial services such as banking).

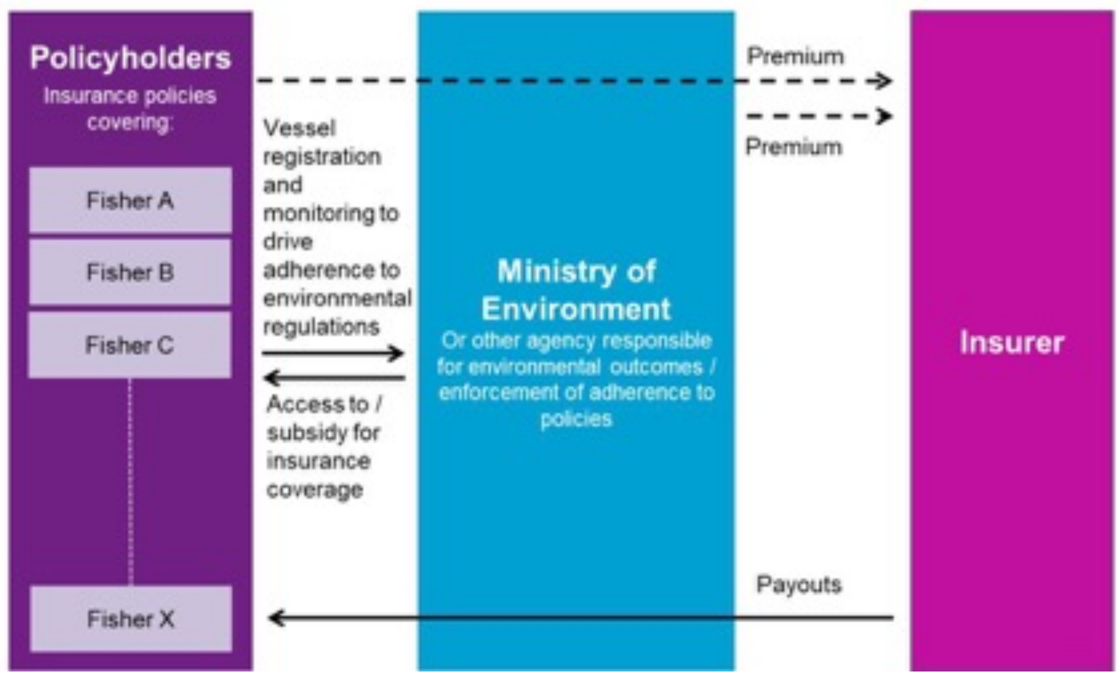

Figure 1.4 Conceptual model of the parametric climate risk insurance product provided as a reward to fisherfolk.

1.8.5 Pilot Transaction Characteristics

In Tables 1.2-1.3, the wind and rainfall trigger levels for different pay-out rates are shown for three key locations in Vanuatu as an example. Note that these wind speed and rainfall numbers are indicative only.

Wind Triggers

Trigger Level	Payout amount (% of limit)	Wind Spd (km/h) Port Vila, Efate	Wind Spd (km/h) Luganville, Espiritu Santo	Wind Spd (km/h) Sola, Vanua Lava
10-yr RP	10%	115	121	119
30-yr RP	20%	128	132	130
75-yr RP	40%	160	164	162
100-yr RP	100%	210	219	215

Rain Triggers

Trigger Level	Payout amount (% of limit)	24-hr Rainfall (mm) Port Vila, Efate	24-hr Rainfall (mm) Luganville, Espiritu Santo	24-hr Rainfall (mm) Sola, Vanua Lava
7-yr RP	10%	195	190	201
20-yr RP	30%	253	242	265
50-yr RP	100%	312	298	324

Tables 1.2-1.3 Illustration wind and rainfall trigger levels for different pay-out rates for three key locations in Vanuatu

For these particular pay-out rates at the given trigger thresholds, the cost of a policy covering both wind and rain would be a little less than 10% rate-on-line, so for each coverage "block" of, say, VUV 25,000, the annual premium would be around VUV 2,500. This rate can be directly varied by adjusting the trigger thresholds and / or pay-out rates, but is also subject to variability due to final administrative costs and to the overall scale of the product distribution (noting that a larger number of policies and a broader range of geographies both tend to lower the premium cost for each individual policy).

To reduce operational costs and increase efficiency, we suggest that the product utilises mobile technology to:

- Deliver pay-outs quickly via mobile money or via a notification that the pay-out can be collected from a pre-agreed financial institution; and
- Deliver early warning messages and preparedness advice, thus helping policy holders to minimise impacts, meaning in turn that any insurance pay-out will go further towards rebuilding livelihoods.

2. Risk Report

Ocean health is crucial to communities across the small island states of the Pacific Ocean. Coastal and island communities are particularly susceptible to climate pressures, and dependence on the blue economy means they are on the frontline dealing with the impacts of climate change and other negative anthropogenic effects on the marine environment.

Healthy oceans and coastal ecosystems provide prosperity and protection to coastal communities. Natural infrastructure such as reefs and mangroves provide coastal protection from storm impacts by absorbing wave energy and reducing storm surge inundation. They are the hatcheries and nurseries for fish populations, which provide a key source of nutrition for small islands. And they generate and protect the coastal land- and seascapes on which tourism revenue is dependent. Furthermore, as more intense storms, floods, droughts, sea level rise, higher temperatures, and ocean acidification increase the vulnerability of coastal communities to climate impacts, threatening both lives and livelihoods, it is a key priority to strengthen the resilience of the ocean environment which provides valuable coastal protection and economic resilience.

Our marine ecosystems, and the ocean systems that support them, are truly valuable physical assets; they may be ‘free’ public goods, but their maintenance is critical to sustaining their value. Like roads and bridges, natural assets can be thought of as public infrastructure, and even though they do not often feature explicitly on government asset lists or balance sheets, revenue streams depend on their presence and continued health. Therefore, like grey infrastructure, communities must establish financial responsibility for the care and upkeep of natural assets, otherwise risking significant stress to the industries and financial flows that depend on their functioning.

Under the insurance workstream of the Pacific Ocean Finance Program (POFP), Willis Towers Watson is exploring the feasibility of insurance instruments to support Pacific ocean health and thereby increase the resilience of Pacific communities. The Office of the Pacific Ocean Commissioner and the Pacific Islands Forum Fisheries Agency, with funding from the World Bank and the Global Environment Facility, are collaborating to implement component three of the Pacific Regional Oceanscape Program: the Pacific Ocean Finance Program. The aim of the POFP is to improve the amount and efficacy of finance for Pacific Ocean governance and focuses on 11 Pacific countries—Fiji, Kiribati, Marshall Islands, Federated States of Micronesia, Nauru, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu, referred to as the POFP11.

The aim of the Pacific Ocean Finance Program—Insurance (POFPI) is to is explore the potential for innovative risk finance to support ocean health, marine ecosystem resilience, and the security and prosperity of Pacific small island communities. This report constitutes an initial risk analysis to inform the design of potential risk finance and insurance programmes. Sections 1 and 2 outline threats to Pacific ocean health and the negative impacts of these threats on the marine environment. Section 3 provides an introduction to risk financing and identifies those risks discussed in Sections 1 and 2, which may be feasible to transfer to insurance markets. Finally, Section 4 presents data sources and initial quantitative risk analyses necessary to inform potential risk transfer and underpin insurance product design.

2.1 Threats to Pacific Ocean Health and Resilience

The following discussion results from a literature review of the threats—or hazards—currently threatening ocean health, including natural threats and human threats, each subdivided into slow-onset, chronic threats (such as those related to climate change like ocean warming and acidification) and shock, acute threats (such as cyclones and rainfall extremes).

Major threats include increase in ocean temperatures, ocean acidification, rising sea levels, disease, ecological effects of poor fishing practices, and poor land-use practices. Many of the major threats identified—rising ocean temperatures and water levels, ocean acidification, and disease—are directly or indirectly linked to anthropogenic greenhouse gas emissions and the resultant changing climate.

While there are many risks to ocean health in the Pacific, due to the nature of insurable versus uninsurable risks, the literature review will focus heavily on the risks that are insurable.

Insurable risks are risks that are not influenced by nor carry moral hazard. A risk has moral hazard when a party has the ability to increase its exposure to risk because the risk is insured, or because someone else bears the cost of the risk. All insurable risks must be free of moral hazard. Moral hazard entails that there is a lack of incentive to guard against risk since the negative consequences are protected against. In the case of the risks to ocean health identified above, the risks that are by and large controlled by human action and activity directly, like overfishing and agricultural runoff, are difficult to structure pure insurance products around because the pay-out can be directly influenced by human action and therefore carries moral hazard. For example, the amount of fertilizer that is used on crops that can run off into the ocean is directly controlled by human activity. Since human activity directly affects how much pollution enters the ocean, there is a possibility that incentives to reduce fertiliser use (and therefore pollution entering the ocean) are undermined because an insurance solution pays out when the pollution occurs. The moral hazard of this situation makes it very difficult to structure any conventional insurance product around these types of phenomena.

Parametric insurance can be useful in managing situations where moral hazard is at play, because an index that is free from moral hazard (i.e. human influence) may be a suitable proxy for the risk. For example, using the agricultural runoff case, if runoff occurs only during heavy rain events then using a rainfall index will still achieve the result of paying out when a pollution event occurs, but is agnostic to the level of fertiliser being applied. In fact, if structured correctly, there can be an incentive introduced; reduced fertiliser use would increase the intensity of rainfall required to cause a “pollution event”, which would in turn decrease the premium for a rainfall index product (because it would only need to trigger for more intense rainfall events).

While we recognise that direct human activities, such as overfishing, agricultural runoff and tourism, have a very significant impact on ocean health, this report and literature review will focus on the more clearly insurable risks that do not carry moral hazard. Figure 2.1 shows selected risks to ocean health and reflects whether they are insurable or uninsurable / more difficult to insure due to moral hazard.

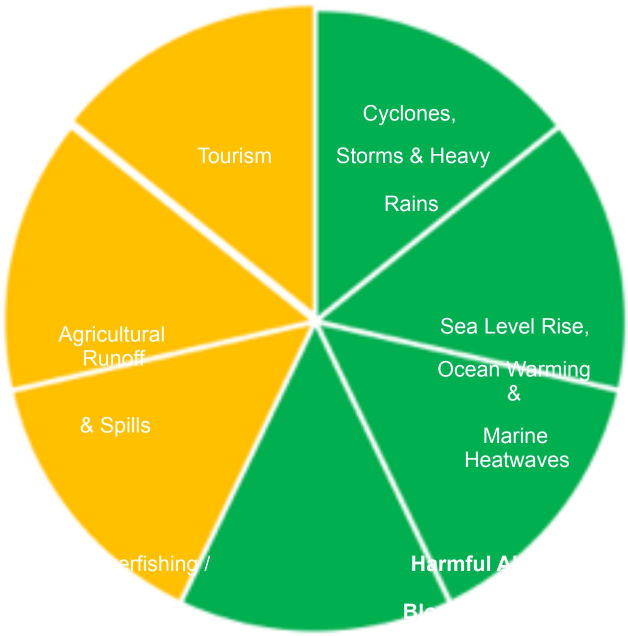

Figure 2.1 Individual ocean risks, split broadly into insurable (green) and uninsurable / more difficult to insure (orange).

2.1.1 Natural Threats

In the Pacific region, climate-related disaster risk has been increasing in the past decades because of increasing hazard, but also increased exposure in the form of people and economic assets. Within the Pacific SIDS, the smaller island states like Tuvalu and Kiribati consist substantially or fully of low-lying atolls that create the most vulnerable countries to climate change, sea level rise and climate disasters, particularly to destructive cyclones with associated storm surge and high wave energy that can overtop large portions of the islands and erode coastal zones.

Acute

Cyclones are one of key shock processes that impact on ocean health and coastal ecosystems, with mainly negative but some positive outcomes. Rainfall extremes can also impact on ocean and coastal health.

Cyclone impact on coastal habitats and marine life

Cyclone activity causes mechanical damage to reefs. Waves and water movement significantly influence the structure and distribution of coral assemblages. Generally, the branching corals are more vulnerable to wave damage than corals with more bulky, rock like form. In addition, changes in wave patterns and tidal water movements can negatively impact on some areas of the reef. In other areas, water movement

results in the accumulation of sediment and rubble; this is unstable and less suitable for coral settlement[1].

Waves generated by cyclones are larger and more powerful than those experienced under normal conditions and, as a consequence, they are the primary cause of cyclone-related damage to corals and coral reefs, often breaking coral branches and overturning colonies. Dislodged coral pieces can cause further damage as they are propelled onto other parts of the reef[2].

High winds also mix ocean water, bringing nutrients to the surface at a time when warm summer waters are often nutrient-depleted. The nutrients spur algae to grow and may create large blooms of algae. These large blooms can compete with coral for space in the reef[3]. The rain-infused water cyclones bring reduces salt levels and otherwise stresses corals. As a cyclone moves toward shore, the underwater currents can cause the sands to shift and muddy shallow waters, blocking sunlight essential to coral and sea life[4].

Slow-moving fish and turtles as well as shellfish beds are often destroyed by the rough undercurrents and rapid changes in water temperature and salinity brought by a cyclone. However, large animals tend to move quickly to calmer waters and are overall not that affected by cyclones[5].

Heavy onshore rainfall during cyclones often causes floods, which carry sediment and debris (including very large objects) to the coast (Figure 2.2) and out to sea, some lodging on coral structures and rapidly degrading them due to enhanced mechanical action during normal wave and tidal flows.

1. Heron, Scott, et al. “Hurricanes and Their Effects on Coral Reefs.” NOAA National Hurricane Center, www.coris.noaa.gov/activities/caribbean_rpt/SCRBH2005_03.pdf
2. Heron, Scott, et al. “Hurricanes and Their Effects on Coral Reefs.” NOAA National Hurricane Center, www.coris.noaa.gov/activities/caribbean_rpt/SCRBH2005_03.pdf
3. Heron, Scott, et al. “Hurricanes and Their Effects on Coral Reefs.” NOAA National Hurricane Center, www.coris.noaa.gov/activities/caribbean_rpt/SCRBH2005_03.pdf
4. NOAA. How do hurricanes affect sea life? National Ocean Service website, https://oceanservice.noaa.gov/facts/hurricanes-sea-life.html
5. NOAA. How do hurricanes affect sea life? National Ocean Service website, https://oceanservice.noaa.gov/facts/hurricanes-sea-life.html

Figure 2.2 Debris close to the shore in Fiji after Hurricane Winston.

While there is always the potential for damage, coral reefs may also benefit slightly from cyclones. During the summer cyclone season, as ocean surface waters become warmer, corals often experience thermal stress. Cyclones can alleviate thermal stress through absorbing energy from surface waters and reducing the temperature of the water. Cyclones can also reduce sea surface temperatures by inducing local upwelling and by bringing deeper, cooler water to the surface. Finally, the clouds associated with cyclones shade the ocean surface from solar heating allowing the water to cool and reducing light stress[6].

Mangrove stands may also be impacted severely by cyclone winds, although mature mangroves will survive all but the most severe cyclones and also provide critical protective value to landscapes and built infrastructure in coastal areas behind them[7] (Figure 2.3).

6.Heron, Scott, et al. "Hurricanes and Their Effects on Coral Reefs." NOAA National Hurricane Center, www.coris.noaa.gov/activities/caribbean_rpt/SCRBH2005_03.pdf
7.Spalding, Mark, et al. "Mangroves for Costal Defense" The Nature Conservancy. https://www.nature.org/media/oceansandcoasts/mangroves-for-coastal-defence.pdf

Figure 2.3 Mangroves in Fiji.

Heavy rain impacts

Heavy rain events, which become more likely in many parts of the world in future climate forecasts, can cause significant impacts on coastal ecosystems in particular, due mainly to enhanced run-off of debris and, particularly, pollutants. Even localised and short-duration heavy rain events can cause flash flooding which, on small islands, often means impacts on coastal and nearshore marine environments. Suspended pollutants are particularly damaging as they can quickly dissipate across wide areas of the nearshore marine environment and cause negative impacts on coral reefs and other marine life.

Major rainfall events can also lead to catastrophic failure of sewerage and other water management systems, and planned or unplanned release of raw sewage, agricultural run-off etc. have major impacts on reefs and animal life in nearshore marine environments.

Chronic

Most of the literature agrees that a rise in ocean temperatures is the most significant threat to ocean health around the world, including specifically in the Pacific region. Global warming is projected to have profound effects on the physical environment in the tropical Pacific Ocean. Average sea surface temperature in the Western Pacific Warm Pool, which has increased by ~0.7°C since 1900, is expected to continue rising and may increase by 1.2° C to 1.6°C by 2050 and 2.2° C to 2.7°C by 2100, relative to 1980–1999, under a high emissions scenario[8].

Since the Industrial Revolution, the atmospheric concentrations of CO_2 and other greenhouse gases have increased significantly, causing the well-known phenomenon of the greenhouse effect and increasing the temperature of the atmosphere[9]. As the atmosphere warms, it transfers heat to the ocean. It is well known that almost all ocean basins have been experiencing a sustained and accelerating upward trend in sea surface temperature, ocean heat content, and sea levels, coupled with rising ocean acidity and decreasing oxygen content.

These factors pose serious threats and challenges to marine and ocean ecosystem health and the blue economy as a whole. According to the IUCN, ocean warming affects global food security as a result of changes in fishery yields and the distribution of fish stocks. Damages to property and the displacement of people are expected to rise as a result of sea-level rise and frequent extreme weather events such as storms and floods. The health of marine species and humans will be affected by increasing bacteria and virus outbreaks as pathogens spread more easily due to the warming waters, while travel and tourism will be impacted by frequent coral bleaching events[10].

Table 2.1 outlines some of the major impacts that ocean warming has on various aspects of ocean health, adapted from XL Catlin's 2018 Ocean Risk report[11] and IUCN's 2016 Ocean Warming report[12].

Microbial Response	Ocean warming and associated reduced oxygen levels affect the biodiversity and functioning of marine microbes including bacteria and viruses. Moreover, the geographic ranges of disease bearing organisms shift due to the warming temperature and could enhance pathogen survival, allowing warm-water diseases to appear in historically cooler seas.
Algae	There has been a strong growth in new harmful algal bloom due to ocean warming.
Plankton	There is evidence of extensive changes in plankton ecosystems over the last decades, including a loss of biodiversity of plankton and change in spatial distribution of plankton. Furthermore, changes in temperature to many planktonic organisms now appearing earlier in their seasonal cycles than in the past. This is leading misbalance between plankton, fish and other marine wildlife. As plankton is the base of an extensive food web, these changes have had effects on fisheries production and other marine life.

8. Johnson, Johanna E., et al. “The Pacific Island Region: Fisheries, Aquaculture and Climate Change.” Climate Change Impacts on Fisheries and Aquaculture, 2017, pp. 333–379., doi:10.1002/9781119154051.ch11
9. “Climate Change 2013: The Physical Science Basis.” IPCC, www.ipcc.ch/report/ar5/wg1/
10. IUCN, 2016: D. Laffoley and J.M. Baxter, (eds), “Explaining ocean warming: Causes, scale, effects and consequences”, Gland, Switzerland: IUCN (2016). 456 pp: http://dx.doi.org/10.2305/IUCN.CH.2016.08.en
11. Niehorster, Falk, and Richard J Murnane. Ocean Risk and the Insurance Industry. AXA/XL Catlin, 2018, Ocean Risk and the Insurance Industry
12. IUCN, 2016: D. Laffoley and J.M. Baxter, (eds), “Explaining ocean warming: Causes, scale, effects and consequences”, Gland, Switzerland: IUCN (2016). 456 pp: http://dx.doi.org/10.2305/IUCN.CH.2016.08.en

Marine fish	Marine fish are sensitive to seawater temperature changes because their physiological performance is largely dependent on environmental temperature. Fish that are tropical like those in the Pacific are generally most sensitive to ocean warming because they have narrower ranges of temperature tolerance. This is resulting in species invasions, local extinctions and shifts in community structure and also affects local fishing economies and conservation efforts. Moreover, ocean warming affects the spawning and migration patterns of fish and imbalances the prey and predator relationships in ecosystem, creating complex cascading effects in marine food webs. As discussed above, the change in plankton also causes fish size to be smaller. One of the greatest biological disturbances to coral reefs in the Pacific is an outbreak of crown-of-thorns sea stars. These sea stars are found throughout the Indo-Pacific region, from the Red Sea to the western coast of Panama. They thrive in the warming ocean waters found in the region, and prey on coral reefs to the point where many local reefs have been destroyed[13].
Coral Reefs	In last three decades the frequency of bleaching stress has increased. Ocean warming and acidification have reduced the proportion of reefs in which ocean chemistry will allow coral reefs to grow from 98% (ca. 1780) to 38% (ca. 2006) and the number continues to drop. When the coral host is stressed, its colourful zooxanthellae expels from its tissues, causing the coral to appear pale or white—a process known as coral bleaching. Severe bleaching is usually associated with environmental stress, such as unusually warm (or cold) water temperatures, increased light or solar radiation, changes in salinity, sedimentation, or other pollution from land. Though bleaching does not mean the coral is immediately dead, if it persists it can impair normal functions of the coral host and lead to coral death (mortality), which has devastating impacts on the ecosystem. After an intense El Niño in 2015–2016 led to the longest global coral bleaching event on record, scientists documented significant coral mortality in the Pacific Remote Islands in 2016

	and 2017. For coral reefs, the projected increase in SST is expected to cause mass coral bleaching at least twice as frequently by 2050, and every 1–2 years by 2100[14].
Mangroves	There can be some positive effects of warming temperatures on mangroves, increasing their biodiversity and productivity. However, sedimentation, salination, and drowning are a serious problem for these ecosystems.

Table 2.1 Summary of the impact of warming on ocean health.

Sea level rise, due to a combination of thermal expansion of water as the oceans warm and conversion of ice on land to water which flows to the sea as the poles warm, impacts particularly on coastal zones, especially where natural habitats are prevented from migration landward by built infrastructure. Further, high tide and storm surge inundation will become more frequent and more severe with sea level rise, all else being equal, simply because the base level of the sea relative to the land will gradually change. For

13.NOAA. How do hurricanes affect sea life? National Ocean Service website, https://oceanservice.noaa.gov/facts/hurricanes-sea-life.html

14.Johnson, Johanna E., et al. "The Pacific Island Region: Fisheries, Aquaculture and Climate Change." Climate Change Impacts on Fisheries and Aquaculture, 2017, pp. 333–379., doi:10.1002/9781119154051.ch11 low-lying atolls across the Pacific, even a small rise in sea level will have huge consequences in terms of lost land area and other impacts such as saltwater intrusion.

2.1.2 Direct Anthropogenic Threats

While the increase in CO_2 emissions and subsequent impacts to atmospheric and oceanic temperature is well understood to have been influenced by human activity, this sub-section will focus on the direct anthropogenic threats to the ocean.

Acute

The majority of pollution in the ocean comes from activity on land[15]. Nonpoint pollution originates from various human sources, like cars, agriculture, timber operations, and often flow over and under the ground with rainwater, as do pesticides, fertilizers, and carbon-, nitrogen-, and phosphorous-rich particulates, eventually reaching the ocean. From the ridge to the reef, pollution from the land—runoff, sedimentation, and nutrients—eventually flows to the sea. Elevated underwater cloudiness or turbidity and sedimentation are perhaps the two principal drivers of coral reef degradation worldwide.

Turbidity reduces light, which corals need (corals have microscopic algae in their tissue and, like plants, need light to make their own food). Sediments directly deposit and accumulate over the coral surfaces causing partial or total death. Like chronic diseases, excess sediments and turbidity reduce the fitness of individual corals, interfering with vital functions and potentially making corals more susceptible to disease. Land pollution can also cause nutrient loading, in which plant fertilizers or sewage and inadequate wastewater management introduce excessive nitrogen and phosphorus. Excess nutrients promote algal growth, which can smother corals and reduce the amount of dissolved oxygen which, in turn, is often associated with an increased amount of bacteria.

Run-off rich in nitrogen and phosphorous can be especially hazardous to marine health by causing algal blooms. Algal blooms are episodes where algae overrun the ecosystem and hinder the ability for other plants to grow. Once these organisms start to sink and decompose, oxygen is depleted and dead zones are created as marine life cannot survive in the environment. Fish and other forms of life that can swim away leave; other species that cannot move die off.

Similarly, oil spills and other human activity can seriously threaten ocean health. It is well understood that oil spills negatively affect marine mammals and birds and eventually can affect fish and other organisms. Dynamite fishing, while illegal in many places, often destroys marine habitats, especially coral reefs. By blasting the area with explosives, the calcium carbonate skeletons are often irrevocably damaged[16]. Dynamite fishing is considered to be one of the main reasons for coral reef loss in some regions, and continuous blast fishing in regions have led to the complete inability of some coral to regrow[17].

15. NOAA Marine Debris Program. https://marinedebris.noaa.gov/resources
16. Slade, Lorna M, and Bakara Kalanghe. “Dynamite Fishing in Tanzania.” Marine Pollution Bulletin, Pergamon, 21 Oct. 2015, www.sciencedirect.com/science/article/pii/S0025326X15005299
17. Raymundo LJ, Maypa AP, Gomez ED, Cadiz P. 2007. Can dynamite-blasted reefs recover? A novel, low-tech approach to stimulating natural recovery in fish and coral population. Mar Pollut Bull. 54(7):1009-1019

Chronic

Damaging tourism practices

Coastal tourism in the vicinity of coral reefs and mangroves is not always benign: negative impacts can include degradation and loss of marine life through activities such as diving and snorkelling[18] as well as indirect impacts arising from poorly planned coastal development, including dredging, building on intertidal spaces, mangrove deforestation, and increases in pollution and solid waste[19]. Despite these risks, tourism may be a less significant threat than fishing, land-based run-off, or coral bleaching[20] and may even help to reduce some threats, notably over-fishing, by offering financial or social incentives for sustainable management[21]. In addition, many visitors to coral reefs have already heightened environmental awareness and reef visitation can both help to fund and to encourage conservation activities[22].

Overfishing

Chronic stressors such as overfishing impact overall ocean health and productivity. For example, overfishing can stress coastal ecosystems by altering natural dynamics, which then in turn affects those ecosystems—as productive natural infrastructure—in the longer-term. For example, overfishing reduces the resilience of coral reefs by increasing coral–algal competition and reducing coral growth and survivorship. These stressors, according to Zaneveld, "Increase turf and macroalgal cover which in turn destabilize microbiomes, elevate pathogen loads, and increase disease more than twofold and mortality up to eightfold. Above-average temperatures exacerbate these effects, further disrupting microbiomes of unhealthy corals and concentrating 80% of mortality in the warmest seasons."[23] This reduced ability of the reef ecosystem to cope with shocks and stressors then ultimately threatens its ecosystem services, including functioning as a vital nursery for future fish stocks.

Overfishing is one symptom of poor / underdeveloped fisheries management and significantly impacts the food security of Pacific Island states[24]. While overfishing is difficult to insure due to moral hazard as discussed above, there is a possibility to design insurance structures where fisherfolk can be beneficiaries of a product that is designed to compensate fishers for staying out of certain areas after a hazard event—so that they have a replacement income while the affected area is given more time and reduced stress to recover. This concept will be further developed in the Insurance Concept Design Report.

Coastal infrastructure and agriculture

Coastal infrastructure, agriculture, and pollution all have harmful effects on marine ecosystems. Rubbish and pollution has been shown to reduce mangrove diversity and productivity, especially in its carbon

18. J.B. Lamb, J.D. True, S. Piromvaragorn, B.L. Willis, Scuba diving damage and intensity of tourist activities increases coral disease prevalence, Biol. Conserv. 178 (2014) 88–96
19. J. Davenport, J.L. Davenport, The impact of tourism and personal leisure transport on coastal environments: a review, Estuar., Coast. Shelf Sci. 67 (1–2) (2006) 280–292
20. V.J. Harriott, Marine tourism impacts on the Great barrier reef, Tour. Mar. Environ. 1 (1) (2004) 29–40
21. A. Cruz-Trinidad, R.C. Geronimo, P.M. Aliño, Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines, Ocean Coast. Manag. 52 (3–4) (2009) 173–180
22. C. Cater, E. Cater, The economic impacts of marine wildlife tourism, in: J. Higham, M. Lück (Eds.), Marine Wildlife and Tourism Management: Insights from the Natural and Social Sciences, CAB International, Wallingford, 2007, pp. 145–162
23. Zaneveld, J.R. et al. Overfishing and nutrient pollution interact with temperature to disrupt coral reefs down to microbial scales. Nat. Commun. 7:11833 doi: 10.1038/ncomms11833 (2016)
24. FAO. 2018. Fisheries of the Pacific Islands. Fisheries and Aquaculture Technical Paper 625

sequestration capabilities[25]. It is well documented that costal infrastructure changes marine ecosystems—in both negative and productive ways. Grey infrastructure can encourage species that might not normally flourish to take over a habitat but, in contrast, may also reduce the diversity of species and encourage the introduction of non-native and invasive species. Sea-wall construction contributes to more sedimentation, costal erosion, and can change the near-shore processes of adjacent ecosystems. Agricultural run-off severely hampers ocean health, producing "dead zones" in the sea as well as algal blooms, as discussed above.

2.1.3 Summary of Ocean Threats

Tables 2.2 and 2.3 summarise, respectively, the hazards and risks related to global climate change and other hazards and risks not directly related to climate change.

Climate change hazard	**Examples of human exposure**	**Examples of increased risks**
Impacts on ecologically and / or commercially important species and ecosystems	Via changes in ecosystem composition and functionality and from changes in distribution and abundance of species	■ Risk to dependent fishing industries ■ Risk to operating costs ■ Risk to income ■ Risk to political and management frameworks ■ Risk to secondary industries ■ Risk to tourism viability and income ■ Risk to human health ■ Risk to dependent marine species ■ Risk of coastal flooding ■ Risk of coastal erosion
Vibrio bacteria	Via range expansion of vibrios	■ Risk to life ■ Risk to human health ■ Risk to tourism viability and income
Regional marine heat waves	Via gross changes to ecosystems—e.g. increased frequency of coral bleaching leading to mass coral reef	■ Risk to tourism viability and income ■ Risk to coastal defences ■ Risk to ecosystem functioning and existence

	die-off, and mass kelp forest die-off	■ Risk to resource-dependent industries, e.g. fisheries ■ Risk to regional reputation and worth

25.“Costal Crisis: Mangroves at Risk,” UN Environment, https://www.unenvironment.org/news-and-stories/story/coastal-crisis-mangroves-risk

Storms and cyclones	Via exposure to more extreme precipitation, winds, and storm surges	■ Risk to life ■ Risk to built infrastructure and habitations ■ Risk to human health ■ Risk to coastal defences ■ Risk to earnings ■ Risk to tourism viability and income ■ Risk of coastal flooding ■ Risk to viability of coastal defences ■ Risk to operating costs
Sea-level rise (SLR)	Via ice melt and thermal expansion	■ Risk to life ■ Risk to built infrastructure and habitations ■ Risk of coastal flooding ■ Risk to viability of coastal defences ■ Risk to operating costs ■ Risk to human health
Harmful algal blooms (HABs)	Via new or increased frequency and extent of blooms	■ Risk to human health ■ Risk to shellfish fisheries ■ Risk to operating costs ■ Risk to aquaculture production ■ Risk to secondary industries
Non-native marine species	Via species extending their ranges into new regions or being introduced by vectors and having a better chance at establishment	■ Risk to fishing and aquaculture industries ■ Risk to operating costs ■ Risk to tourism
El Niño events	Via increased frequency of severe	■ Risk to life

	events	■ Risk to fisheries ■ Risk to agriculture ■ Risk to marine ecosystem health ■ Risk to human health
Ocean deoxygenation	Via warming of waters and increased stratification in the water column	■ Risk to fisheries ■ Risk to dependent recreational industries ■ Risk to regional productivity ■ Risk to marine ecosystem health

Methane hydrates	Via warming melting the gas hydrate and releasing more methane into the water and air	■ Risk of exacerbating regional deoxygenation ■ Risk of increasing powerful greenhouse gas emissions ■ Risk of destabilising seabed areas leading to underwater landslides

Table 2.2 Summary of ocean hazards and increased risks due to global climate change.

Non climate change hazard	Example of increased risks
Overfishing	■ Risk of resource depletion ■ Risk of reduced biological growth rates and low biomass levels ■ Risk of critical depletion and unsustainable fisheries ■ Risk to food security
Agricultural Runoff & Spills	■ Risk to biological productivity ■ Risk to marine ecosystems ■ Risk to tourism ■ Risk to aquaculture production ■ Risk to human health
Damaging Tourism Practices	■ Risk to sustained tourism ■ Risk to marine ecosystems and biological productivity
Coastal Infrastructure	■ Risk of non-native species ■ Risk to operating costs

Table 2.3 Summary of ocean hazards and increased risks due reasons other than global climate change.

2.2 Contingent Impacts of Threats to Pacific Ocean Health

This section presents results from desk-based research into the potential impacts of the threats to ocean health described in Section 1, focusing particularly on contingent impairment of ecosystem services to fisheries and tourism productivity, as well as coastal infrastructure. We highlight those threats where we see that risk financing might be usefully deployed to help manage risk, drawing on tools that are either in use in other contexts, or which can be developed in the near-term using known data and structuring techniques.

2.2.1 Contingent Impairment

Section 1 discussed the direct impacts of the many current threats to ocean health. The contingent impacts of ocean health deterioration are largely around the blue economy, that is, the economic value derived from marine and coastal ecosystems and ocean transport.

Fisheries

While overfishing is a threat to ocean health, the fisheries sector in the Pacific region is exposed to significant additional risk in the face of degrading ocean health and climate change. The sector is vital to the region's economies, and fishing provides sustenance to a large portion of the population[26]. Great resilience of the fisheries sector in the face of threats to ocean health will allow greater sustainability of the services provided, including domestic food security, employment and income for many island communities, and government income through licensing of fishing rights.

Especially important to the region is tuna fishing, which takes place predominantly in the open ocean within the aggregated Exclusive Economic Zone (EEZ) of the Pacific islands. Climate change is expected to alter the timing, location, and extent of the upwelling processes on which most oceanic primary productivity depends, like the production of phytoplankton. Production of organisms at higher trophic levels in the food web is constrained by variations in phytoplankton production, and directly by environmental factors such as temperature and ocean acidification. Redistribution of tuna stocks, in both the short and long term, will disrupt established fishing rights and the economic value derived from those rights.

In nearshore areas, a diverse range of coastal fisheries resources depend on coral reefs, mangroves, seagrasses and intertidal flats, with many of these fish species being important to the food security and livelihoods of coastal communities in the Pacific islands. As previously discussed, coral reefs are threatened by a wide range of local stressors, such as declining water quality, pollution and physical destruction (as well as global stressors, such as warming and ocean acidification). Ultimately, these changes threaten to destabilise reef-related livelihoods for thousands of people throughout the Pacific region. Climate change is expected to compound existing anthropogenic pressures on the range of coastal fish habitats from development, resource extraction and pollution. The greatest impacts from climate change are likely to occur as the result of increased temperature stress, increased sedimentation and turbidity from higher rates of runoff, ocean acidification, rising sea levels, and physical damage from the combination of rising sea levels and more severe cyclones[27].

Tourism

Coral bleaching and other damage and degradation of coral reefs can dampen tourism and reduce related revenues significantly. The marine heatwave of 2016/17 led to the biggest coral bleaching event in history, where approximately 93% of the reefs on the Great Barrier Reef were bleached. Studies by the Centre of Tourism and Regional Opportunities at Central Queensland University showed that tourism to the reef and surrounding towns fell dramatically[28]. Tourism is the largest source of GDP in many of the Pacific Island states (e.g. Fiji), and is a major pillar of economic growth for some in the region, including Samoa. Some reports state that Fiji's tourism industry took a major hit following Cyclone Winston in 2016[29], although some studies suggest that tourism numbers largely remained steady after

26.Johnson, Johanna E., et al. "The Pacific Island Region: Fisheries, Aquaculture and Climate Change." Climate Change Impacts on Fisheries and Aquaculture, 2017, pp. 333–379., doi:10.1002/9781119154051.ch11
27.Johnson, Johanna E., et al. "The Pacific Island Region: Fisheries, Aquaculture and Climate Change." Climate Change Impacts on Fisheries and Aquaculture, 2017, pp. 333–379., doi:10.1002/9781119154051.ch11
28.Prideaux, Bruce, Carmody, Julie, Pabel, Anja, "Rescuing the Reef's Reputation", Central Queensland University Australia, https://www.cqu.edu.au/research/research-excellence/impact/case-studies/preserving-reef-reputation-as-coral-bleach-coverage-hits
29."Fiji's Tourism Industry Takes Big Hit Following Hurricane Winston", Radio New Zealand, https://www.rnz.co.nz/international/programmes/datelinepacific/audio/201790617/fiji's-tourism-industry-takes-big-hit-following-cyclone-winston

the cyclone[30]. The discrepancy shows that further research and analysis needs to be completed on the effects of cyclones on tourism in the industry.

Coastal Infrastructure

The rise in sea level and increased temperature of the sea surface is likely to cause more intense and sustained flooding. Every year coastal flooding causes a significant amount of economic damage and insured losses globally. The protective effects of various coastal habitats help to reduce the damages from coastal erosion, inundation and storm surges via general wave attenuation, storm surge attenuation and maintaining shoreline elevation. However, as these protective coastal ecosystems are degraded or lost due to various factors described above, the potential for financial losses from flooding due to extreme weather events in affected coastal areas is increased[31]. Thus, there is an expectation that the deterioration of ocean health will cause more damage to coastal infrastructure.

2.3 Insurable Risks

This section explores the applicability of insurance as a financial mechanism to help manage ocean risk. We present preliminary feasibility considerations, which will be built on in the Insurance Concept Design Report.

2.3.1 Introduction to Risk Financing

Risk financing tools and mechanisms can help to mitigate the negative economic and social impacts of shock events. Risk financing may be arranged in advance (*ex ante*) or on the occurrence of an event and identification of the need (*ex post*); the former is generally considered both more efficient and more effective than the latter. *Ex ante* risk financing builds resilience—of a business or an organisation or a government—all of which operate best when budgets and capital flows are not disrupted by external shocks generally deemed outside the control of the enterprise.

The most common form of *ex ante* risk financing via risk transfer is insurance. Insurance placed through traditional (re)insurance and capital markets can provide a critical source of capital in the event of a shock event or loss. It is paid for up front and can be used to support emergency response, to smooth financial shocks, and to finance early recovery (particularly through parametric insurance instruments) and long-term recovery and reconstruction (using indemnity insurance instruments).

2.3.2 Analysis of Existing Environmental Risk Insurance Products

While insurance has broad applications to mitigate the risks posed by the impacts of natural hazards, its traditional use has been to cover the losses from physical damage and finance repair / rebuilding of property / assets / grey infrastructure, with extension to directly related business interruption. Recently, however, insurance products have been developed and implemented to finance emergency response costs, agricultural losses due to drought and other extreme weather, and even protection of livelihood (e.g. for low income populations with no or little in the way of fixed assets). In terms of insurance products

30.The Economist Intelligence Unit, "Tourist Numbers Hold Up Despite Hurricane Winston". http://country.eiu.com/article.aspx?articleid=834233267&Country=Fiji&topic=Economy&subtopic=Forecast&subsubtopic=Extern al+sector
31.M.W.Beck, Losada, I.J., Menéndez Fernández, Pelayo, Reguero, B.G., Diaz-Simal, Pedro, Fernández, Felipe. (2018). The global flood protection savings provided by coral reefs. Nature Communications. 9. 10.1038/s41467-

that cover risk to the environment itself (rather than physical assets or government / business financial flows), however, there is only one: an insurance policy protecting the reef and beach in Quintana Roo, Mexico from hurricanes.

Because there is only one example of an existing environmental risk insurance product, it is useful to look to related, if not strictly ‘environmental,’ insurance products to inform the design of novel products to address risks to Pacific ocean health. The following section provides a critical analysis of the initial pilot environmental risk insurance product in Quintana Roo, as well as examples from agriculture, forestry and aquaculture.

Existing Environmental Risk Insurance

Table 2.4 provides key details of the one existing insurance product, which covers natural capital—specifically, reefs and beaches—in the state of Quintana Roo, Mexico[32]. This insurance provides coverage to ecosystems themselves, paying out to fund response activities following hurricanes.

<table>
<tr><td>Policy Name</td><td>Quintana Roo Reef and Beach Cover</td></tr>
<tr><td>Policy Form</td><td>Parametric insurance</td></tr>
<tr><td>Buyer / Policy
Holder / Insured</td><td>The State of Quintana Roo, Mexico</td></tr>
<tr><td>Source of Premium</td><td>Blended—portion tourism tax and portion philanthropic donations</td></tr>
<tr><td>Seller / Insurer</td><td>Afirme Seguros Grupo Financiero SA de CV</td></tr>
<tr><td>Structure</td><td>Windspeed index, within a defined area, with the below triggers:
<table>
<tr><th>Windspeed (Knots)</th><th>Pay-out Percentage</th></tr>
<tr><td>>110</td><td>40%</td></tr>
<tr><td>> 130</td><td>80%</td></tr>
<tr><td>>160</td><td>100%</td></tr>
</table>
Pay-outs are split 50% for reef restoration and 50% for beach restoration</td></tr>
</table>

Table 2.4 Quintana Roo reef and beach insurance policy details.

This policy incepted on 1 June 2019 and is therefore new but not untested, given the relatively standard design of the parametric triggers. The value of insurance is seen in the long term rather than immediately, since it is specifically designed to prove itself in the face of relatively remote risk. Therefore, and especially because it is the first of its kind to tackle risk to the environment / ecosystems themselves, this insurance has yet to demonstrate its full effectiveness and value. What can be seen already, however, is a commitment from both the government of Quintana Roo and the tourism industry to incorporate natural capital into risk management frameworks, as the insurance premium is partially funded through a levy on hotels that depend on the reef and beach as critical recreational, protective, and productive assets. Additionally, the part of the Mesoamerican reef that is protected through this

32.https://www.nature.org/en-us/explore/newsroom/quintana-roo-worlds-first-coral-reef-insurance/

insurance coverage is better prepared to recover quickly from hurricanes, since the promise of insurance pay-outs offers local communities predictable funds around which to build contingency plans, enabling a rapid response when an extreme event does happen.

Of additional note is the amount of research and development that went into the successful placement of this first insurance policy for natural capital. The concept was initially discussed nearly 10 years ago[33], and extensive research and technical work providing the underpinnings of this product has been ongoing for more than two years. Further, the demand for products like these is not immediately obvious to most stakeholders; the ultimate purchase of the reef and beach insurance was the result of extensive engagement with the government of Quintana Roo and the tourism industry. This process of engagement to build the awareness of economic value of natural capital, an understanding of the beneficiaries of healthy ecosystems and the case for insurance as a valuable risk management tool for natural systems is not to be underestimated in its importance and effort required. The long-term sustainability of insurance premiums is also a key challenge for new and relatively unproven insurance products, especially in the public sector, since loss avoidance (particularly when an insurance policy likely will not pay out in any one politician's term) is much less politically attractive than other, more 'positive,' investments.

Existing Agriculture / Forestry / Aquaculture Insurance

Due to the scarcity of examples of existing environmental risk insurance products, we also provide examples of insurance that covers risks relevant to agriculture, forestry, and aquaculture. These types of insurance are largely 'index-based' (further detailed in section 4.2.3) and offer some clues as to how natural assets, and risks to ocean health in general, might be covered. Therefore, we present the following case studies to demonstrate how insurance can mitigate risks to 'living assets' beyond the traditional insurable interests, e.g. property.

Agricultural Insurance

Table 2.5 outlines the details of the weather index insurance product of the R4 Rural Resilience Initiative (R4)[34] in Ethiopia. R4 is a safety net programme, which offers drought insurance to small-scale farmers to increase their resilience to climate risk.

Product Name	R4 Rural Resilience Initiative (R4)—Ethiopia
Policy Form	Parametric insurance
Buyer / Policy Holder / Insured	Farmers in Ethiopia
Source of Premium	Individual farmers, some subsidised through other programmes; cash constrained households can pay premiums by engaging in asset creation activities (with cash premium funded by the World Food Programme)
Seller / Insurer	Africa Insurance Company

33. The concept of parametric hurricane insurance as a financing source to support rapid clean-up on the Mesoamerican reef was first developed by MAR Fund and Caribbean Risk Managers in 2010/11
34. https://www1.wfp.org/r4-rural-resilience-initiative

Structure	Rainfall index designed to cover two main drought perils: (i) severely late onset of rainfall or significant dry spells after sowing or in the middle of the season; and (ii) severely early cessation of rainfall or significant dry spells late in the season. As pay-outs are based on the same contract and rainfall measurement for a unit area, the need for an in-field assessment is eliminated and all insured farmers within this defined area receive the same pay-out levels.

Table 2.5 Agricultural insurance example—the R4 Rural Resilience Initiative.

R4 is a great example of a weather index insurance product, and it is also interesting because the scheme, supported by the World Food Programme, allows insured farmers to pay premiums through asset creation activities rather than just cash. This principle could also be applied to insurance for ocean risks, as governments or communities could receive insurance protecting natural capital in exchange for conservation activities / regular maintenance of ecosystems. This would be a way to incentivise communities to mitigate the risks they can control (e.g. overfishing / pollution) by providing them access to coverage for those risks that they cannot (e.g. cyclones).

Forestry Insurance

Table 2.6 provides key details of a parametric insurance product covering wildfire. This product uses remote sensing to quantify burned area, paying out based on a burnt-acre index.

Policy Name	Forest Fire Burnt Acre Index Insurance
Policy Form	Parametric insurance
Buyer / Policy Holder / Insured	Regional governments, communities, forestry organisations, wineries, tourism industry, and / or businesses
Source of Premium	Could be public, private, or blended
Structure	Burnt acre index—amount of burned area calculated by remote sensing (e.g. NASA satellite open source data set), with a set pay-out per burnt acre

Table 2.6 Forestry insurance example- burnt acre index.

While existing forestry insurance products protect the value of timber rather than the forest or health of the environment itself, similar principles can be used to protect the value of similar marine assets, such as reefs and / or mangroves. For example, similar to a burnt acre index, a coral bleaching index could be designed.

Aquaculture Insurance

Table 2.7 provides details on a form of insurance available for aquaculture / biomass. While it is also possible to cover the risk to offshore equipment and / or of stock (fish) mortality while in transit (e.g. between farm sites or from hatcheries) as an extension to the below biomass insurance, that is typically only offered as an extension of a biomass policy.

Policy Name	Biomass insurance
Policy Form	Indemnity insurance
Buyer / Policy Holder / Insured	Aquaculture organisations
Source of Premium	Private
Structure	'All Risks' policies are available, which protect against all risk of stock mortality unless specifically excluded within policy wording. 'Named Perils' policies are available, which protect against only those perils agreed in policy wording. Typical named perils include:

Offshore	Onshore
■ Pollution ■ Plankton bloom / red tide ■ Jellyfish attack / bloom ■ Theft and malicious acts ■ Predation- physical damage caused by predators or other aquatic organisms (not sealice or other ectoparasites) ■ Storm ■ Lightning ■ Tidal wave ■ Collision ■ Sudden and unforeseen structural failure of equipment ■ Freezing, Supercooling, ice	■ Theft and malicious acts ■ Predation- physical damage caused by predators or other aquatic organisms (not sealice or other ectoparasites) ■ Flood ■ Storm ■ Lightning ■ Tidal wave ■ Subsidence, landslip, structural failure, breakage, or blockage of any part of the water supply system ■ Drought ■ Fire

	damage ■ Deoxygenation due to competing biological activity or to changes in the physical or chemical condition of the water, including upwelling and high water temperature ■ Any other change in concentration of the normal chemical constituents of the water, including change in pH or salinity ■ Disease	■ Explosion ■ Earthquake ■ Sudden and unforeseen structural failure of equipment ■ Freezing, frost damage, frazil ice ■ Mechanical breakdown or accidental damage to machinery and other installations ■ Electrical breakdown, failure or interruption of the electricity supply, electrocution ■ Deoxygenation due to vegetation, microbiological activity, or high water temperature ■ Any other change in concentration of the normal chemical constituents of the water, including change in pH or salinity ■ Disease

Table 2.7 Aquaculture insurance—biomass insurance options.

While aquaculture insurance protects the value of stock, rather than the health of the environment itself, it does offer an indication of the types of risk that can be transferred in traditional insurance markets. For example, plankton blooms / red tide and jellyfish attacks / blooms can be insured.

Additional Considerations

Additionally, one burgeoning initiative in the Pacific, although it is not strictly 'environmental,' is worth discussing—the Pacific Islands Climate Change Insurance Facility (PICCIF). PICCIF has been proposed as a regional facility to explore potential risk transfer instruments that address slow onset climate change impacts. It remains in the concept design phase and doesn't yet address risks to ocean health or ecosystems; however, the POFPI project team is engaged in ongoing discussions to investigate and further define the role PICCIF could have—especially as the technical gearbox to fully explore where risk transfer might be an efficient and effective financial instrument to address these climate change impacts to Pacific countries. PICCIF is a natural regional focal point for discussion around the technical development of environmental risk insurance products in the Pacific, especially where climate change impacts such as ocean warming are a concern. We will further outline how the concepts developed under POFPI can complement and leverage regional initiatives such as PICCIF and the Pacific Catastrophe Risk Insurance Company (PCRIC)—the Pacific sovereign risk pool—in the Insurance Concept Design Report.

It is also worth noting that there are existing environmental liability insurance products, which cover policy holders against the cost of restoring damage caused by environmental accidents for which they are legally liable. These policies financially protect the party who does damage, rather than proving additional protection to ocean health itself, as once they kick in, it is already given that the policy holder is bound to cover the cost of restoration / clean-up. These policies do ensure that companies are able to cover the costs of accidents, though. The key for governments and those otherwise mandated with clean-up and restoration following damaging accidents is to successfully prosecute environmental liability cases. Therefore, support and additional capacity to pursue these cases would be beneficial to ocean health in the Pacific.

Product Design Considerations: Types of Insurance

Following from the above examples of existing insurance products, there are two types of insurance for consideration in the design of novel insurance concepts to cover risks to Pacific ocean health. The above Quintana Roo Reef and Beach Cover, as well as the agriculture and forestry insurance examples are all parametric products, whereas the biomass insurance for aquaculture is an indemnity product.

In traditional indemnity insurance, the size of the insurance pay-out is dictated by the size of the actual loss, so that, for example, a damaged building is repaired back to its prior state. In parametric (also called index-based) insurance, the amount of the pay-out is dictated by an objective measure of the causal event (e.g. the speed of the wind in a cyclone). Table 2.8 lays out the further variations in between.

There are four basic differences to consider between these types of insurance with regards to their suitability, driven by the following key considerations: the purpose of the financial instrument; the temporal requirement for a pay-out; the availability of suitable data to underpin product design; and the legal and regulatory environment.

>

Loss

Adjustment&More

Hazard

Data Requirements

Risk Basis & Speed out-Pay

-- Simplicity

>

Modelled Loss Basis

Pays out based on estimated loss from a catastrophe model Basis risk should be low, but still real

Requires time and expense to build the catastrophe model

Catastrophe models are good for homogeneous exposures (i.e. domestic property), but less suitable for complex risks

Parametric Index

A simplified version of a modelled loss

Formulae estimate hazard at certain reference points (e.g. wind speed, ground shaking, rainfall)

Additional formula estimates the loss resulting from this hazard

Lower basis risk than pure Parametric, but higher than Modelled Loss

Parametric

An event occurs, payment is made

Simple and relatively predictable

Event definition made by a verifiable independent agency

Higher basis risk: smaller events may trigger a relatively large pay-out, a large event may conversely trigger a relatively low pay-out

Table 2.8 Insurance typology.

Purpose: recovery of losses vs. smoothing of financial volatility

Indemnity insurance is designed to 'make the policy holder whole' following physical damage, whereas parametric insurance is designed to provide liquidity when it is needed. This makes indemnity insurance particularly well suited as the instrument to finance the replacement, recovery, or restoration of physical assets such as property and infrastructure. Parametric insurance, on the other hand, is designed to smooth financial shocks due to shock events, such as extreme weather or natural catastrophe events. Therefore, parametric insurance is particularly useful to finance the risks to financial flows from external conditions, which do not necessarily cause physical damage. Put differently, parametric insurance is an option to finance costs rather than losses, or revenue shocks rather than damage. So, for example, parametric insurance can be used to finance the costs of emergency response activities or smooth shocks to revenue caused by bad weather.

Requirement: speed of pay-outs

The speed of insurance claims pay-outs will be much quicker with parametric than indemnity insurance, since parametric insurance pay-outs are triggered by the occurrence of an event, which is easily recognised and / or measured and then verified. Further, parametric insurance contracts stipulate the reporting and calculation agents for the transaction, who are responsible for reporting event parameters and performing pay-out calculations, respectively. With indemnity insurance, on the other hand, actual losses must be assessed, calculated, and verified, and loss adjustment has a high cost and can result in significant payment delays. Therefore, where pay-out speed is paramount, parametric insurance can be a particularly useful instrument.

Data availability and suitability

There are two main issues to think about when it comes to data availability and suitability at the product design stage:

Pricing

Because of their different structures, parametric and indemnity insurance have different data demands at the product design stage. While the insurance pricing / underwriting methodology is much simpler and more transparent (since pay-outs are made based on transparent, relatively predictable, and based upon homogenous hazard data) for parametric than indemnity insurance, it is crucial that a good relationship is established between the parametric index and financial impacts. Therefore, the critical data in parametric product design relates to the setting of pay-out thresholds, or 'triggers'. The parametric triggers are designed through linking the severity of independent events (e.g. windspeed) with financial impacts (e.g. emergency response costs), thus establishing the index as a proxy for financial requirements.

Indemnity product design does not require the establishment of such an index, since claims are settled on the basis of actual damage and loss. However, since indemnity insurance is designed to pay back the exact amount required to recover damages, the underwriting (i.e. pricing) methodology is more complex and prone to high uncertainty. Where there are developed insurance markets with historical loss / claims data, this data can be used to price coverage. However, where local insurance markets are less well developed, there is often not enough data on the expected losses of potential coverage for risk-takers to underwrite new policies. Therefore, parametric mechanisms offer a solution to extending insurance capacity to new markets, since the underwriting methodology of parametric insurance relies on hazard information, which is often public and easily accessible.

Claims settlement

The data required for the claims settlement process must be considered at the insurance product design stage. With indemnity insurance instruments, information on actual losses and replacement costs is collected during 'loss adjustment,' which is a potentially expensive and lengthy process. 'Simplified' indemnity products are being explored, however, in which fixed pay-outs are made on the basis of partial or complete damage; so, for example, houses are insured for a pre-agreed total amount and claims of either 100% or 50% of that amount are settled following receipt of a photograph of either complete or partial damage, respectively.

Claims from parametric insurance coverages are paid on the occurrence of pre-agreed triggering events, or thresholds of a measure of the event. Therefore, movements in the underlying index are monitored and reported by a designated 'Reporting Agency', which is specified in the contract wording, and is an independent, transparent, and often publicly available data source. Where the parametric index is more complicated, or the pay-out function is on a modelled loss basis, there is also a 'Calculation Agent' named in the contract, which performs the pay-out calculations based on the processing of data from the Reporting Agency/ies.

Crucial trade-off: basis risk

It is crucial to note that the lack of loss adjustment, and, therefore, the speed of pay-outs of parametric insurance presents a trade-off: basis risk. Basis risk is the risk that event-triggered pay-outs may not relate accurately to actual loss. Basis risk is of particular concern when parametric insurance is used as a loss recovery instrument rather than a financial smoothing instrument, but it can also occur if the index is either too coarse or a poor proxy for financial impact. Product structure and design (i.e. identifying a suitable independent index, which is a good proxy for loss) can minimise this risk.

Basis risk reveals a necessary step in the development of parametric insurance; because it is still a relatively new instrument, and it is suited for a slightly different purpose than traditional insurance, communication and end-user engagement is key. The details of what this type of coverage is and what it is most and least suited for must be effectively communicated to any policy holder; i.e. parametric insurance is a coverage against independent events, rather than damage to physical assets (although the pay-out can certainly go towards the repair / recovery of physical assets). This engagement is also a key benefit of parametric insurance, however, as it illustrates the bespoke and individualised nature of the product.

Legal and regulatory environment

One way parametric insurance may be particularly well suited as a risk financing mechanism for ecosystems / natural capital / blue-green infrastructure is that you do not need to actually own an asset to insure it in this way. All insurance requires the policy holder to have an 'insurable interest.' Insurable interest in indemnity insurance is associated with the cost to repair damage to physical assets / the financial value of losses, and, in order to establish losses to the policy holder, those physical assets must be owned by that policy holder. Alternatively, with parametric insurance, insurable interest is simply the relationship between the independent event and any financial impacts; the ownership of physical assets is not a consideration here, and anyone with a financial dependence on the health of a marine ecosystem (where there is a good independent index, which captures that dependence) can protect that financial flow using parametric insurance.

It is worth noting, however, that since parametric insurance is a relatively new instrument, not all legal and regulatory frameworks are yet established to allow it. Therefore, it is important to identify regulatory barriers at the product design phase, so they can be addressed.

2.3.3 Potential Role of Risk Financing as a Tool for Ocean Health

Considering the risks to Pacific ocean health identified above, and combined with basic insurance product design requirements and considerations (of both indemnity and parametric insurance instruments), we have narrowed down the potential role of risk financing as a tool for ocean health.

Why insurance for ocean health?

Marine ecosystems such as reefs and mangroves provide critical ecosystem services and benefits to biodiversity, industries such as tourism and fishing, and risk reduction to coastal communities. These assets support important fish species, providing food and livelihoods, they generate tourism revenue and are key recreational resources, and they provide coastal protection from storm impacts by absorbing wave energy and reducing storm surge. However, damage to ecosystems such as reefs and mangroves reduces their ability to protect the coast and provide ecosystem services vital to the sustainable growth of the blue economy.

Risk financing can provide coverage and liquidity to respond to threats to ocean health and blue infrastructure, also de-risking investments in coastal ecosystems and their conservation. Furthermore, insurance can incentivise risk-smart behaviour and stewardship of the environment.

It is important to note that insurance is not a stand-alone financing mechanism; it is a risk financing instrument that responds to negative events and impacts on assets and financial flows. Therefore, insurance plays a role in connection with other finance mechanisms and ongoing initiatives and projects.

The development and implementation of risk financing for the marine environment and ocean health objectives could deliver significant benefits, including:

- Protecting investments in the maintenance, protection, and / or conservation of marine ecosystems;
- Providing immediate liquidity for early post-event responses to threats to the marine environment from hazards such as tropical cyclones, extreme rainfall, and / or extreme ocean temperatures; and
- Incentivising stewardship of the marine environment while increasing the financial resilience of communities reliant on the blue economy.

2.3.4 Transferrable Risks

This section discusses risks to Pacific ocean health that could be transferred to insurance markets. It is worth noting that even if a market transaction is not the most cost-effective solution, the following risks have been identified as potentials for structured risk financing, where risk analytics and trigger-based finance mechanisms could be highly beneficial and provide value beyond a risk transfer transaction itself.

Hazard

Firstly, it is important to consider the hazards which impact Pacific ocean health. The prime driver behind that selection will be to consider those hazards which cause maximum threat to life, livelihoods, marine health, and prosperity, but frequency of event is also important. Risk financing is generally used to protect against financial shocks which cannot be easily absorbed through everyday means. It is therefore important to identify those risks to Pacific ocean health that currently shock government, conservation, and even business, budgets and financial flows.

Another factor to consider when identifying those hazards that may benefit from financing through an insurance mechanism is the extent to which the hazard can be understood, measured, and modelled. A truism in insurance is that the greater the uncertainty, the higher the cost. Additionally, insurance mechanisms must be structured so as not to introduce perverse incentives, known as 'moral hazard.' If damages or threshold triggers can be caused by human actions, these threats cannot be covered through insurance. For example, an insurance instrument that would pay out based on the incidence of wastewater impacts on marine health may actually incentivise poor waste-water management (and it certainly wouldn't incentivise risk reduction). Therefore, in general, threats due directly to human activity cannot be financed through insurance.

As identified in Sections 1 and 2, warming oceans, cyclones, and other extreme weather are some of the most important hazards to Pacific ocean health, all of which are good candidates for risk transfer, although it is worth noting that cyclones are not of concern to all of the POFP11 (because cyclones cannot exist in the open Pacific Ocean within about 5° of the equator). The feasibility of developing innovative coverage for these hazards and their impacts on Pacific ocean health will be dependent upon consistent and verifiable historical and current data sources.

There are reliable data and / or models available for tropical cyclone and excess rainfall across the POFP11. The most reliable historical and modelled data currently available is for tropical cyclone. The WMO-mandated cyclone reporting agencies for the Pacific (including the Japanese, Fijian, and Australian meteorological services) provide highly reliable, publicly available historical and real-time data. That data is in the form of 6-hr nodes (position, intensity etc.), and forms the input data for a full cyclone hazard model. Such a model produces a continuous wind field and takes topography, land friction, etc. into account. Detailed wind field data for all POFP countries can be generated in the model used by the Pacific Catastrophe Risk Insurance Company (PCRIC).

For rainfall data, many National Meteorological Services (NMSs) in the Pacific record daily meteorological observations and data at one or more stations, although such information is not always suitable for use in probabilistic hazard and risk modelling. Satellite rainfall data is also available from NASA (e.g. TRMM and GPM) and other satellite-based sources.

It is worth noting that storm surge is usually covered in tropical cyclone models as a secondary hazard to wind, along with, sometimes, rain and wave height. However, for small islands, the resolution of existing models may be too coarse to capture impacts to the small inlets and bays that focus storm surge. Additionally, high resolution bathymetric data is important for the modelling of storm surge run-up, and the availability of this data can be a challenge.

Exposure and Vulnerability

Insurance design must consider what is going to be covered, e.g. fixed assets, governmental emergency response requirements, and / or people's livelihoods. Most catastrophe insurance has traditionally covered property, mostly domestic property, and (in the private insurance market) commercial and industrial property (and potentially also including business interruption costs). But such covers require a good understanding of the buildings to be covered and how they will respond to a catastrophe event; i.e. where they are, how they are constructed, how well maintained they are, how tall they are, whether or not they have basements, what are they used for, what their value is, etc. For some property, often government assets historically uninsured, little of such data exists. This is almost invariably true of infrastructure assets and certainly true of natural capital assets.

But, parametric insurance offers an alternative option to simply insuring assets and the indemnification of losses. The exposure and vulnerability in this case considers liquidity needs, e.g. requirements for adequate funds immediately after a catastrophe event to respond to natural infrastructure, clear debris, and get recovery underway immediately. Emergency response programmes like this, or livelihood protection schemes for that matter, need an informed estimate of how much money would be required, to a country, province, city, business, government department, or individual if an event of a given magnitude occurs.

2.3.5 Potential Insurance Concepts

Considering the above potentially transferrable risks, this section describes the key elements of three broad insurance concepts, which could be implemented to support ocean health and governance in the Pacific. Potential product design will be elaborated and further developed in the Insurance Concept Design Report; however, in order to inform the risk analytics in Section 4, it is necessarily to illustrate these broad concepts (and begin to identify potential use-cases).

We have identified two broad uses for insurance:

- To finance risk to marine ecosystems as infrastructure assets; and
- To incentivise stewardship of the marine environment and build financial resilience of communities.

It is worth noting that each of the potential insurance concepts identified are parametric instruments, which respond to the intensity of natural catastrophe events (e.g. cyclones, extreme rainfall, and marine thermal stress events), the frequency and severity characteristics of which are outside the control of the POFP11 to address through disaster risk reduction measures. Therefore, in these cases, parametric insurance itself has the potential to offer resilience benefits, as it can be used to pre-finance contingency plans, the execution of which reduces the negative impacts of such events. Furthermore, where risk reduction has taken place, parametric triggers can be adjusted to reflect the greater resilience, leading to a reduction in the cost of risk transfer.

Risk financing for marine ecosystems

As discussed, parametric insurance offers an innovative way to finance risk to more than just traditional property. For example, this trigger-based instrument could be structured to provide finance to aid the recovery of ecosystems following damaging events such as storms or other extreme weather. It can even be used as a mechanism to provide funding and respond to coral bleaching events.

For this type of insurance, the policy holder will likely be either a public-entity or a public-private partnership, since the risk to marine ecosystems is ‘owned’ by the public sector, as governments are responsible for these public goods. As public goods, response activities to aid the recovery of natural infrastructure will likely need to be implemented and organised, or at least endorsed in some official capacity, by governments—likely the Ministry / Department of Environment as the responsible ministry. The only requirements to be a beneficiary and, therefore, a policy holder of insurance for natural capital, however, are:

- To have a financial interest in the recovery of the natural asset after an extreme event; and

- To be able to undertake activities to assist the natural asset to recover after an extreme event.

Therefore, it is also possible that any entity that fulfils those requirements may be a policy holder and, therefore, both a source of premium finance and a beneficiary of an insurance product.

Ultimately, the type of capital (private, public, or mixed) likely to fund insurance premiums will vary location to location and product by product. The most appropriate policy holder / type of capital should be identified on a case by case basis through an identification of the ultimate risk-holder(s) and a beneficiary analysis (which will be detailed in the Insurance Concept Design Report).

In terms of scale, it is much more likely that this type of insurance is applicable at the meso- and macro-level than the micro- level, simply due to the fact that response activities must be undertaken at at least the meso- level to have any effect on marine ecosystem recovery.

Figure 2.4 shows an illustrative conceptual model for the transfer of natural catastrophe risk (which could cover impacts of tropical cyclones, extreme rainfall, or both, and / or slow onset climate impacts such as marine heatwaves) for several reefs (the same concept would also apply for mangrove forests), allowing the communities that depend on them to pool and transfer risk.

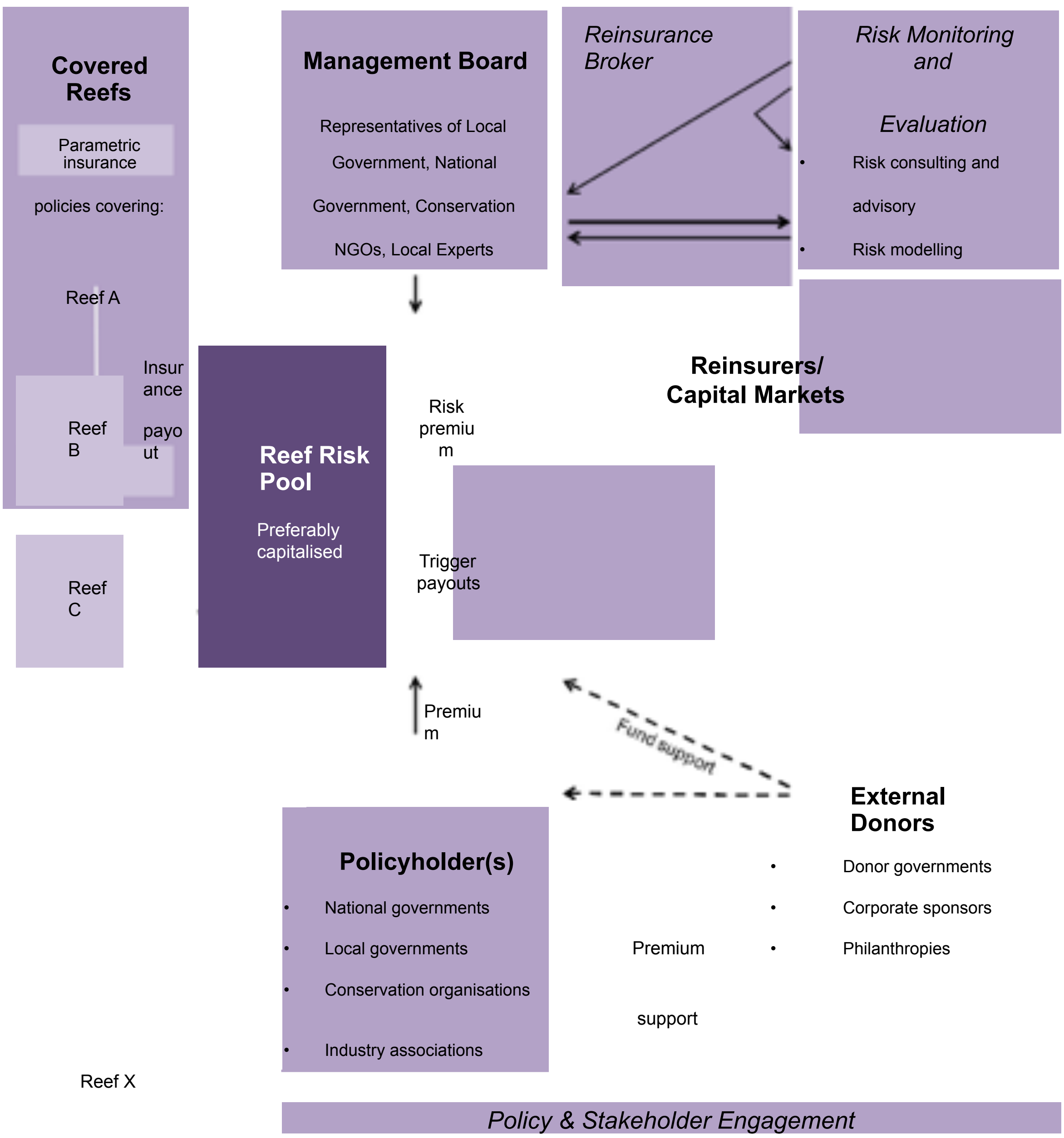

Figure 2.4 Conceptual model for reef risk pool.

Parametric Insurance for Blue / Green Infrastructure

As identified in Sections 1 and 2, coral reefs and mangroves are severely impacted by tropical cyclones. High windspeeds cause mechanical damages and can completely destroy mangrove forests, and sediment, trees and other detritus can severely damage and even kill corals in the days and weeks after a storm. Furthermore, nutrients from runoff following extreme rainfall events can cause an increase in the numbers of Crown of Thorns starfish, which can devour the corals of entire reefs.

Reef recovery is greatly speeded and enhanced by rapid clean-up and Crown of Thorns eradication. However, following a natural catastrophe event, there is often a lack of resources to finance response activities for natural infrastructure. Additionally, mangrove restoration is not always a high priority in the aftermath of a catastrophe event, and therefore, a risk financing mechanism to respond specifically to this need could mobilise necessary finances to jump-start replanting.

Parametric insurance could protect coral reefs and mangroves, providing rapid funding to respond to damaging events such as cyclones and heavy rain through:

- Financing rapid reef clean-up (funding early response that increases reef recovery after cyclones, which in turn can incentivise planning for response);
- Financing rapid restoration and / or replanting of mangroves;
- Providing rapid liquidity for waste and water infrastructure response to address impacts of run-off on ocean health;
- Providing rapid liquidity for Crown of Thorns eradication before irreparable damage is done;
- Financing activities to assist in-shore fisherfolk to fish away from impacted reefs to allow the reefs to recover with as little anthropogenic pressure as possible; and / or
- Potentially providing a more general insurance coverage for revenue interruption suffered by MMA-type conservation business models to maintain their liquidity post-event and to finance early recovery.

Slow-onset Climate Risk Financing

Coasts and islands are particularly susceptible to the impacts of climate change and resulting increases in ocean risk, many of the effects of which will be chronic and slow onset, rather than acute and immediate. While insurance is typically most effective to mitigate the financial impacts of shock events, it can also protect against timing risk, in a term-life insurance-like model. Therefore, we propose the development of ‘term-life insurance’ for coral reefs.

Coral reefs are particularly susceptible to changes in ocean temperature and acidification. Insurance could potentially provide liquidity during a coral bleaching event, which can be used to fund activities to reduce pressure on reefs, allowing them to recover. An insurance programme could also serve as a mechanism to pool the risk of severe bleaching events to a range of stakeholders / across a wide geographical zone.

The rate of ocean warming and occurrence of temperature and related conditions likely to cause bleaching events can be measured globally and represented as an index, and, therefore, parametric insurance can be designed, triggering pay-outs if key metric(s) exceed pre-agreed thresholds. The premium rating for such coverage will be closely linked to carbon emission projections (since carbon emissions are the main driver of ocean warming) so, assuming the ‘polluter pays’ principle operates, the higher premium cost of this insurance as carbon concentrations grow would strongly incentivise emission mitigation measures.

Insurance as reward

Taking up the idea that risk financing incentivises risk management and reduction behaviour, insurance programmes can be designed specifically with the environment in mind. For example, risk finance can be structured such that a subsidised premium is offered to incentivise continued ecosystem stewardship and natural capital maintenance. Pay-outs from an insurance product could also be specified towards environmental activities, such as debris removal on reefs following storms or financing activities to support fisherfolk post-event to refrain from fishing and allow ecosystems to recover when they are at their most vulnerable. Furthermore, this innovation could have a significant and positive impact on the resilience of developing economies, as it encourages a robust understanding of risk, allowing for the management of that risk in addition to providing finance to increase resilience.

For this type of insurance, the policy holders will most likely be individuals, although it is possible they could be an association or even a sovereign or sub-sovereign government with a way of distributing pay-outs to individuals based on adherence to environmentally sustainable practices. The scale of the product (i.e. micro, meso, or macro) will be dependent on a variety of factors, including the availability of potential beneficiary information held by associations or governments and the existence of associations / potential risk aggregators in the first place. These factors will vary from place to place and will therefore be product-specific and further developed in the Insurance Concept Design Report.

In terms of types of capital, the premium will likely need to be subsidised, if not wholly funded, by public capital in order to work as an incentive for behavioural change.

Insurance to Support Fisherfolk Resilience and Fisheries Management

Fisheries play a vital role in food security for the world's population and provide livelihoods to some of the poorest and most vulnerable communities. Yet fishing is a high-risk activity, with injury and loss of life all too common. Physical risks threaten assets such as boats, and volatile catch quantity and prices create high inter-annual income variability. Furthermore, destructive or damaging fishing activities threaten the very resource these communities rely on. Therefore, supporting a resilient and sustainable fisheries sector is a key pillar for prosperity and long-term ocean health.

Preferential access to insurance products can be provided as a reward for registration and tagging and / or in exchange for adherence to responsible fisheries management. This can incentivise environmental stewardship, support sustainable fisheries, and increase the financial resilience of fishing communities.

Insurance coverage for fisherfolk could be through a microinsurance initiative or sovereign level insurance scheme, and could include:

- Life and health insurance;
- Vessel coverage; and / or
- Livelihood protection.

This concept offers insurance coverage as an incentive for sustainable practices, and the coverage could be voided in the case of non-adherence. In this case, the tools of science-based planning and innovative financial mechanisms could work together to promote sustainable growth and prosperity for the benefit of local communities- acting both as an incentive to facilitate adherence to such sustainable policies and to increase the financial resilience of small-scale fishing communities.

Figure 2.5 shows an illustrative conceptual model of a potential *insurance as reward*. The actual risk transferred could cover life and health and / or the impacts of natural catastrophe events, depending on the demands and needs of the communities themselves.

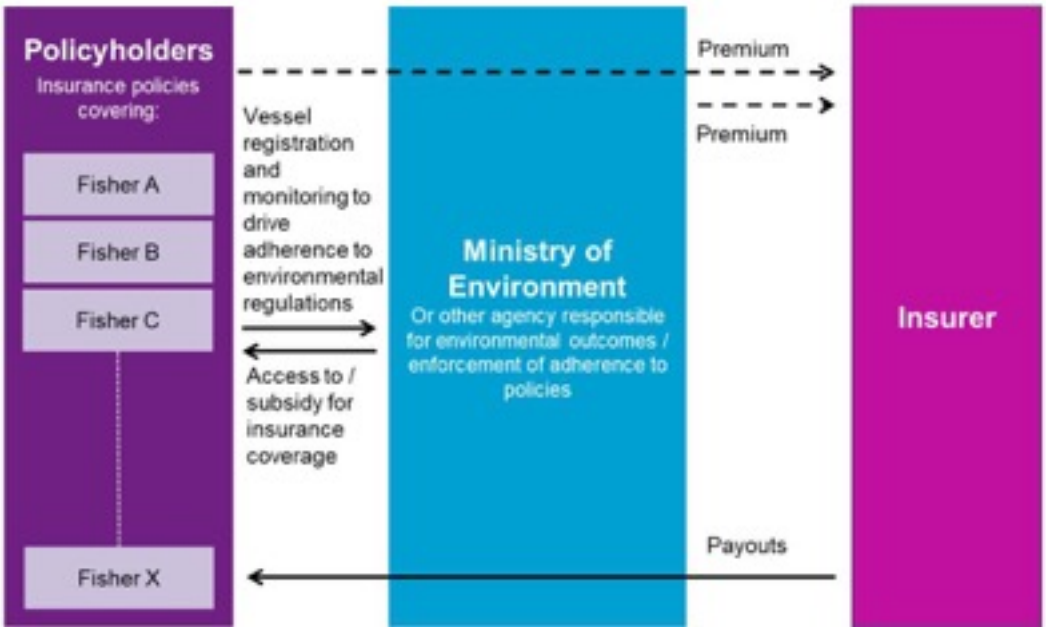

Figure 2.5 Conceptual model for insurance as reward.

2.4 Risk Analytics

This section presents a sampling of the kind of detailed risk data and analytics which are necessary to underpin the insurance concepts presented in Section 3. First, we provide rainfall analytics for Fiji (including the Vatu-i-Ra-Seascape, a large Marine Managed Area) to illustrate how satellite derived rainfall data can underpin insurance product design (therefore also illustrating the parametric insurance design process). Second, we provide historical tropical cyclone track maps for all of the POFP11 that have some level of wind risk. Finally, we provide a sample of the data and analytics required for the 'term-life insurance' for coral reefs, providing an example at the Great Sea Reef in Fiji.

The relevant risk analytics will be further developed at specific geographies in the Insurance Concept Design Report, including at least one large Marine Protected or Managed Area, once the pilots and case studies have been selected.

2.4.1 Rain Analytics for Fiji

The following plots illustrate one approach to capturing rainfall risk, using TRMM (satellite) data. While we present only Fiji here (including one large Marine Managed Area, the Vatu-i-Ra-Seascape, which will be further detailed in the Insurance Concept Design Report), this and similar satellite-based rainfall datasets are available globally and could be applied to any of the other POFP11, once case studies are identified in the Insurance Concept Design Report.

The first step in the risk analysis necessary to underpin the design of any parametric insurance coverage is to understand the hazard. It is critical to have access to historical hazard data, and there are often openly available datasets. For example, for rainfall, there are satellite-based datasets, and Figure 2.6 illustrates one such source, TRMM, which is gridded rainfall data from NASA.

The second step in the risk analysis necessary for product design (and to inform pricing) is to assign probabilities to rainfall parameters. Figure 2.7 shows annual maximum rainfall (y-axis) at each TRMM cell in Fiji (referenced by number along the x-axis) from 1998-2011, which allows one to assign probabilities to various rainfall profiles. For example, based on this data, on average there is a 10% chance of 208 mm or more on any one day in a year, 5% chance of 238 mm or more, 2% chance of 278

mm. or more, and 1% chance of 308 mm or more. These are averages across all of Fiji, but would be used at higher resolution (e.g. at the individual TRMM cell level) as the basis for a risk profile for underwriting and pricing of a parametric product.

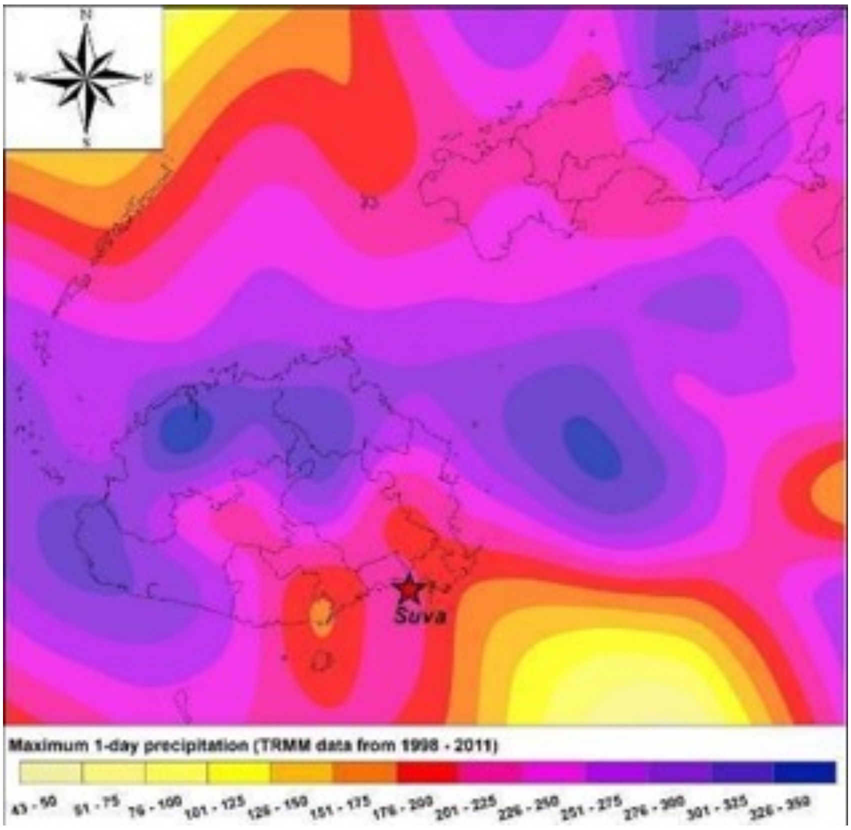

Figure 2.6 Distribution of maximum 1-day rainfall for Fiji.

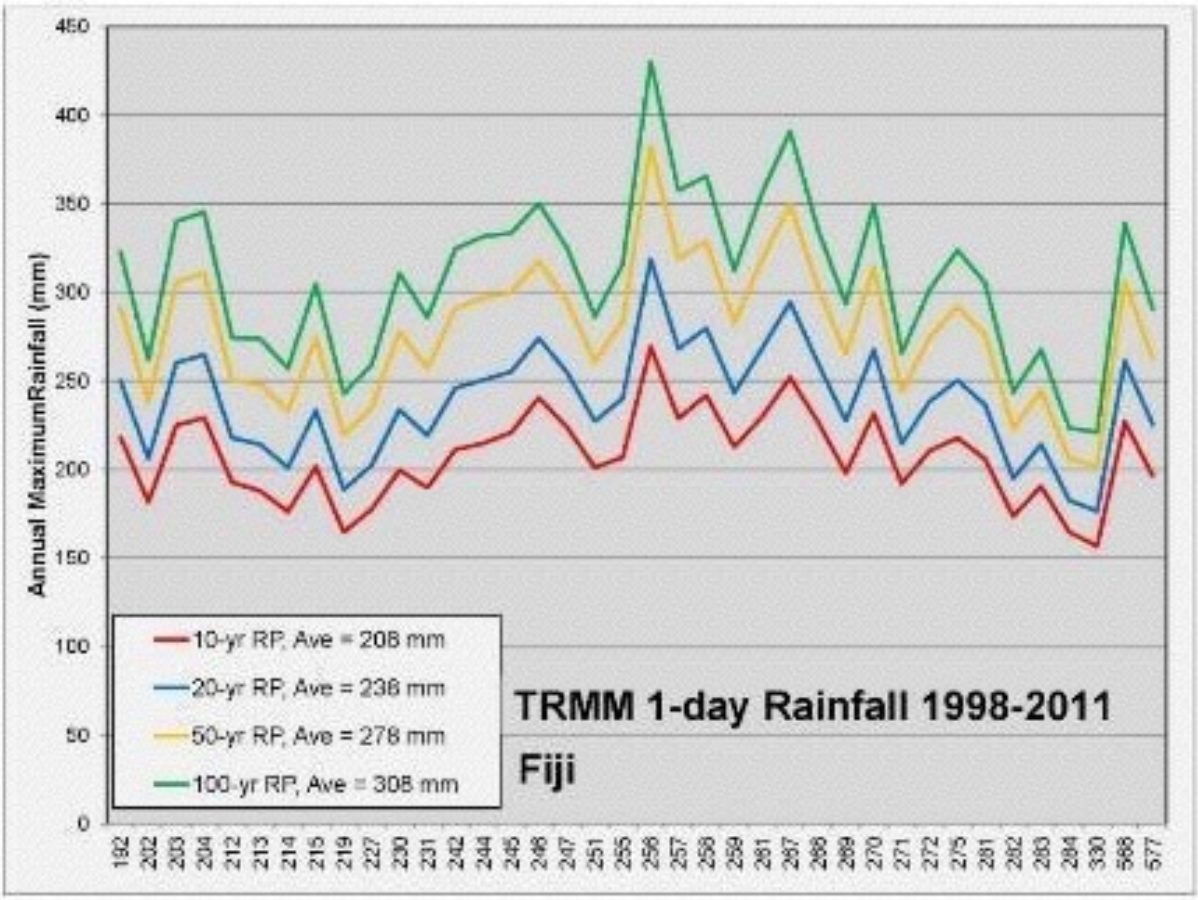

Figure 2.7 Graph of 1-day rainfall amount at various return periods for all the TRMM cells covering Fiji.

The third step in risk analysis to underpin parametric product design is linking the hazard data and parameter probabilities to impact data. The exceedance probability (EP) curve in Figure 2.8 illustrates one approach—assigning a loss rate to different rainfall levels for a given infrastructure type and then applying that to the dollar value of that infrastructure type across Fiji. While parametric insurance for blue / green infrastructure will not necessarily consider the impacts to grey infrastructure, it is a useful illustrative example of risk analytics in the more traditional case of asset protection. The Insurance Concept Design Report will include the development of an EP curve for the selected case study.

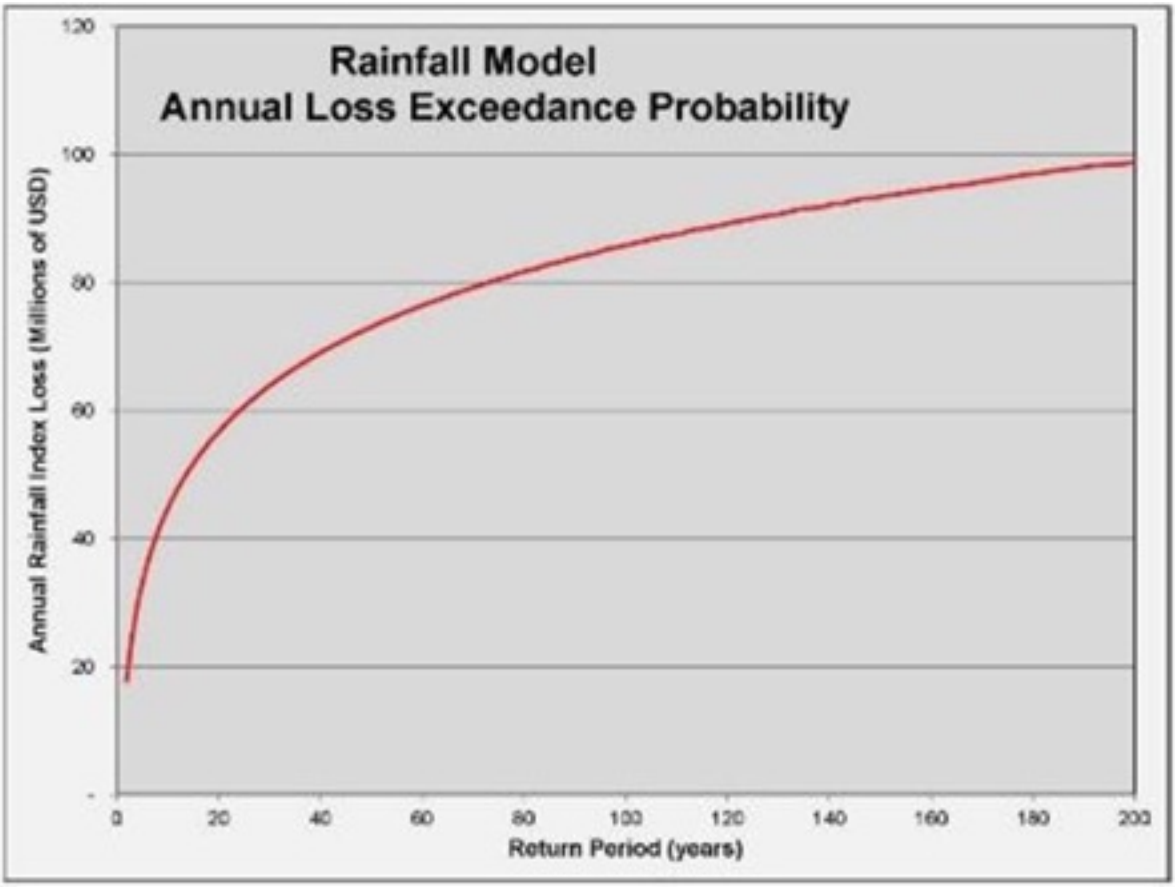

Figure 2.8 An exceedance probability (EP) curve illustrating the likelihood of certain levels of loss due to physical infrastructure damage from rainfall in Fiji.

2.4.2 Historical Tropical Cyclone Data

The following maps (Figures 2.9 to 2.15) provide a visual representation of the historical data available for wind hazard, which can be used to design and price a parametric insurance product. While hazard is only one element of product design (as it is also necessary to link hazard parameters with financial impacts), as illustrated above, it is the crucial first step in exploring the feasibility of insurance coverage. Further product design, including analysis of the relationship between hazard and impact, needs to be bespoke and site-specific, and, therefore, will form the core component of the Insurance Concept Design Report.

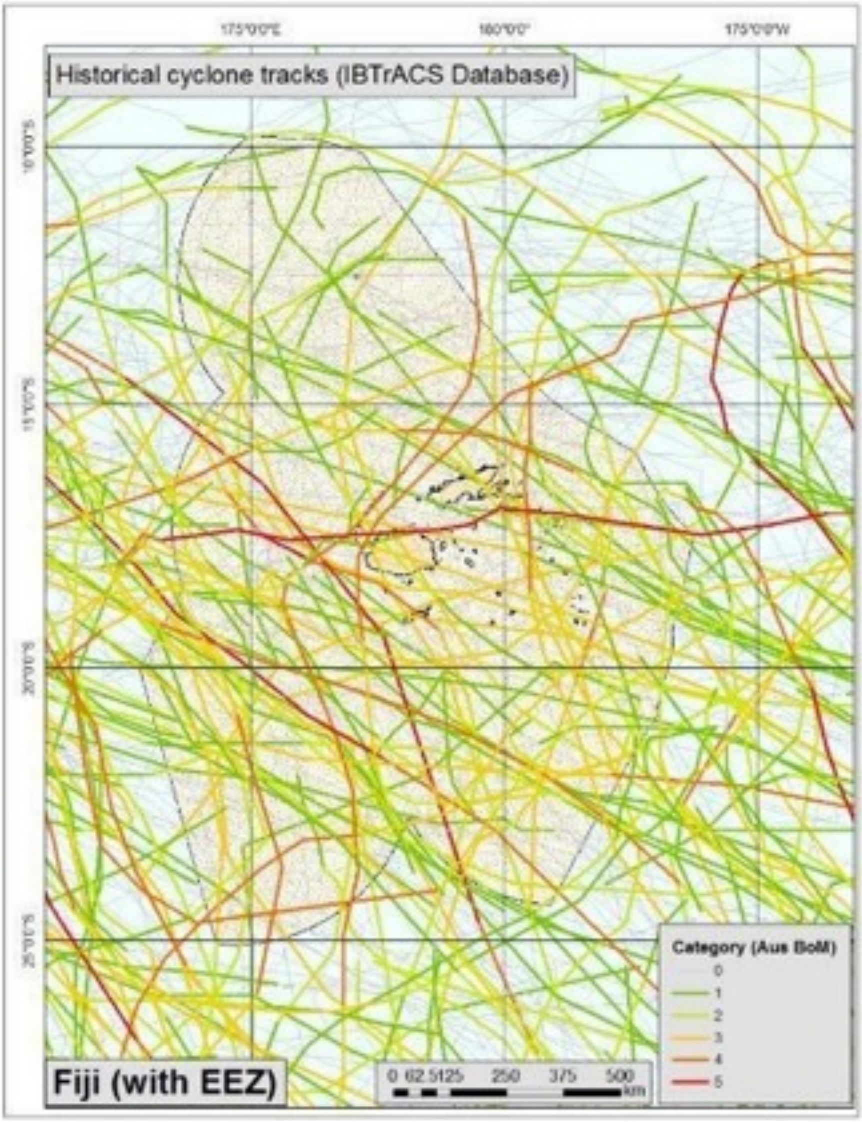

Figure 2.9 Fiji historical cyclone track map, including EEZ.

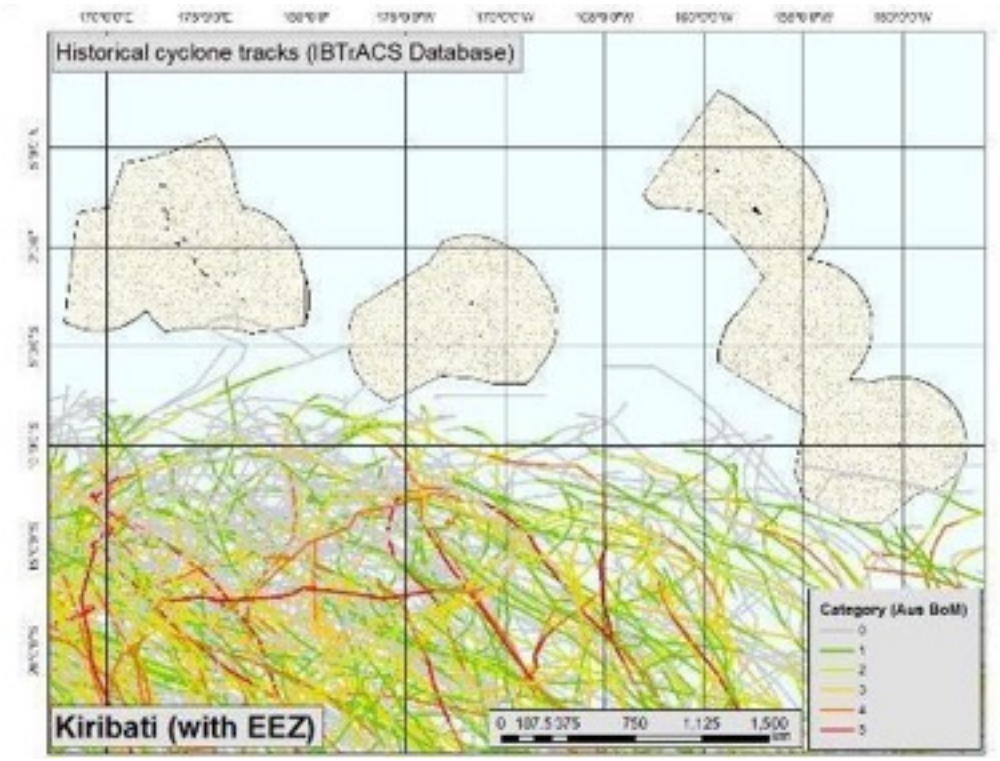

Figure 2.10 Kiribati historical cyclone track map, including EEZ.

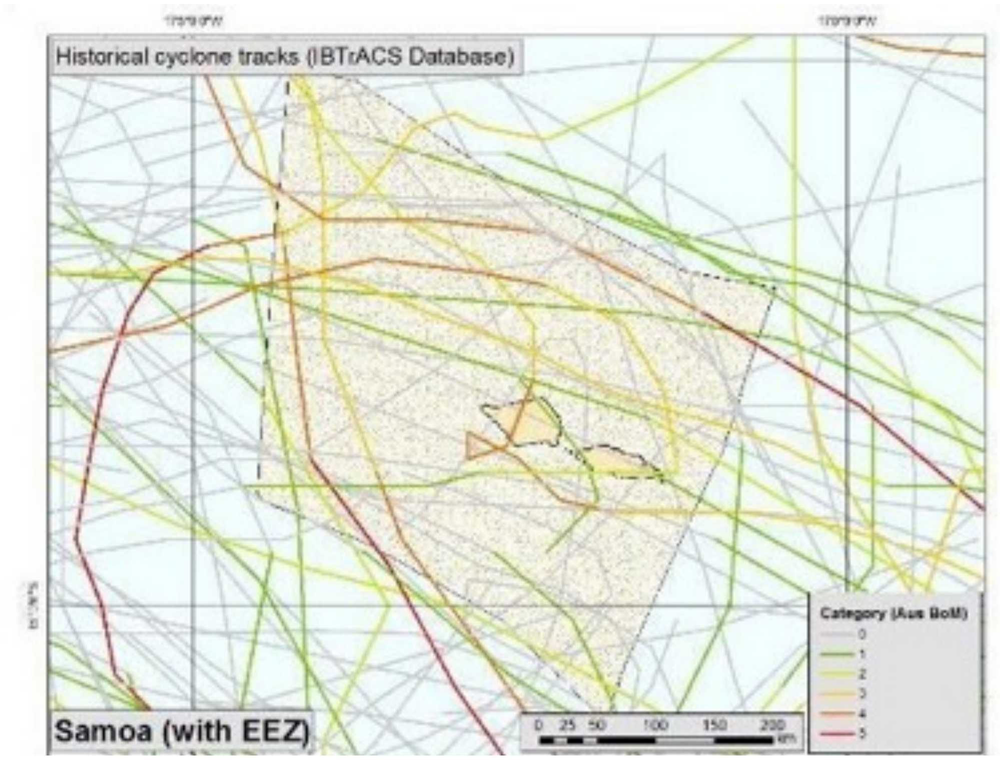

Figure 2.11 Samoa historical cyclone track map, including EEZ.

Figure 2.12 Solomon Islands historical cyclone track map, including EEZ.

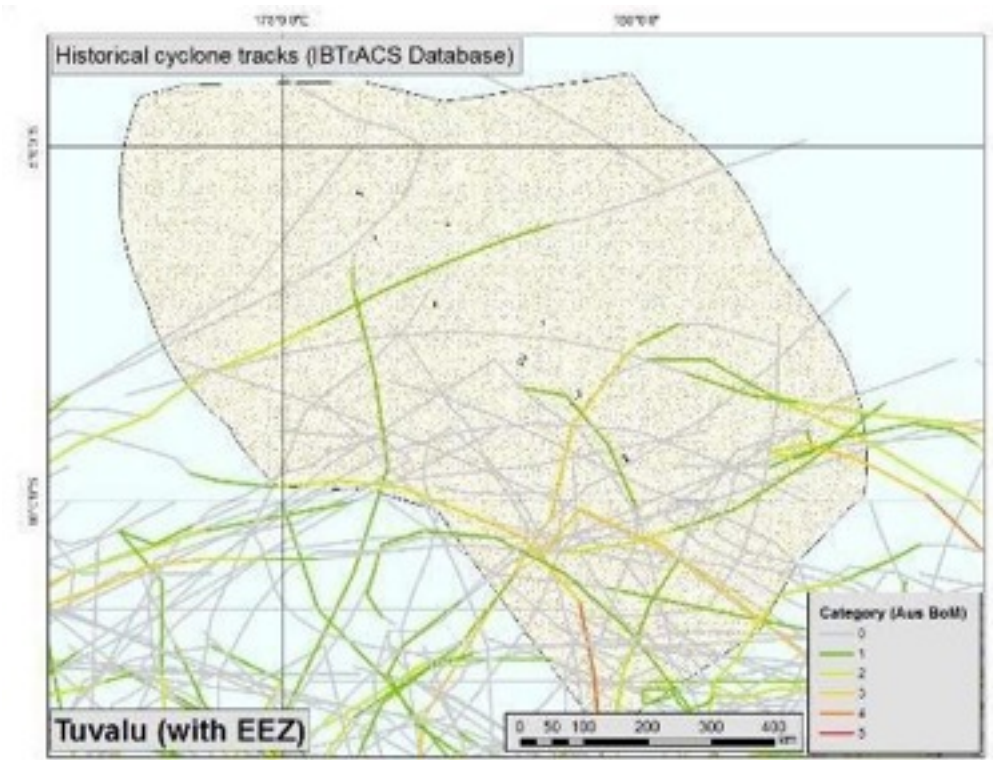

Figure 2.13 Tuvalu historical cyclone track map, including EEZ.

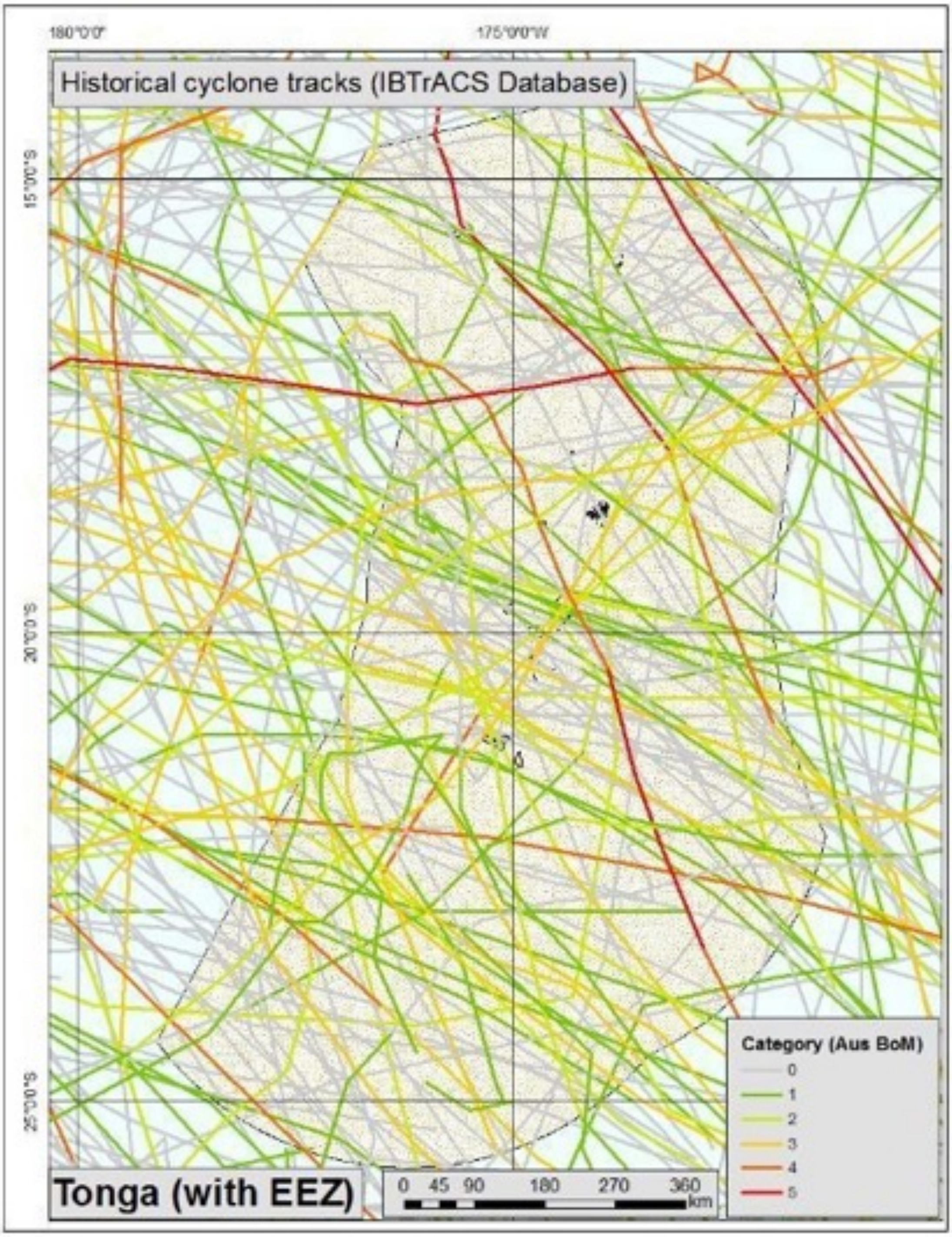

Figure 2.14 Tonga historical cyclone track map, including EEZ.

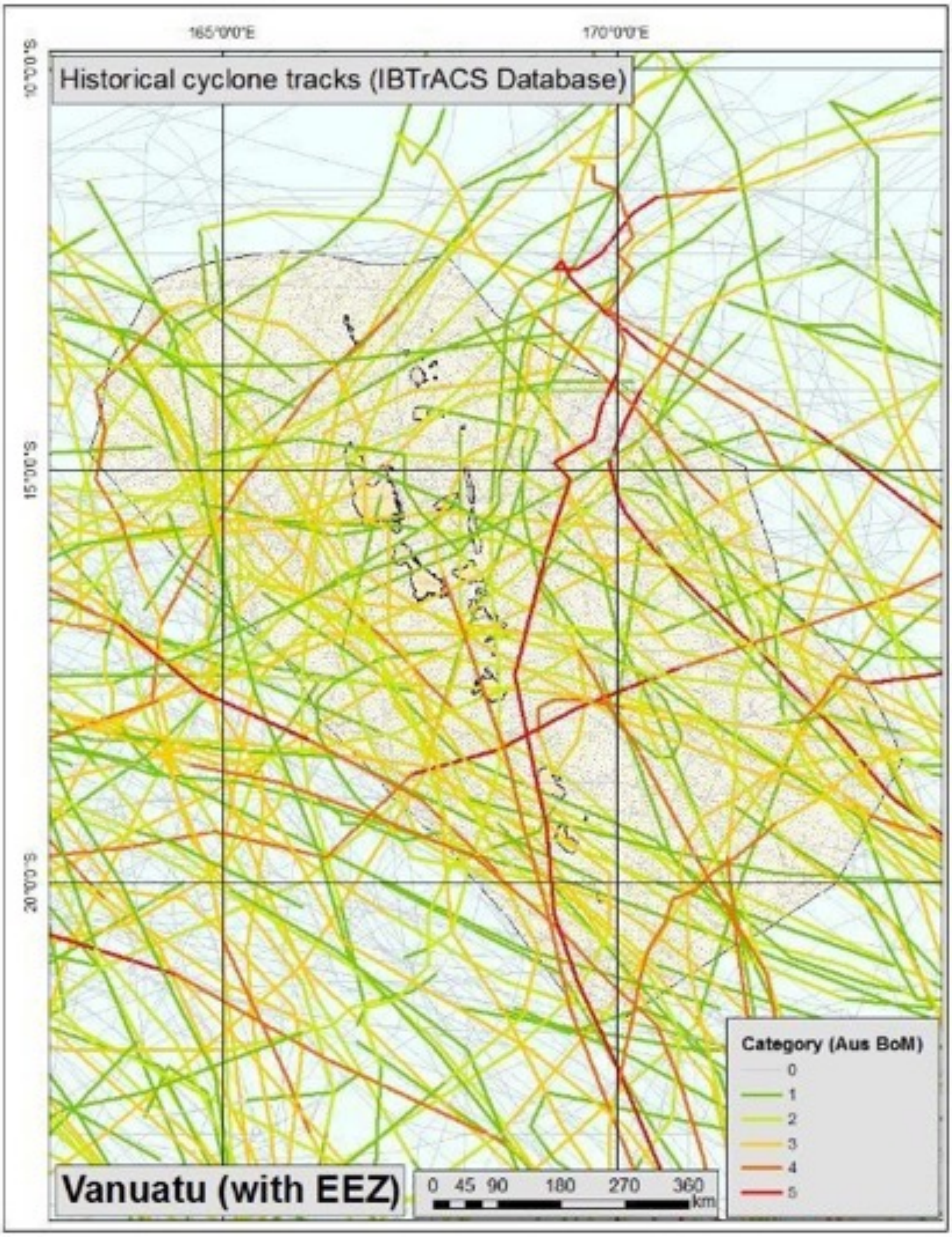

Figure 2.15 Vanuatu historical cyclone track map, including EEZ.

2.4.3 Potential Indices for Coral Reef 'Term-Life Insurance'

There are several long-term datasets that could potentially be used to underpin a parametric product, which would act like 'term-life insurance' for coral reefs—covering them against unexpectedly rapid ocean temperature rises or spikes. This hazard data could underpin a coral reef bleaching product, and the following indices are available at 5 km resolution globally.

Figure 2.16 represents two potential indices from the NOAA Coral Reef Watch (CRW) programme[35] that could be used to underpin a coral bleaching product, which would provide parametric insurance coverage against slow-onset climate impacts:

- The Daily Global 5 km Satellite Coral Bleaching Heat Stress Degree Heating Week (DHW) index[36]; and
- The Daily Global 5 km Satellite Sea Surface Temperature (SST) Anomaly index[37].

The DHW index shows accumulated heat stress, has been linked to coral bleaching. The scale of the index ranges from 0°C to 20°C-weeks, and it has been shown that significant coral bleaching usually occurs when the DHW value reaches 4°C-weeks.

The SST Anomaly index displays the difference the SST on any given day and the long-term average. The scale ranges from -5°C to +5°C, with positive values meaning that the daily temperature measured is warmer than average and negative values meaning cooler than average. This index is noisy, even on a 30-day moving average (as illustrated in Figure 2.16); however, we are investigated methods of cleaning this dataset with scientists from the University of Queensland.

Both the DHW and SSTA are available daily and globally at 5 km resolution, back to 1985, making them candidates to underpin parametric insurance products.

35.https://coralreefwatch.noaa.gov/
36.https://coralreefwatch.noaa.gov/product/5km/index_5km_dhw.php
37.https://coralreefwatch.noaa.gov/product/5km/index_5km_ssta.php

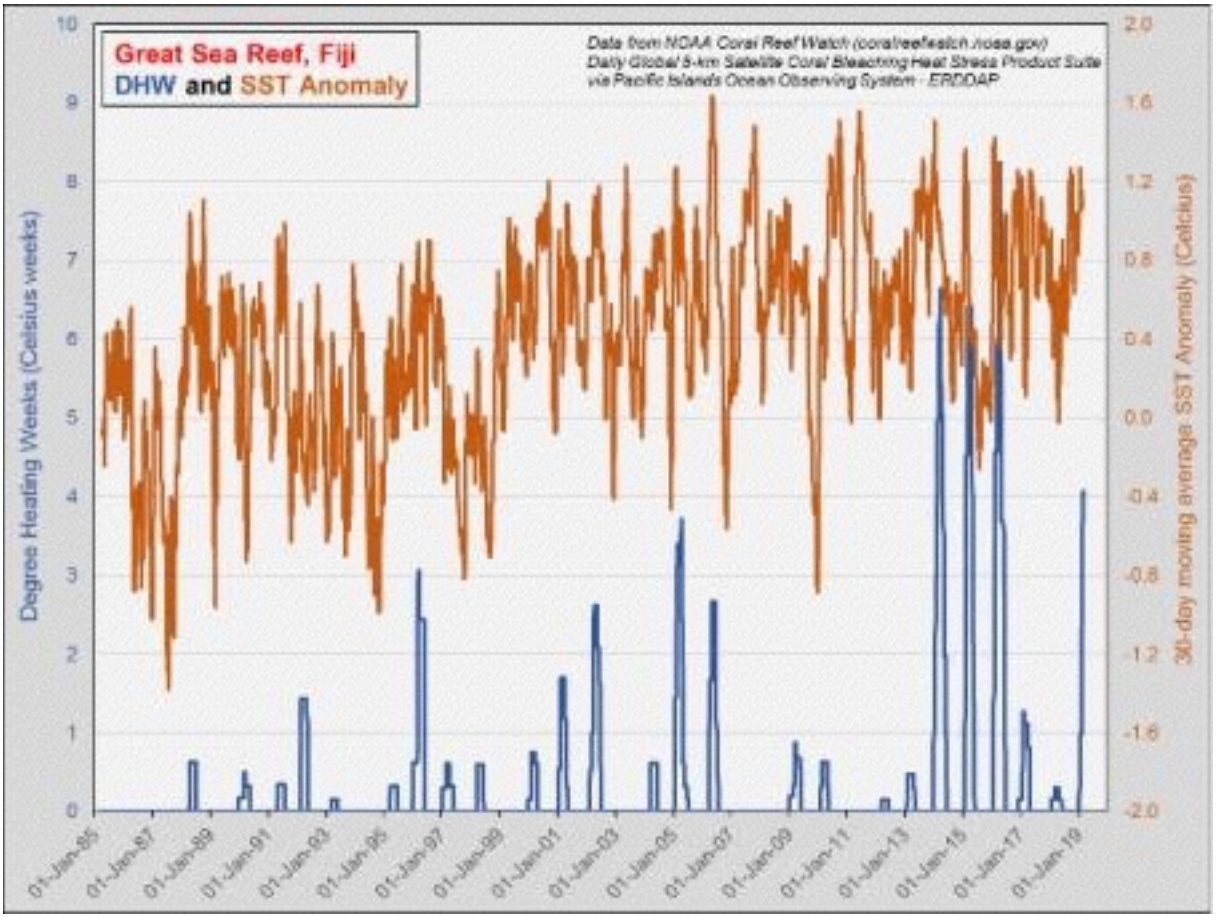

Figure 2.16 Graph including the NOAA Coral Reef Watch (CRW) Degree Heating Week (DHW) index and Sea Surface Temperature (SST) Anomaly for a representative grid cell (latitude -16.275°; longitude 178.525°) for the Great Sea Reef in Fiji.

3. Concept Design Report

In this concept design report, we provide detailed technical information for three potential insurance product concepts and present a conceptual ecological, social, and economic model for each. For each concept, we have selected a specific use-case in a specific location; however, we wish to emphasise that all three concepts have potential utility broadly across most, if not all of, the POFP11 countries. Further, the datasets we have selected as those underpinning the insurance product in all cases are available at the same resolution and quality, both historically and in real time, across the entire POFP11 set of countries (and, indeed, beyond those countries to the entire set of Pacific island countries and territories). These product concepts are thus eminently scalable, both within a single country and across the region.

Below we summarise the three product concepts, the use-case for each, and the state of the product concept in terms of pathway to being implementable (and, indeed, implemented), the aspect which is further elaborated in a companion report.

- **Concept 1: Parametric Cyclone Insurance for Reefs, Fiji**. This design uses established parametric insurance concepts to capture risk of damage to coral reefs from cyclones. Proceeds from fast-paying parametric insurance can be used for a variety of purposes, including clean-up and early restoration efforts for reefs already under stress from other hazards (including local pollution, overfishing, and ocean warming and related effects due to global carbon pollution and consequent anthropogenic climate change). The use case is as part of a larger reef resilience programme being led by WWF Pacific, targeting the building of adaptation capacity in coastal communities along the Great Sea Reef (GSR). This concept is far advanced, with only modest additional technical work required to enable pricing to be completed. Regulatory authorisation is likely to be straightforward, but other administrative aspects (establishing the insurance contract counterparts and policy administration, including real-time trigger calculation processes and responsibilities) require work. Finally, raising premium finance will be necessary, most likely as part of the larger WWF-led GSR project.

- **Concept 2: Parametric Sea Surface Temperature Insurance for Coral Bleaching, Palau**. This concept is at the earliest stage of the three proposed and requires significant technical work to establish viability as an insurance product. This is because it addresses the risk of shock climate events, which are driven very directly by slow-onset climate change; therefore, the forward-looking risk analytics required to be able to price an insurance product require the use of data with a high degree of uncertainty embedded in both climate models themselves and in the future carbon emissions pathway the world follows. Further, even if there is an analytic methodology, which allows the quantification of this risk with appropriately limited uncertainty, making risk transfer a reasonable option (from a relative cost perspective), it may emerge that in many areas, the risk of bleaching is just too high to make insurance viable. Despite these challenges, we believe this concept worthy of further investment and exploration, given the long-standing desire for testing of insurance tools and products to quantify and address long-term climate change impacts, a desire particularly strongly communicated by the Pacific island nations. The use case is Palau, where two major pillars of the tourism industry, diving on coral reefs and visiting Jellyfish Lake, are at direct risk from ocean heat stress events, which lead to bleaching and mortality of corals and mortality of jellyfish, both of which have a direct and significant impact on the economy of Palau and the livelihoods of many of its citizens. A significant data analysis programme is required before this concept can be deemed viable in terms of an insurance product; if it is deemed viable, then design and implementation of a product in Palau, or elsewhere, would take some time, but we believe it would be possible.

- **Concept 3: Parametric Livelihood Protection for Climate Risk to Coastal Communities, Vanuatu**. This concept is well-developed in terms of the administrative and operational requirements, given that it can build on experience from the Caribbean and relevant preparatory work completed in the Pacific. On the technical and analytical side, while the cyclone risk analytics and trigger design are also well-advanced, extreme rainfall analytics using the most recent satellite-based data need to be completed before the product is ready for underwriting and pricing. The use-case for this concept is for fishing communities in Vanuatu, where access to insurance would be provided as a reward for the implementation of improved fishing practices and enabling of monitoring of those practices. There is a strong co-benefit of financial inclusion, as well as climate adaptation, to this model, and implementation is likely to be most effective when it is done in a collaborative way between government and community-based organisations working on broader financial inclusion programmes to support climate adaptation in coastal communities. Other than the technical work that will be required on the rainfall trigger, and some refinement of the cyclone trigger analytics, there will be significant work required on the local administration and operationalisation elements of a parametric insurance programme. Although there are successful models, similar to the proposed concept, currently up and running around the world, given the relative lack of exposure to parametric products of the government and insurance business sector in Vanuatu, local engagement will be key to any potential implementation. This programme also relies on public funding of premiums, which is most likely to materialise within a broader development project focussing on coastal community climate adaptation.

The three sections that follow provide details of each of these three concepts, with background technical information provided in annexes.

3.1 Concept 1: Parametric insurance for blue infrastructure

This concept develops the use of parametric climate risk insurance to support ecosystem conservation and climate resilience of blue infrastructure. In particular, it leverages the ability of parametric insurance contracts to settle very quickly (days to a few weeks), based on objective triggers, and with regular, disciplined premium payments made in advance. This contrasts starkly with the current funding mechanisms for shock event response, namely an ad hoc approach which can only support slow and fragmented attention to response and early recovery, often funded (if it is funded at all) through the diversion of philanthropic financing streams (over many months), new philanthropic fundraising (which may take years), and / or academic research funding (generally taking multiple years).

Through exploring global experience and engaging with stakeholders in the POFP11, we have identified a number of potential use cases for this broad concept, including:

- Financing rapid reef clean-up (funding early response that increases reef recovery after cyclones, which in turn can incentivise planning for response);
- Financing rapid restoration and / or replanting of mangroves;
- Providing rapid liquidity for waste and water infrastructure response to address impacts of excessive run-off on ocean health after high rainfall events;

- Providing rapid liquidity for Crown of Thorns eradication before irreparable damage is done;
- Financing activities to assist inshore fisherfolk to fish away from impacted reefs to allow the reefs to recover with reduced anthropogenic pressure; and
- Potentially providing a more general insurance coverage for revenue interruption suffered by MMA-type conservation business models to maintain their liquidity post-event and to finance early recovery.

Risk financing in general de-risks, and therefore unlocks, investment; this is no different for natural infrastructure than other public assets. Therefore, the development of insurance instruments to provide comfort to investors and support the financial resilience of blue infrastructure (e.g. reefs and mangroves) is a crucial step in the scaling up of finance for natural assets.

Our specific case study for this concept required a context in which a broad conservation programme was either in place or planned, with a sustainable financing model at least somewhat independent of the public purse, which is threatened by cyclone impacts. We identified the Great Sea Reef in Fiji as having the necessary characteristics, with the Government of Fiji supporting and endorsing a broad, long-lived, and sustainable coral reef conservation and coastal community resilience project led by WWF Pacific.

3.1.1 Ecological and social context

Coral reefs are severely impacted by wave action during cyclones, and sediment, trees, and other detritus cause even greater damage in the days and weeks after a storm. Reef recovery is greatly speeded and enhanced by rapid clean-up, to curtail ongoing damage. Rapid advances in the science of coral restoration and regeneration are also unlocking opportunities for longer-term recovery efforts such that active interventions over an extended period can greatly mitigate the medium to long-term impacts of cyclones on coral reefs. Especially with growing stressors from anthropogenic sources including thermal stress and pollution, reefs exposed to tropical cyclones need all the help they can get to recover rapidly and maintain resilience to these other stressors.

We have identified the Great Sea Reef (GSR) as our focus for detailed risk analytics and insurance product design. The GSR is the third longest continuous barrier reef system in the world, stretching over 200km offshore to the northwest of the two main islands of Fiji, protecting the north coasts of Viti Levu and Vanua Levu. The provinces of Ba, Ra, Rau, and Macuata are those with coastlines adjacent to GSR; together, these provinces host 40% of Fiji's population and 70% of Fiji's tourism (which translates to a quarter of national GDP). The GSR also provides the source of 80% of Fiji's offshore fishing revenue as well as hosting huge areas of inshore fisheries, which underpin nutrition and livelihoods for coastal communities along the entire length of the GSR.

The GSR is the focus of a major initiative led by WWF Pacific in collaboration with the Government of Fiji, which aims to bring a systems approach to effective management of the marine and terrestrial environments that impact the reef. The scoping programme is targeting a transition towards sustainable stewardship of the reef and development of the related economy. The stated programme vision is as follows: "By 2025, the Great Sea Reef and coastal ecosystems are healthy and resilient to a changing climate, supporting sustainable business, inclusive livelihoods, food security and community wellbeing."

Within the proposed integrated reef and community resilience approach, stakeholders have identified a role for reef insurance to help to manage the major risk of cyclone impacts undermining key elements of the GSR programme, as summarised in Table 3.1.

Policy purpose	Provide rapid pay-outs for major cyclones affecting the GSR in the coverage area, to enable rapid action to clean up the reef post-storm, undertake early recovery efforts such as re-attaching broken corals and planting nursery-raised corals, and to potentially support local populations with payments for activities which support de-stressing of the reef ecosystem in the months following the cyclone impact.
Brief index description	Parametric cyclone "cat-in-a-box" or onshore peak wind, both as a proxy for cyclone impact on reefs off the north coast of Macuata province, Vanua Levu island.
Coverage area	Reef area running offshore along the north coast of Vanua Levu, containing the most important, and potentially resilient, reef zone and approximately coincident with the Macuata provincial boundaries onshore. Labasa, the largest town on Vanua Levu, sits at the heart of the area of interest.
Index as proxy for 'loss'	Cyclone intensity has been demonstrated to be a good proxy for negative impacts on coral reefs, including in the Caribbean and along the Great Barrier Reef in northeastern Australia. These negative impacts include transportation of large debris (including tree trunks, human debris such as cars, etc.) and deposition on the reef, where they continue to do damage under normal ocean conditions, as well as direct mechanical damage to corals through breakage and removal. Reef damage extent appears to increase somewhat linearly with cyclone intensity, so a stepped trigger will be used. Coverage amounts must relate to use of funds should a pay-out be triggered, with premium increasing linearly with coverage amount so that the greater the premium available, the more extensive the use of funds planning can be.

Table 3.1 Summary characteristics of the proposed insurance product.

3.1.2 Product design and economic model

Parametric insurance is a form of insurance that provides pay-outs based on the occurrence and intensity of a hazard event, as a proxy for impact and loss, rather than indemnifying against actual loss (which is the traditional insurance approach). This focus on hazard rather than loss creates a broad range of potential applications, which could not be served by indemnity insurance. These include protection of assets which are public goods creating value across a broad range of actors, operability with lower data requirements than conventional insurance, and an ability to settle very rapidly, generating pay-outs within days, which can be applied immediately to arrest ongoing loss development and underpin early—and thus more effective—recovery.

In the case of coastal natural infrastructure (and, particularly in this case, coral reefs), this type of cover can replicate traditional risk financing for non-traditional fixed assets, providing rapid funding to respond to damaging events such as cyclones through:

- Rapid reef clean-up (funding early response that greatly increases reef recovery after cyclones, which in turn incentivises planning for response);
- Medium term coral rehabilitation activities such as re-attaching broken coral fragments, introducing nursery-grown corals, and other developing techniques for reef rebuilding; and/or
- Payments to fisherfolk to not fish, provision of fish aggregating devices and assistance to fish offshore, or provision of other social benefit support to ease post-cyclone stress on reefs and / or mangroves.

We have selected the coverage area to encompass the section of reef adjacent to the north coast of Macuata province, which is in the heart of the GSR and is a locally-protected area. This area scored the highest of any on the GSR in a study of the value of coral reefs in terms of contribution to the global survivability of coral reefs in the face of projected ocean warming and acidification due to anthropogenic climate change (the 50 Reefs study, Beyer et al., 2018[38]), and it is therefore a relatively critical area of reef on which to focus resilience building efforts, including developing and funding rapid response to cyclone impacts.

We have identified two options for parametric insurance policy design, one of which (Option a) is simpler and more easily deployable and the other of which (Option b) requires a specific data source and associated risk transfer pathway, through the Pacific Catastrophe Risk Insurance Company (PCRIC), a regional public-good risk pooling facility created as an outcome of the PCRAFI project.

Option a: Simple "cat-in-a-box" design, targeting a particular area of interest to focus premium dollars in generating pay-outs for events that have high impact on the reefs and are therefore of particularly importance to the policy holder. Historical cyclone records (track points and intensity) are available back to 1955 in the public record (see Technical Annex 1), which can be used to build a view of what track and intensity characteristics correlate with impact on the segment of reef of interest. A buffer zone around the reef area can then be drawn, with increasing intensity of cyclone recorded within the buffer zone triggering progressively larger pay-out percentages including an initial trigger level and a maximum intensity at which the full coverage value is paid out.

38.Beyer, H.L. et al., 2018. Risk-sensitive planning for conserving coral reefs under rapid climate change. Conservation Letters, 2018;e12587. https://doi.org/10.1111/conl.12587.

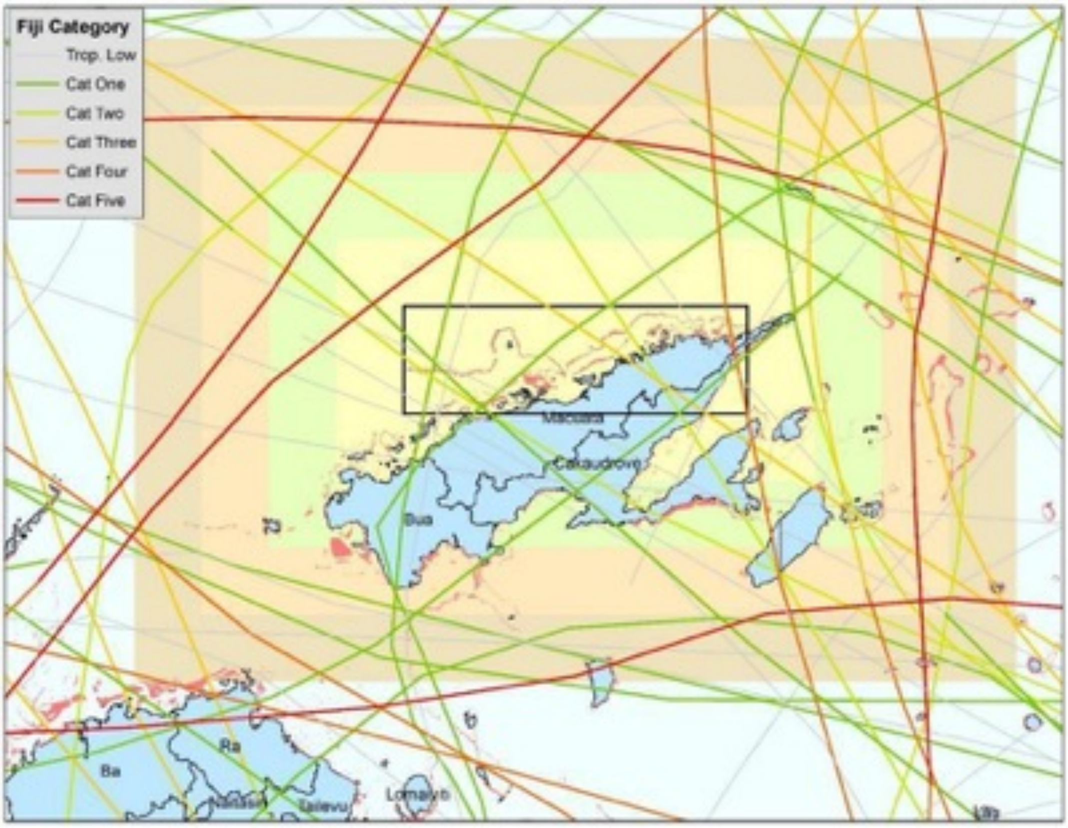

Figure 3.1 Testing historical cyclone activity within different buffer zones around the GSR offshore of Macuata province. The overall aim is to identify an area which captures storms that affect the reef but excludes storms which do not.

Category	Number of Storms in Box			
	100km	75km	50km	25km
One	12	10	7	5
Two	6	6	5	3
Three	5	4	3	2
Four	4	3	1	1
Five	5	5	3	1

Table 3.2 Historical cyclone count of different categories within different size boxes. See Technical Annex 1 for description of storm category assignment for Fiji.

Based on the historical record, a box of around 50km around the defined reef zone north of Macuata province (the light green box in Figure 3.1) appears to best capture the cyclones of interest in terms of reef damage.

Option b: Modelled wind speed parametric, which could be underwritten by PCRIC and likely participate in the Pacific regional pool, thus benefiting from diversification of risk across the region and access to the global risk markets at scale, based on a known and trusted model. PCRIC's current tropical cyclone model, built and operated by AIR Worldwide, can provide an estimate of wind speed at a high number of points on the ground in any of the 15 Pacific islands within the model for any cyclone active within the Pacific, based on the track and intensity information provided by the regional meteorological agencies. In the case of offshore reefs, we estimate that peak wind speed in the adjacent land area (in this case Macuata province) will be a very good proxy for intensity of hazard affecting the reef. Given that data from PCRIC is not fully within the public domain, we have not fully developed the risk analytics for Option b; however, we are confident, based on past experience, that the risk metrics will align closely with those summarised above for Option a so that pricing for each option will be very similar (for the same trigger thresholds and pay-out rates).

Table 3.3 provides a draft term sheet for this case study, with differences between the two options annotated as (a) or (b) as per the descriptions above.

Policy Name	Parametric cyclone insurance for reef damage response and recovery funding
Policy Form	a) Cyclone "cat-in-a-box" b) Modelled (onshore) wind speed index
Buyer / Insured	Preferably, the entity responsible for coordinating reef response / the implementation of the activities funded by potential pay-outs (e.g. not-for-profit conservation NGO and / or community organisation would be the Insured, but premium might be collected from a broader range of actors, including national or regional government and private sector (where there are benefits to that sector)
Seller / Insurer	a) Three options: i) local fronting insurer, passing all risk to international markets; ii) local insurer taking some risk; or iii) direct to international markets (depending on regulatory view). PCRIC could play a role either as a primary insurer or as a risk-taker, although experience is limited in this particular transaction type b) PCRIC, as it has license to the modelled wind speeds required to price and trigger this form of cover, and the modelled wind speed used for pricing is the same as already used by PCRIC for its standard sovereign cover
Structure	Simple parametric with stepped triggers; three pay-out levels at Fiji

	category 3, 4, and 5 wind speeds, which for (a) would be peak wind for a cyclone within the defined box and for (b) would be peak modelled wind speed within Macuata province
Defined Geographical Zone	a) Precisely defined box around area of interest, see Figure 3.1, outer limit of green (50km) box. b) Macuata province (on land, as PCRIC/AIR model doesn't include offshore wind speed reporting)
Covered Assets / Area	Coverage is for response and early recovery costs for reef clean- up and restoration, so coral reef itself is the covered asset (though a public good rather than individually held).

Policy Period	Likely to be most efficient when a multi-year (e.g. 3 years) transaction is completed, as administrative burden for annual renewals will be high relative to the likely size of risk transfer
Event	Any named Tropical Cyclone reported by the Reporting Agency on its public website
Covered Event	a) Any Event which has an Event Parameter with a Location within the Defined Geographical Zone b) Any Event which has an Event Parameter greater than zero within the Defined Geographical Zone
Reporting Agency	a) WMO-mandated cyclone reporting agency for area of interest; for Fiji, this is RSMC Nadi b) AIR Worldwide, via PCRIC and based on track and intensity data from the US Joint Typhoon Warning Center
Event Parameter	Maximum 10-minute sustained wind speed in km/h, rounded to the nearest whole number
Event Parameter Calculation	a) For each Event, the Calculation Agent will calculate the Event Parameter (10-minute sustained wind speed in km/h, rounded to the nearest whole number) continuously along the track. The track and peak wind speed data will be taken directly from any Public Advisory issued by the Reporting Agency for that event, each such node representing the start and end points of each track segment and will be calculated by linear extrapolation between the start and end points of each track segment b) Event Parameter is reported by AIR Worldwide, in its reporting to PCRIC, and is the highest 10-minute sustained wind speed in km/h, rounded to the nearest whole number, modelled within the Defined Geographical Area for a given Event
Eligible Event	A Covered Event which has an Eligible Event Date occurring within the Policy Period, subject to the following: Any Eligible Event may

	only comprise one single Covered Event, i.e. each named Cyclone is considered to be a separate Event
Eligible Event Date	The date on which the highest Event Parameter for the Eligible Event occurs
Triggering Event	An Eligible Event with a highest Event Parameter equal or greater than the Trigger Threshold
Trigger Threshold	10-minute sustained wind-speed of at least 118 km/h, but subject to change based on final trigger structure
Event Limit	FJD [500,000]
Aggregate Policy Limit	FJD [500,000]
Calculation Date	1800 UTC on the day following the date of the final Public Advisory issuance by the Reporting Agency for a Covered Event
Date Convention	A 24 hour period starting at 00.00.00 and ending at 23.59.59

<table>
<tr><td>Pay-out Percentage</td><td>Note that this trigger / pay-out structure is indicative only and would
be varied depending on the particular circumstances of the
coverage.
<table><tr><td>Category</td><td>Wind Speed (km/h)</td><td>% of Limit</td></tr><tr><td>3</td><td>118 – 158</td><td>30%</td></tr><tr><td>4</td><td>159 – 199</td><td>60%</td></tr><tr><td>5</td><td>>= 200</td><td>100%</td></tr></table></td></tr>
<tr><td>Claim Payment Amount</td><td>For each Triggering Event, the Claim Payment Amount will be equal
to the Event Pay-out Percentage multiplied by the Event Limit,
subject to the Aggregate Policy Limit</td></tr>
<tr><td>Claim Payment Date</td><td>For each Triggering Event, the Claim Payment Amount due under
this policy will be fully paid within [14] days of the Calculation Date,
subject to confirmation that the client has endured a loss</td></tr>
<tr><td>Calculation Agent</td><td>a) TBD, though Reporting Agency data is in the public domain and
highly accessible, so unlikely that independent party would be
needed
b) AIR Worldwide (AIR)</td></tr>
</table>

Table 3.3 Example Term Sheet for the proposed insurance product.

Potential pricing and use of funds

We are able to provide an indicative cost for Option (a) as described above, based on historical event counts and the three trigger levels (and consequent pay-out rates) stated in the term sheet, based on the highest category reached by a particular cyclone within the defined box, namely 30% pay-out for Category 3, 60% pay-out for Category 4 and 100% pay-out for Category 5.

We estimate that a parametric insurance policy could be purchased for a little less than 10%, annually, of the policy limit (maximum pay-out amount). For example, for FJD50,000 premium, coverage could be purchased which paid out FJD150,000 for a cyclone which reached Cat 3 level within the defined box, FJD300,000 for a Cat 4 cyclone and FJD500,000 for a Cat 5 cyclone within the box.

Final pay-out would likely be made subject to evidence of negative impacts on the reef from the relevant event, to meet the regulatory requirements for insurance. The regulator may also require formal constraints on the use of funds, although it is more likely that such constraints would be self-imposed, to ensure effective use of pay-outs and to help build out an evidence base for the value of early financing to aid reef recovery.

Detailed planning and budgeting for use of funds has not yet been considered for this case study; however, we are aware of a study in the Mesoamerican Reef area which will likely be in the public domain in the near future, which explores this matter in detail and can likely provide a solid starting point for “use of funds” work in the case of the GSR. The development of the pay-out use and distribution aspects of a pilot will be further discussed in the accompanying Guidance Document. Establishing the use of funds will also facilitate the customisation of the appropriate product limits and stepped trigger pay-out percentages.

3.1.3 Risk mitigation and financing impact

The GSR in the area of Macuata province provides a number of critical and valuable services to the coastal communities, including physical protection from waves and coastal flooding, and livelihood support through underpinning tourism and fisheries. As the global oceans warm, reefs are becoming inherently less resilient, and therefore require active intervention, when and where possible, to reduce the rate of resilience erosion and, even, to reverse it.

One case where active intervention is not only possible, but also known to be very valuable, is in reef clean-up and promotion of early recovery in the days to a few weeks after a cyclone impact. Raising funds in an ad hoc manner post-event for such activities is challenging, and parametric insurance is a proven mechanism for paying up-front for an obligation to finance, to a pre-agreed level which scales with the amount paid up-front (the premium), these early actions. In addition to providing the finance for these early actions, the *ex-ante* nature of insurance also facilitates contingency planning. The predictability of post-event funding—and the obligations enshrined in an insurance contract—incentivises, and even requires, the various stakeholders involved in the execution of post-event response to pre-plan and pre-agree arrangements for the speedy implementation of a timely and expected pay-out.

3.1.4 Feasibility assessment

The key barriers to transaction completion for a GSR reef insurance policy relate to the source of premium and the use and distribution of pay-outs (including the identification of the appropriate policy holder and necessary institutional arrangements for the execution of post-event response). For the former, initial support through grant funding as part of the broader GSR programme funding envelope would be highly advantageous, with sustainability of premium funding based on the shared benefits of an intact and healthy reef and mutual contributions from derived value across public and private sectors. For the latter, community engagement and organising of response strategies for post-cyclone reef clean-up and recovery enhancement can form an integral part of the GSR programme. These crucial next steps will be further discussed in the Guidance Document.

In Table 3.4 below, we provide a commentary on each of the six key feasibility criteria that we think most relevant to the deployment of a parametric insurance solution. Each is discussed further in the accompanying Guidance Document for this insurance product.

Feasibility Criteria	*Fiji GSR Case Study*
Legal and regulatory barriers	Insurance regulation in Fiji is undertaken by the Reserve Bank of Fiji (RBF), which has been very supportive of implementing innovative parametric insurance coverage in Fiji, so we do not view the reef insurance product as being problematic in terms of licensing. Identifying an appropriate legal entity to be the policy holder and therefore receive and manage use of pay-outs is likely to be more challenging, although the GSR project does include the setting up of a dedicated trust fund to support a range of activities, and

	other existing conservation trust funds may also be suitable. Alternatively, the Government could be the insured entity, although this would present some challenges.

Funding of premium	Within the GSR project framework, many actors have been brought together in the interests of conserving the GSR; many of those actors benefit in some way from the reef being healthy, and we envisage that the financial sustainability model for GSR should be able to support reef insurance once it has reached a mature state; in the meantime, grant support for insurance premiums is very likely to be required.
Suitable underwriting and settlement data availability	We have presented two options on the technical product design side, both of which are implementable immediately and with no additional data—though option (b) would require cooperation from PCRIC (which would be very beneficial anyway).
Risktransferpossible at acceptable technical price	PCRIC has established good access to the international markets for parametric cat risk, and both structure options are familiar to and will be fully diversifying for a number of markets, so we are confident that an attractive technical price can be obtained, although a small scale transaction is likely to be less competitively priced due to lower interest.
Effective use of pay-outs	This is the least-developed aspect of the proposed concept, at least for the GSR, although there are learnings available from elsewhere, and a strong project team in place along with established community engagement channels, so planning for use of pay-outs—and then execution of that plan when required, should be possible.
Unintended outcomes	We believe management of expectations is critical to help ensure that both the circumstances (i.e. scale of cyclone impact) which trigger pay-outs and the use of pay-out funds are fully understood.

Table 3.4 Discussion of key feasibility criteria for the GSR case study.

3.2 Concept 2: Cover for business interruption of the blue economy from carbon pollution

Island countries in the Pacific such as Palau continue to develop blue economy models, which are highly reliant on tourism revenue to underpin economic development. Such economies are necessarily undiversified and are highly susceptible to marine thermal stress events, which cause coral bleaching and mortality, as well as other ecological impacts (including jellyfish mortality in Jellyfish Lake, a major tourism site in Palau).

We note that marine thermal stress events also impact ecosystem services relevant to sectors and economic activity beyond tourism, for example, impairing natural assets' (such as coral reefs) risk reduction characteristics or potentially negatively impacting fisheries productivity. While it is possible that insurance products may be applicable to smooth financial volatility related to thermal stress impacts on these sectors, we have chosen to develop a business interruption cover for tourism in Palau as an initial concept, since the future negative impacts and their effects on the development of the Palauan economy and the prosperity and livelihoods of individuals, are so clear and direct. While it is relatively uncertain *exactly how* fisheries will be effected by climate change, and it is relatively difficult to translate an increase in physical coastal risk *specifically from thermal stress events* into nationwide economic impacts, the reliance of Palau's economic development and citizens' livelihoods and well-being on revenues related to marine tourism (and even more, directly related to the identified coverage area) is abundantly clear. Therefore, this concept details a product designed specifically to address those very direct economic impacts- from thermal stress events to widespread and severe negative economic impacts due to reduced tourism-related revenues.

Such thermal stress events are likely to increase in both frequency and severity as ocean warming continues due to carbon pollution, and parametric insurance based on one or more indices, which can detect with high accuracy and at high resolution thermal stress events, could be used to protect national, sub-national and / or private sector actors (including the conservation NGO sector) from the negative impacts of a reduction in revenue derived from tourism.

Palau, part of Micronesia located in the western Pacific just north of the equator, is an independent nation with a small land area spread across hundreds of islands and a very large ocean area. It has a high profile on the international stage as a result of its innovative approaches to conservation finance and is recognised as one of the countries most at risk from climate change.

The impacts of thermal stress events on the marine and coastal ecosystems of Palau are well documented, thanks in large part to the high number of internationally recognised research institutions and conservation organisations active in the country. The Palau International Coral Reef Center and the Coral Reef Research Foundation are two such institutions, which, alongside international collaborative partners, are undertaking research and monitoring of Palau's nearshore marine environment, with particular focuses on thermal stress events and resiliency in reef systems to such events and rehabilitation of coral reefs after stress events (including typhoon impacts).

There are a number of actors in Palau which could act as the insured party, passing benefits on to impacted individuals and communities and / or maintaining conservation investments. While use of funds and pay-out management / distribution is discussed further in the Guidance Document for this pilot, the following list outlines potential policy holders.

- At the national level, the government collects income and business taxes as well as sales tax, so sees a drop in revenue when tourism activity is diminished.
- The State of Koror provides services to a significant portion of Palau's population and is heavily reliant on user fees from the marine areas within its jurisdiction (namely Rock Islands Southern Lagoon and Jellyfish Lake, each of which requires an entry fee of USD50 for up to 10 days, with Jellyfish Lake requiring an additional USD50 fee for each entry)—when user fee revenue is reduced, basic services are hit hard.
- The Protected Areas Network (PAN) Fund coordinates and funds conservation activities across a large number of protected areas in all 12 of Palau's states, with the vast majority of its revenue coming from the Green Exit tax paid by all visitors to Palau. Although the PAN Fund holds a reserve to respond to shock events, thermal stress events tend to be widespread, so holding a sufficient reserve to respond appropriately to such events in the absence of ongoing revenue is challenging.
- Local conservation organisations suffer a substantial decline in income from both tourist donations and from local individuals and business contributions, so impacting significantly on their ability to maintain, let alone increase, conservation activities during and after thermal stress events. Such organisations do not have the capacity to hold funds in reserve for such eventualities. Local

branches of the large international conservation NGOs have the benefit of financial backstopping from overseas and so are not subject to the same acute pressures.

In terms of payment of premiums for this coverage, there is a very strong case to be made that polluting countries (those listed in Annex I to the UN-FCCC) should pay, given the direct causal link between carbon pollution and ocean warming, between ocean warming and more frequent and more severe marine thermal stress events, and between such thermal stress events and the economic health of Palau and its population.

Palau is already investing heavily in conservation efforts, more than meeting its obligations of stewardship of the global public goods within its territory, and it seems reasonable to ask polluting countries to pay premium for an objective insurance mechanism which pays out when thermal stress events occur.

In closing this introduction, we note that while Palau is already highly exposed to thermal stress events, the increasing focus on developing the blue economy across the Pacific will inevitably lead to increasing exposure of many other national economies to marine thermal stress events, so that this form of parametric insurance coverage is likely to be relevant for many of the POFP11 countries. As with other natural catastrophe events, pooling of this risk across the region, through a vehicle such as the Pacific Catastrophe Risk Insurance Company, would bring efficiencies in terms of financial risk management, and there would also be a stronger case for polluting countries to pay premium if the programme operated at the regional level (following suitable piloting in one or a few countries). While the Guidance Document for this product will focus on the requirements for the implementation of an initial pilot, it will also comment on potential regional risk pooling.

3.2.1 Ecological and social context

The small islands of the Pacific are particularly susceptible to the impacts of climate change and resulting increases in ocean risk, many of the effects of which will be chronic and slow-onset, rather than acute and immediate. Coral reefs are particularly susceptible to changes in ocean temperature, and many other marine ecosystems also suffer from heat stress, some dramatically.

As sea surface temperature (SST) rises along with surface atmospheric temperatures due to the greenhouse effect, more SST peaks, which happen seasonally and are enhanced by the El Niño Southern Oscillation (ENSO), are high-stress events for marine ecosystems. High heat stress leads to coral bleaching and, if sufficiently severe, widespread coral mortality. Other marine species also undergo mass mortality events due to extreme heat stress. Such events not only have a devastating ecological effect, they also impact significantly on island economies dependent on tourism; reduction in tourism revenue leads to economic hardship and, ultimately, reduced resilience.

We have identified Palau in Micronesia as an appropriate location to develop an insurance concept to help mitigate the impact of marine heat stress events on economic activity. Palau has a high profile in global climate change discussions due to its extreme vulnerability, and also in recognition of its own major investments in marine conservation over many decades. There is a very strong link in Palau between the economy (dominated by tourism and with an important fisheries component) and the health of the marine environment.

Within Palau, we have explored two potential applications of parametric insurance based on heat stress, both within the Rock Islands Southern Lagoon World Heritage Site. One targets coral bleaching, concentrating on Ngemelis Island Conservation Area (where the world-renowned Blue Corner reef is located), and the other targets jellyfish mortality within Ongeim'l Tketau, commonly known as Jellyfish Lake, a major tourist attraction.

Ngemelis Island

Known informally as the "underwater Serengeti" and home to the Blue Corner reef (which is usually rated in the top few dive sites in the world;[39] Figure 3.2), Ngemelis is the most frequented dive site in Micronesia. It is of critical importance to the Palauan economy in terms of the tourism value alone, let alone counting the other positive benefits the reef brings for fisheries, biodiversity, etc.

Figure 3.2 Blue Corner Reef, Ngemelis Island, one of the world's top dive sites.

Bleaching events in 1998, 2010 and, to a lesser extent, in 2016-18 significantly impacted the reef and therefore Palau's economy (although other macro-economic issues had larger effects in the most recent bleaching event due to ongoing issues around Chinese and Taiwanese tourist arrival numbers).

The conservation area around Ngemelis Island (Figure 3.3) is protected under Koror State law (K8-191-2007) which prohibits fishing at dive and snorkel sites.

39.e.g. https://www.scubatravel.co.uk/topdives.html; https://www.divein.com/articles/top-10-dive-sites-in-the-world/

Figure 3.3 The Ngemelis Conservation Area with Ngemelis Island in the mid-background.

Ongeim'l Tketau

OIT is a marine lake with a unique ecosystem due to its isolation from the main Rock Islands Southern Lagoon. The golden jellyfish is normally present in numbers of millions, and this along with their daily cross-lake migration, makes the lake a major tourist attraction. Access to the lake is carefully controlled and includes a substantial user fee which serves as a major revenue source for the Koror State government.

The first well-documented mass mortality event in Jellyfish Lake occurred in late-1998, when the entire jellyfish population died off over a few months (Dawson et al., 2001[40]). A die-off in 1987 was also known but poorly documented. Changes in the temperature profile and biochemistry of the lake are thought to have been the main contributing factor, almost certainly triggered by the strong ENSO event in 1998/99.

A further die-off started in 2016 and continued through to 2018, again coincident with an extended ENSO event.

Current scientific thinking is that high water temperatures and low rainfall, both associated with negative ENSO trough[41] and / or the year after a positive ENSO peak,[42] may both play a role in the mass mortality events.

40.Dawson, M.N., Martin, L.E. & Penland, L.K. 2001. Jellyfish swarms, tourists, and the Christ-child. Hydrobiologia 451: 131–144.
41.Martin, L.E., Dawson, M.N., Bell, L.J. & Colin, P.L. 2006. Marine lake ecosystem dynamics illustrate ENSO variation in the tropical western Pacific. Biol. Lett. 2, 144–147. doi:10.1098/rsbl.2005.0382
42.https://www.ncdc.noaa.gov/sites/default/files/attachments/Pacific-Region-El-Ni%C3%B1o-Impacts-and-Outlooks-Palau-2015.pdf

Figure 3.4 Jellyfish Lake, Rock Islands Southern Lagoon, Palau.[43]

Palau provides a strong contextual environment for implementing insurance solutions, both locally (e.g. Koror State government, national government or through conservation agencies such as the PAN Fund) and regionally (e.g. through PCRIC, potentially as a programme nurtured within the Pacific Island Climate Change Insurance Facility (PICCIF)).

Table 3.5 provides a summary of the key characteristics of the proposed insurance product.

Policy purpose	The purpose of the cover is to provide finance to replace lost revenue due to non-arrival of tourists—either due to decline in interest (e.g. in visiting bleached coral or an empty Jellyfish Lake) or due to closure of sites (to protect them from further stress). Drop in tourist revenue affects both State (particularly Koror State as they collect user fees for both Rock Islands Southern Lagoon, the main area in Palau for in-water tourism, and for Jellyfish Lake) and national (responsible for taxation on tourism industry profits and tourism wages and collection of the Green Exit Tax which provides resources to the PAN Fund) budgets.
Brief index description	Multiple indices will likely be required depending on final use case(s). A primary one will be a derivative of sea surface temperature based on the NOAA Coral Reef Watch SST dataset, which can detect thermal stress events at high spatial (5km) and temporal (daily) resolution. For the Jellyfish Lake use case, additional indices may be required, including one

	identifying low rainfall (likely the NASA Global Precipitation Mission dataset, or possibly NOAA ground station data) and one identifying ENSO signal focussed on the western Pacific.
Coverage area	Two areas are potentially covered in this pilot, one being Jellyfish Lake, a marine lake within the Rock Island Southern Lagoon, and the other being specific reef areas important for in-water tourism; here we use Ngemelis Island Conservation Area as the target area for coverage.

43.https://www.wondermondo.com/jellyfish-lake/

Index as proxy for 'loss'	Marine thermal stress events directly impact on tourism in Palau; tourism arrivals decline and user fee revenue drops significantly—potentially to zero in the case of closure of Jellyfish Lake. This drop in revenue affects the provision of basic services at State and national levels, as well as livelihoods of individuals. Ultimately, ongoing conservation efforts funded either directly (via PAN Fund and the Green Exit Tax) or indirectly (through budget allocations of government and through philanthropic contributions from businesses) suffer significantly too, at a time in which more, rather than less, conservation work is required.

Table 3.5 Summary characteristics of the proposed insurance product.

3.2.2 Product design and economic model

Palau boasts a high level of ongoing scientific study through local institutions such as the Coral Reef Research Foundation and the Palau International Coral Reef Center, which has led to very well-documented coral bleaching and Jellyfish mortality events attributed to short-term (days to weeks to a few months) peaks in SST which are, in turn, correlated with La Niña events (periods of highly negative ENSO index).

Measurements of SST at high temporal and spatial resolution are publicly available in real time, most notably through the Coral Reef Watch (CRW) programme of the US National Oceanographic and Atmospheric Administration (see Technical Annex 2 for further details on data retrieval and usage). Related scientific endeavours over many decades have led to an excellent record of past SSTs (although at lower resolution), and climate models resolve future changes in SST at the same resolution as the historical record, though with significant uncertainty related both to modelling uncertainty (i.e. incomplete scientific knowledge, challenges in downscaling, etc.) and to future carbon emissions, which is the dominant parameter controlling future SST forecasting.

Under the CRW programme, derivatives of satellite-based SST estimates at 5km spatial resolution and daily temporal resolution have been shown to be excellent proxies for coral bleaching events. In particular, the Degree Heating Weeks (DHW) metric has been developed to underpin a coral bleaching warning system, with DHW reflecting both the severity and duration of heat stress. We have therefore developed risk analytics for this pilot using DHW as the index to proxy impactful events at both sites, with pay-outs triggered to address loss of revenue from tourist user fees and / or general tourist arrivals.

As further highlighted below, DHW may be usefully adapted somewhat for the particular case of coral bleaching in Palau (noting that the 2016-18 event picked up in the DHW index was not a major bleaching event in Palau) and may be supplemented by a secondary trigger, possibly related to rainfall or regional ENSO signal, in the case of Jellyfish Lake golden jellyfish mortality.

Ngemelis Island

The area of interest is the conservation area itself, although SST characteristics from a 15km by 15km area (Figure 3.5) have been used to test different potential parametric index structures.

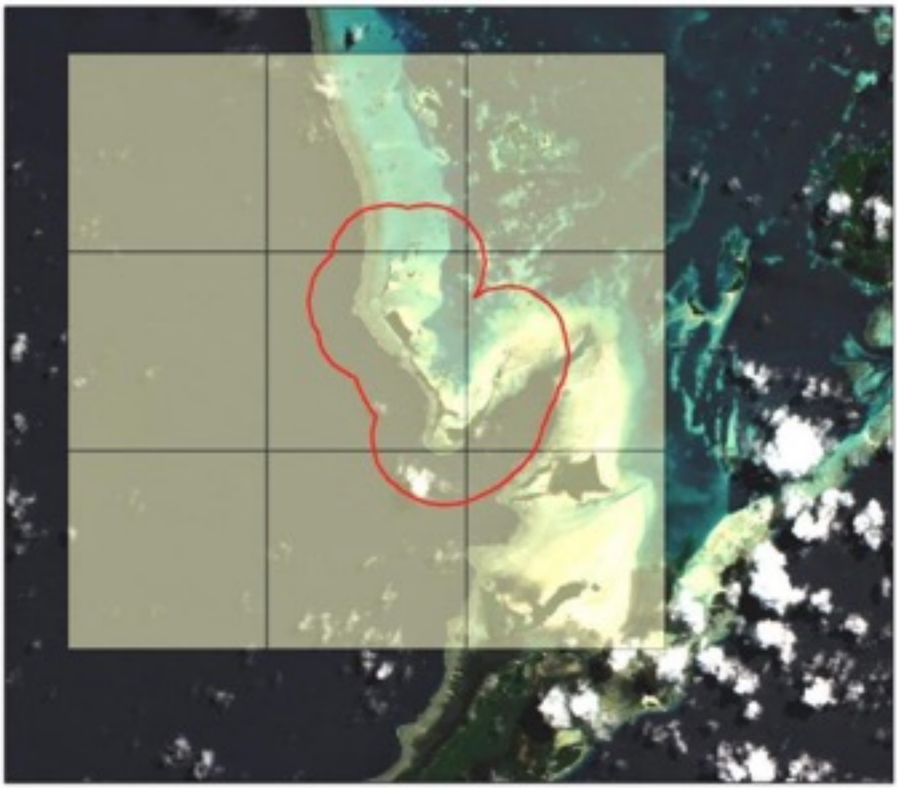

Figure 3.5 Map showing the conservation area and 5km grid cells representing the CRW data points available to act as the parametric index.

Figure 3.6 illustrates the behaviour of the DHW index since mid-1985—showing both the average daily DHW across all 9 cells around Ngemelis Island and the maximum DHW in any single cell of the 9.

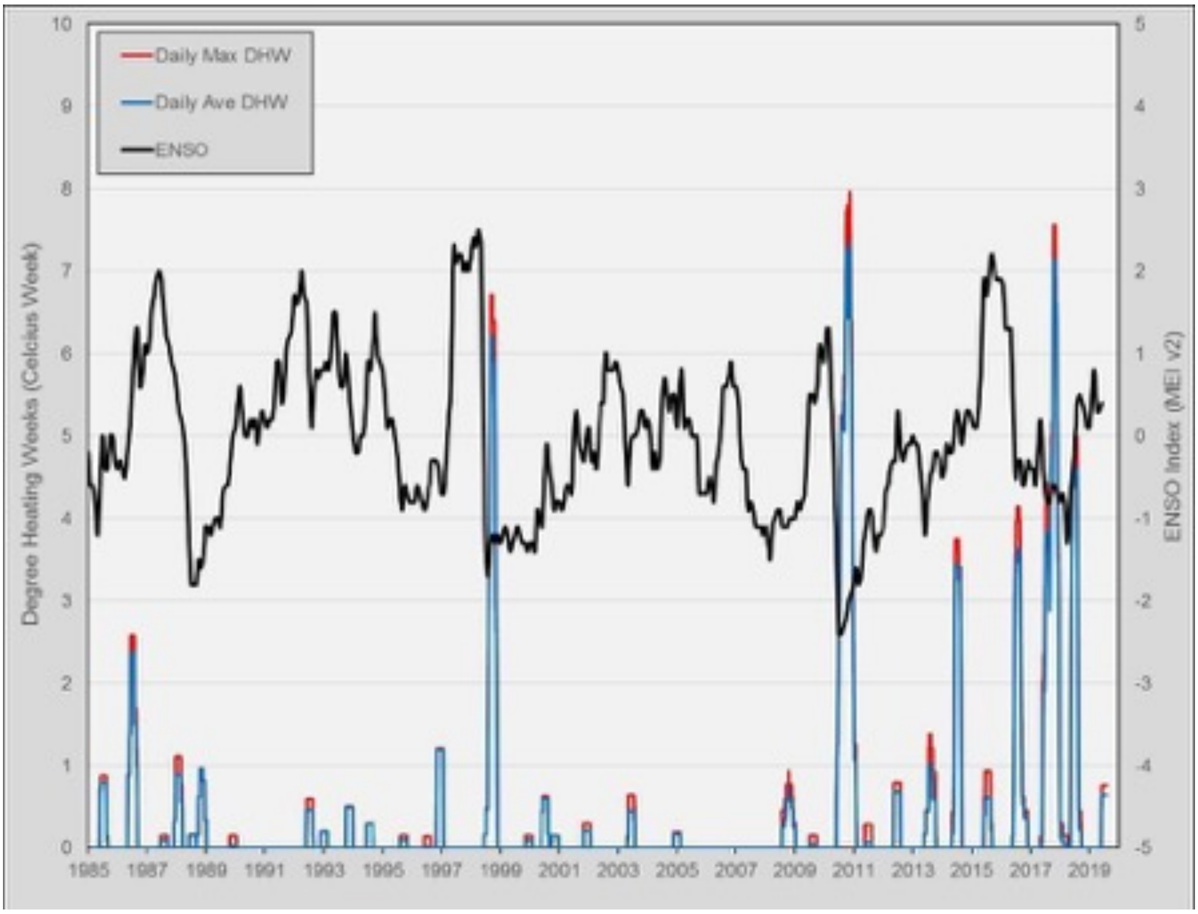

Figure 3.6 Plot of daily DHW since 1985; red is the maximum daily DHW across all 9 cells shown in Figure 4.1, and blue is the average daily DHW across those cells. The MEI v2 ENSO index is shown in black; strongly negative values are La Niña events. Significant coral bleaching usually occurs when the DHW value reaches 4 °C-weeks and by the time the DHW value reaches 8 °C-weeks, widespread bleaching is likely and significant coral mortality can be expected.

Table 3.6 tabulates three separate thermal stress measures from the CRW suite on an annual basis (noting that the annual period runs from 1 April so that peak thermal stress is mid-year): peak DHW for any cell of the 9 covering the area of interest, the number of days in the year with a DHW value in any of the 9 cells of 4 °C-weeks or higher, and the number of days in the year where the daily SST anomaly in at least one of the 9 cells is at +1 °C or above (referred to as the Hotspot value within the CRW data suite).

Year	Peak DHW	Days DHW>=4	Days HS>=1	Year	Peak DHW	Days DHW>=4	Days HS>=1
1985/86	0.87	0	5	2002/03	0.00	0	0
1986/87	2.58	0	15	2003/04	0.64	0	4
1987/88	1.11	0	8	2004/05	0.19	0	1
1988/89	0.97	0	7	2005/06	0.00	0	0
1989/90	0.15	0	1	2006/07	0.00	0	0
1990/91	0.00	0	0	2007/08	0.00	0	0
1991/92	0.00	0	0	2008/09	0.93	0	8
1992/93	0.60	0	5	2009/10	0.15	0	1
1993/94	0.51	0	3	2010/11	7.96	**155**	**85**
1994/95	0.30	0	2	2011/12	0.29	0	2
1995/96	0.15	0	1	2012/13	0.79	0	5
1996/97	1.21	0	8	2013/14	1.38	0	9
1997/98	0.00	0	0	2014/15	3.75	0	**21**
1998/99	6.71	**74**	**39**	2015/16	0.93	0	6
1999/00	0.15	0	1	2016/17	4.14	**27**	**30**
2000/01	0.63	0	5	2017/18	7.56	**143**	**78**
2001/02	0.30	0	2	2018/19	4.99	**70**	**27**

Table 3.6 Summary of CRW thermal stress indicators on an annual basis for the Ngemelis Island area. Years start on 1 April, so 1985/86 runs from 1 April 1985 to 31 March 1986 inclusive. Highest SSTs in Palau occur during the second half of the calendar year, usually peaking in October, so the data selection has been done such that peak bleaching events fall in the middle of the 12-month period.

Figure 3.6 and Table 3.6 clearly illustrate that the major bleaching index peaks in Palau are related to minimum ENSO index numbers (peak La Niña conditions), although the low ENSO index value in 1987/88 does not correlate with a high bleaching index value, and the bleaching index peaks from 2016 to 2018 do not contain either prolonged or a major peak of negative ENSO index.

In terms of correlation with known bleaching events, 1998 and 2010 correlate with documented bleaching episodes in Palau, while the 2016-2018 period did not result in significant bleaching. This suggests that DHW for Palau is an effective proxy for coral bleaching events, perhaps improved by modification in some way by a global or regional ENSO index. Other derivatives of the CRW data do not appear to do any better or worse than DHW in picking bleaching events.

Ongeim'l Tketau

Although still under scientific investigation, the causes of the golden jellyfish mortality events appear to be some combination of high lake temperatures (which, in turn, are closely connected to SST) and low rainfall, both of which are associated with La Niña conditions.

As illustrated below, while neither ENSO index, DHW, or low rainfall is a perfect proxy for jellyfish mortality events, a combination is likely to be suitable to form the basis for parametric insurance triggering for jellyfish mortality events

The CRW parameter grid square for the site is mainly over land and, while adjustments are made in NOAA processing, the SST is likely to not track exactly with the lake temperature—which is anyway different to the lagoon / ocean temperature when measured directly. Figure 3.7 illustrates the DHW index behaviour for the grid cell containing Jellyfish Lake.

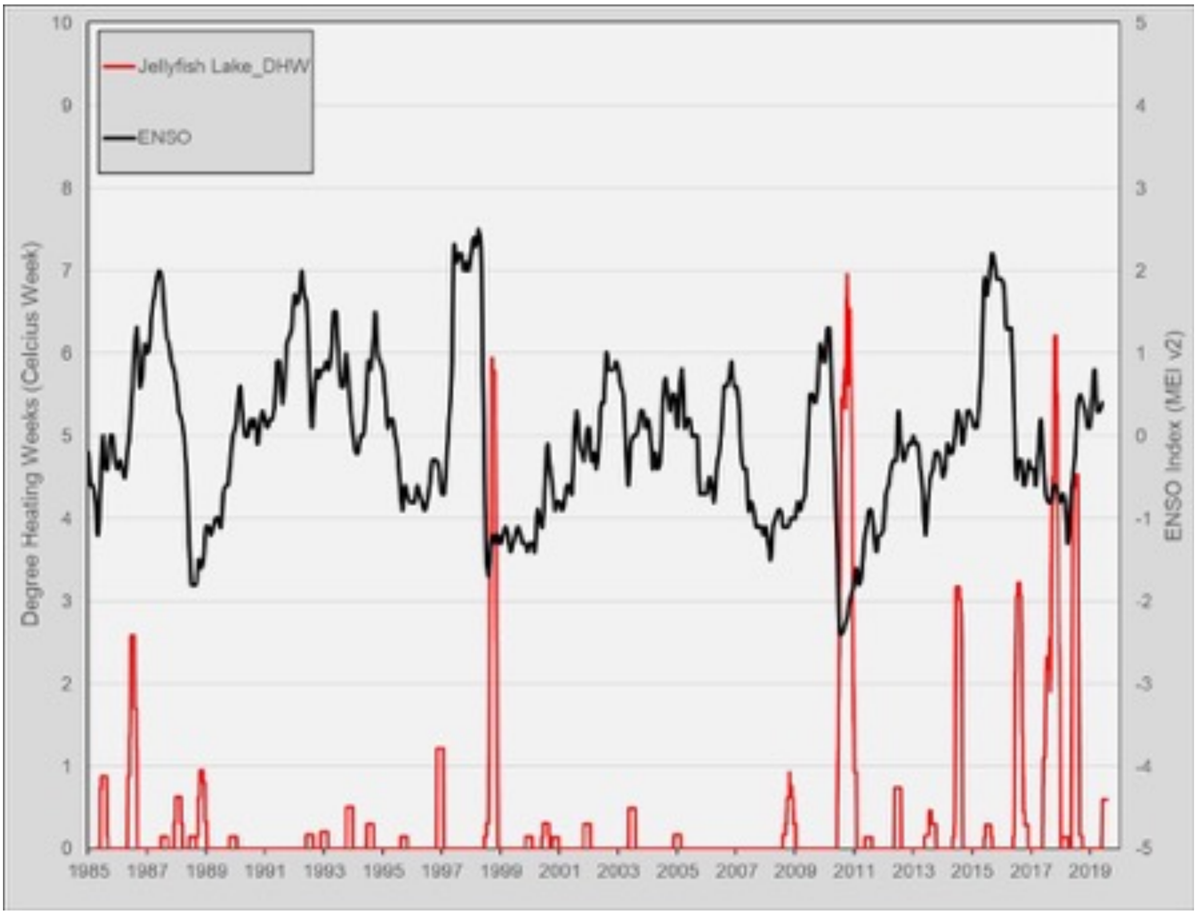

Figure 3.7 DHW for the CRW cell containing Jellyfish Lake, and ENSO index.

Table 3.7 tabulates the related indices of thermal stress in the same grid cell as DHW is plotted in Figure 3.7, for all years since 1985/86.

Year	*Peak DHW*	*Days DHW>=4*	*Days HS>=1*	*Year*	*Peak DHW*	*Days DHW>=4*	*Days HS>=1*
1985/86	0.88	0	5	2002/03	0.00	0	0
1986/87	2.58	0	15	2003/04	0.49	0	3
1987/88	0.63	0	5	2004/05	0.17	0	1
1988/89	0.95	0	7	2005/06	0.00	0	0
1989/90	0.15	0	1	2006/07	0.00	0	0
1990/91	0.00	0	0	2007/08	0.00	0	0
1991/92	0.00	0	0	2008/09	0.93	0	6
1992/93	0.21	0	2	2009/10	0.00	0	0
1993/94	0.51	0	3	2010/11	6.96	**148**	**71**
1994/95	0.30	0	2	2011/12	0.14	0	1
1995/96	0.15	0	1	2012/13	0.74	0	5
1996/97	1.22	0	7	2013/14	0.46	0	3
1997/98	0.00	0	0	2014/15	3.17	0	18
1998/99	5.94	**71**	**34**	2015/16	0.29	0	2
1999/00	0.15	0	1	2016/17	3.22	0	**22**
2000/01	0.31	0	3	2017/18	6.21	**76**	**51**
2001/02	0.30	0	2	2018/19	4.53	**66**	**25**

Table 3.7 Summary of CRW thermal stress indicators on an annual basis for the Jellyfish Lake cell. Years start on 1 April, so 1985/86 runs from 1 April 1985 to 31 March 1986 inclusive. Highest SSTs in Palau occur during the second half of the calendar year, usually peaking in October, so the data selection has been done such that peak bleaching events fall in the middle of the 12-month period.

As can be seen in Figure 3.7 and Table 3.7, DHW does not register the 1987/88 jellyfish mortality event, but it does register an event in 2010/11, which did not cause mass jellyfish mortality. The global ENSO index shown in Figure 4.3 does catch the 1987/88 mortality event but also gives a false positive for 2010/11.

As previously noted, periods of extreme low rainfall have also been postulated as a potential contributor to mortality events; it is notable that such droughts are generally associated with negative ENSO events. We have analysed rainfall data from two ground sites in Palau and the satellite-based GPM data from NASA and find that the data is sufficiently noisy that it does not appear to add value to the proxy over and above DHW and global ENSO.

Further work will be required to ascertain whether or not a rainfall signal can be a useful addition to the index; that work must include comparison with actual lake temperature and golden jellyfish mortality data, which is held by Koror State and which has not been obtained as part of the current project.

Table 3.8 presents a draft term sheet for this product; it is based on the Ngemelis Island use-case and is presented as a simple DHW index parametric.

Policy Name	Marine Thermal Stress Parametric Index
Policy Form	Parametric index
Buyer / Insured	Insured could be Koror State, national government, PAN Fund, or other conservation trust fund / entity Buyer (i.e. payer of premium) will be UN-FCCC Annex I countries
Seller / Insurer	TBD—this product would be highly innovative in terms of the need to forward model thermal stress events in a changing climate, so risk markets would need to be engaged at a very early stage, and only a few are likely to be willing to apply resources given the likely small size of the initial transaction
Structure	Binary or stepped trigger mechanism
Defined Geographical Zone	9 5km by 5km CRW cells encompassing the Ngemelis Island Conservation Area
Covered Assets / Area	Index is used as a proxy for severe thermal stress on coral reefs within the Conservation Area
Policy Period	Rolling multi-year coverage, at least 3 years, running from 1 April, with a year added to the end of the term after the first year of the term has passed—to ensure that ENSO signal is not influencing pricing and availability
Event	Marine thermal stress event as defined by the Degree Heating Weeks index (which is a derivative of the Sea Surface Temperature anomaly) produced by the Reporting Agency
Covered Event	Only one event can occur in any one annual period, and it is defined as the day on which the maximum DHW value across all 9 CRW cells of the Defined Geographical Zone for that annual period is achieved
Reporting Agency	US National Oceanographic and Atmospheric Administration, Coral Reef Watch programme

Event Parameter	Degree Heating Weeks (°C-weeks)—reported daily for each cell
Event Parameter Calculation	Maximum value of DHW achieved across the 9 cells of the Defined Geographical Zone within an annual term
Eligible Event	Maximum DHW at or above the trigger level
Eligible Event Date	Date on which the maximum DHW value occurs
Trigger Threshold	May be one or two trigger thresholds. Most simple form might put the DHW trigger threshold at 8, Another form might have an initial, smaller pay-out triggered at, say, DHW of 6 .5 or 7 with the full pay- out occurring at DHW of 8 upwards
Annual Policy Limit	TBD, depending on what entity is being covered. Likely range USD100,000 to USD500,000
Triggering Event Date	Final settlement process would need to be at year-end, but pay-out made based on a peak value during the policy period is possible as pay-out can only be higher
Date Convention	Day as defined by Reporting Agency. Policy period is year starting 1 April
Pay-out Percentage	TBD
Claim Payment Amount	TBD

Claim Payment Date	Potentially within a week or two of a DHW peak had been reached (based on some period of decline from a peak—though noting that DHW peaks are quite 'clean'), with an additional payment made if a subsequent higher trigger level is achieved later in the policy period
Calculation Agent	TBD, though Reporting Agency data is in the public domain and highly accessible, so unlikely that independent party would be needed

Table 3.8 Example Term Sheet for the proposed insurance product.

Potential pricing and use of funds

We have identified a significant challenge to operational testing of this concept, which is achieving an appropriate level of certainty around forward-looking risk analytics on SST and DHW to enable private markets to participate in risk-taking at an acceptable technical price. We believe that the case studies selected provide a unique opportunity to overcome this challenge, thereby unlocking a tool with great potential to support blue economy development across the Pacific.

We do not have the resources under the current project to fully investigate the potential for future modelling of thermal stress events; However, we are able to make the following relevant observations:

- The international scientific community continues to improve modelling of future oceanic and atmospheric conditions based on general circulation models (GCMs), with steady improvements in spatial and temporal resolution of future projection and increasing stability across models.
- However, despite this progress, the best SST data for future climate is more than an order of magnitude coarser in temporal and spatial resolution than the real-time and historical CRW data, creating significant challenges to using such datasets.
- For all models, and independent of resolution, the dominant driver of future SST is the carbon emissions pathway used to seed the climate model (Figure 3.8).

This last point highlights an interesting dynamic in this case study; market pricing of a parametric insurance policy using SST as the basis for the index will be dictated largely by the future emissions scenario, and will therefore be responsive to mitigation actions (or a lack thereof) in the medium to long-term. With the polluting countries paying the premium, what they pay will be dictated by their actions in curtailing carbon emissions, thus providing a positive, financial incentive to take action on mitigation.

Should a market-based pricing of risk not be acceptable to the Annex I countries, then their own capital could be set aside in a Trust Fund (with ongoing top-up to maintain the fund balance), with the same parametric rules dictating outflows from the Fund, bringing objectivity and discipline to the operations of the Fund. Additionally, by providing rules-based finance to initial pilot countries (of which Palau could be the first), the Fund could provide the mechanism by which to expand to support a regional portfolio, pooling risk across the Pacific island countries and, if it becomes financially efficient over time (e.g. with advances in climate science or international commitments on mitigation), potentially leveraging and securing its capital by transferring tail risk of severe events to international risk markets (potentially through PCRIC). This potential risk pooling will be further discussed in the Guidance Document.

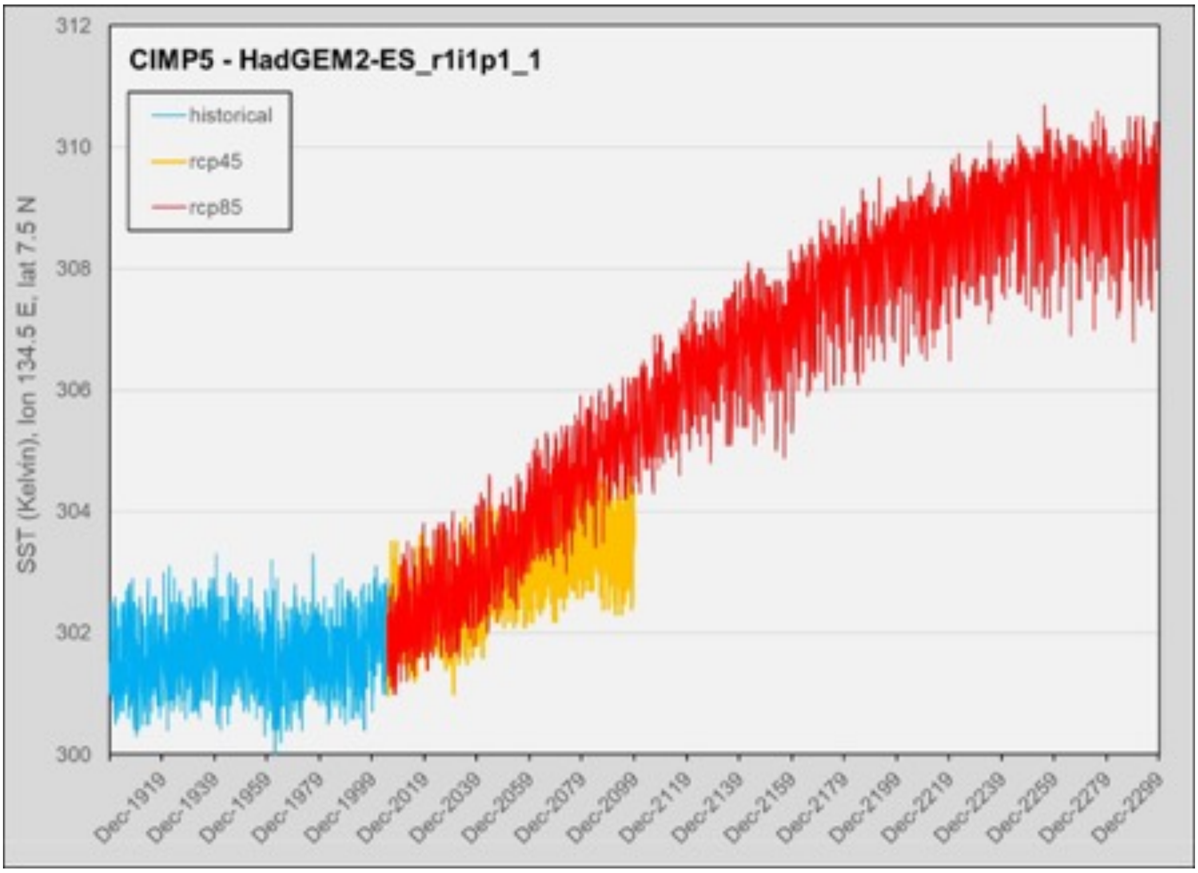

Figure 3.8 Illustration of the importance of emissions scenario selection in modelling of future SST. Data from the UK Met Office Hadley model, as part of the CIMP5 multi-model research programme of the IPCC.

In this case study design, with Annex I countries paying premium, use of pay-outs would require careful consideration. Assuming the structure is for replacement of a revenue stream from tourism to the public sector via a user fee or exit tax, then pay-outs could reasonably be used in the same way as the revenue from such user fees or exit tax is normally used. In Palau, the Green Exit Tax collected by the national government is attributed according to legal statute, with PAN Fund being a major beneficiary, with a purpose of investing in conservation. For Koror State, user fees go to general revenue, part of which funds the State's own conservation programmes—so again, a reasonable end-use for pay-outs would be for the same purpose as the user fees which are being replaced.

3.2.3 Risk mitigation and financing impact

As outlined above, for Palau, there is a very clear and direct connection between the health of marine ecosystems and the tourism-based economy. Insurance to protect against interruption of ongoing conservation programmes is inherently supportive of Pacific Ocean health, and the communities which rely on that health. While this concept does not directly address the resilience of coastal communities, filling a hole in the revenue stream to the State or national government enables the continued provision of critical services, rather than their interruption due to a budget shortfall.

The case studies we have identified are both protected areas under Koror State law (the State having jurisdiction over this part of the marine territory of Palau), and they are also within a World Heritage Site. Additionally, the proposed insurance concept provides for the continued pro-active management and conservation of these sites when they become stressed and tourist revenue declines or disappears altogether (for example, when the State closes Jellyfish Lake to prevent further ecological degradation).

Palau is at the forefront in the implementation of sustainable financing mechanisms to support conservation of the marine and coastal environment, and this product would directly complement these efforts.

3.2.4 Feasibility assessment

We note that this concept is highly innovative and will doubtless present significant challenges in implementation (which will be outlined and discussed in the Guidance Document). However, we believe that the use-case is highly compelling, and that testing the concept in Palau has the best chance of establishing the viability of risk transfer based on future SST estimates.

In Table 3.9 below, we provide a commentary on each of the six key feasibility criteria that we think most relevant to the deployment of a parametric insurance solution. Each is discussed further in the accompanying Guidance Document for this insurance product.

Feasibility Criteria	*Palau Case Study*
Legal and regulatory barriers	We do not believe that implementation of this parametric insurance solution would have additional legal or regulatory barriers relative to other parametric solutions.
Funding of premium	We believe that this product will only be viable if Annex I countries pay the premium. The "polluter pays" principle is well established under the UN-FCCC, and this policy allows for premium payments to be made on a regular basis while pay-outs would only occur when specific thermal stress events (which are inherently linked to carbon pollution) occur and lead to inevitable impacts on the economy of Palau and its ability to continue to provide services to its population, as well as stewardship of the marine environment (a benefit to the local population and global commons).
Suitable underwriting and	Settlement data is readily available, underwriting data requires

settlement data availability	significant work as the historical record is not a sufficient basis for pricing this risk. This is the most significant challenge in implementing this concept.
Risktransferpossible at acceptable technical price	The underwriting analytics and interaction with markets will be required before any idea about potential technical pricing can be formed. It should be noted that this concept does not necessarily require risk capital; the rules-based approach could be used to control pay-outs from a traditional source of capital such as a Trust Fund, if risk markets are unable to appropriately price the risk.

Effective use of pay-outs	Palau already has systems in place within its public sector to implement conservation programmes—so effective use of pay-outs should be achievable with little additional planning or operationalisation.
Unintended outcomes	While we believe this concept has the potential for wide applicability, it will need to be tested and proven appropriate both for the beneficiary and for the premium payer, and further use-cases will need to be carefully identified and developed. A key unintended outcome would be to have raised expectations that this approach could be a catch-all for climate risk in large ocean states.

Table 3.9 Discussion of key feasibility criteria for the Palau case study.

3.3 Concept 3: Insurance as reward

Preferential access to financial services, including insurance products, on a fully or partially subsidised basis, can be provided as a reward for improved compliance by artisanal fishers, for example by registering and tagging their boat, enabling monitoring of their catch, and agreeing to learn about and then follow safe and responsible fisheries management practices. This in turn incentivises environmental stewardship, supports sustainable fisheries, and increases the financial resilience of fishing communities.

Many small islands struggle to effectively execute fisheries management plans and sustainable fisheries policies due to difficulties in reaching, educating and monitoring artisanal fisherfolk. Most are outside of the formal financial services sector, lacking access to credit and having little or no financial resilience to shock events. Incentivising such small-scale fisherfolk to become part of the formal economy and follow best practice in fisheries management is potentially beneficial for a number of reasons and providing a basic financial service as incentive is far preferable to other options such as paying cash. Providing an insurance product as the reward immediately builds resilience and also represents progress on financial inclusion.

There are a number of options for insurance products which could be useful, including traditional products such as life insurance and boat and/or equipment insurance, as well as more innovative products such as parametric livelihood protection coverage.

Our case study area is Vanuatu, where the challenges described above have been recognised by officials in the Fisheries Department, especially in connection with an ongoing initiative to identify potential value-add options to incentivise the uptake of fishing licences. In this context, we believe the parametric livelihood protection insurance will be the most suitable insurance product to offer as reward for compliance, though we recognise that other insurance offerings might be more appropriate in other settings.

Note that this is the least developed of the three insurance concepts presented in this Report, given project resources. This is also partly because, while Vanuatu has been identified as a promising pilot country due to Government engagement, the overall concept is applicable and adaptable to every

POFP11 country and scalable as a regional programme. Additional considerations regarding the potential roll-out of a livelihood protection programme, besides government interest and support, include premium financing, local community interest in insurance, and local insurance infrastructure. The enabling profile for the development of a livelihood protection programme, as well as gaps in the current design and next steps toward implementation will be outlined in the accompanying Guidance Document.

3.3.1 Ecological and social context

Fisheries play a vital role in food security for the world's population and provide livelihoods to some of the poorest and most vulnerable communities. Yet fishing is a high-risk activity, with injury and loss of life all too common. Physical risks threaten assets such as boats, and volatile catch quantity and prices create high inter-annual income variability. Destructive or damaging fishing activities also threaten the very resource these communities rely on. Supporting a resilient and sustainable fisheries sector is a key pillar for prosperity and long-term ocean health, particularly in light of the negative impacts climate change is having on livelihoods.

Incentivising small-scale fisherfolk to register for fishing licences (and even install transponders on their vessels), participate in monitoring of catch volumes, and follow sustainable fishing practices, amongst other things, is a key element of implementing a sustainable fisheries policy, and provision of insurance as a reward, as well as providing a building block to greater financial inclusion (including potentially unlocking access to credit), has the additional benefit of providing some level of livelihood security when natural catastrophe events occur.

We have identified Vanuatu as a good example of where government is keen to get higher participation from artisanal fisherfolk in programmes aimed at implementation and monitoring of sustainable fishing practices. Our case study explores the provision of some basic level of livelihood protection, through parametric insurance against extreme climate events, by the government, not only to reward participation in government programme(s) but also to provide a platform for the expansion of insurance penetration by allowing individuals to purchase additional cover beyond that provided for free, potentially at subsidised rates up to a certain level.

In the event of a natural catastrophe event, the government assumes great responsibility in supporting low income communities, many of which are reliant on subsistence fishing. By providing insurance and inviting the topping up of that insurance by individuals, the government is both bringing discipline to its own management of natural catastrophe risk (and the duties of care and contingent liabilities it holds) and enabling individuals and communities to pick up some of the risk burden themselves.

Table 3.10 summarises the key characteristics of the proposed livelihood protection product.

Policy purpose	Livelihood Protection Policy—a "shock absorber" for individuals in order to help them cope with losses related to cyclones and excess rain events. Offered at basic level as reward for certain actions by fisherfolk, but open to be expanded through purchase of additional "blocks" of insurance which may be subsidised or may be available at full cost.
Brief index description	Two indices will be used, one based on cyclone wind speed (as a proxy for intensity and therefore impact) and the other based on satellite rainfall data.

Coverage area	Each policy will be tagged to a specific geographical area, across which the index will be reasonably consistent. In the case of Vanuatu, this may be individual islands or administrative divisions on the bigger islands.
Index as proxy for 'loss'	The index is intensity of the event in a particular area, which broadly correlates with impacts and losses, including to physical assets as well as to income from paid activities, which are impacted by a climate shock event (e.g. reduction in opportunistic earnings from tourism servicing, fishing, or agricultural activities).

Table 3.10 Summary characteristics of the proposed insurance product.

3.3.2 Product design and economic model

Vanuatu is prone to many different types of extreme weather events, all of which impact the population and their livelihoods. Most important among these for fishers and other coastal zone communities are cyclones and heavy rain events (noting that drought events are equally important for farmers, but not for fishers). The livelihood protection coverage proposed in this case study uses indices of cyclone intensity (through wind speed) and rainfall amount (daily peak rainfall), measured across a geographical area consistent with the scale of data available and the distribution of land areas in Vanuatu.

An individual index for each peril is available for each geographical area (comprising individual islands with close neighbouring islands, with some subdivision for larger islands). Because the risk profile is different for each area, a mechanism in which the value of the metric (peak wind speed or 1-day rainfall) at a fixed return period is used to define pay-out triggers. This enables the pricing of the insurance product to be constant across all of the regions, ensuring equity in terms of the provision of the base coverage by the government and also greatly reducing the administrative burden for additional "blocks" of insurance purchased by individuals to top-up coverage.

While the precise structure of the triggers will need to be refined via input from both the government and beneficiaries (which is discussed in the Guidance Document for this product), we envisage three or four trigger levels, enabling small pay-outs for smaller events which are likely to happen relatively frequently, and progressively larger pay-outs for more intense events, such that the total coverage limit could be paid-out for a single large event or for several smaller events in the same annual policy period.

This form of insurance contract allows upscaling in a straightforward manner; "blocks" of coverage can be purchased for a fixed premium, and each provides pay-outs at the same trigger levels. So, if an individual (or head of household) purchases one additional block to the one provided for free, perhaps at a subsidised rate to incentivise scaling up of protection, the pay-out will be doubled at each trigger level.

We envisage administrative processes to be embedded within the private sector, with PCRIC potentially able to reinsure the primary insurance company issuing the policies or directly insure the government for the first "block" of insurance for each individual. The process needs to be scalable and able to accommodate direct purchase of top-up coverage by individuals alongside the main government-

purchased coverage. The next steps regarding product implementation and administration are discussed in the Guidance Document.

Table 3.11 presents a draft term sheet for this product.

Policy Name	Livelihood Protection Cover
Policy Form	Parametric micro-insurance with indices for cyclone and extreme rain perils
Buyer / Insured	Artisanal fisherfolk, first “block” provided as reward for compliance activities, subsequent blocks available for subsidised or full premium
Seller / Insurer	Local insurer would issue and administer policies, with risk ultimately held by PCRIC or reinsurance markets
Structure	Parametric index, with several trigger steps at fixed return periods so that pricing is uniform across all areas (including, potentially, different countries)
Defined Geographical Zone	Each policy will be tagged to a specific geographical area, and triggers will be specific to that area
Covered Assets / Area	No requirement for specific assets to be listed; payment is automatic once trigger is met, use of funds is at the discretion of the Insured
Policy Period	Annual
Event	Named cyclone in area of Vanuatu, peak 24-hour rainfall
Covered Event	Event which produces windspeed and / or rainfall amount at or above the minimum trigger threshold in the relevant geographical area
Reporting Agency	For cyclone—AIR Worldwide, via PCRIC and based on track and intensity data from the US Joint Typhoon Warning Center For rain—NASA Global Precipitation Mission data
Event Parameter	For cyclone—Maximum 10-minute sustained wind speed in km/h For rain—peak 24-hour rainfall amount in mm

Event Parameter Calculation	For cyclone—Event Parameter is reported by AIR Worldwide, it its reporting to PCRIC, and is the highest 10-minute sustained wind speed in km/h, rounded to the nearest whole number, modelled within the Defined Geographical Area for a given Event For rain—Event Parameter will be calculated by external agent (TBD) based on GPM data but continuously aggregated to identify individual rainfall events and the highest 24-hour rainfall amount, on a running aggregate basis, for the event
Eligible Event	A Covered Event which has an Eligible Event Date occurring within the Policy Period, subject to the following: Any Eligible Event may only comprise one single Covered Event, i.e. each named Cyclone is considered to be a separate Event, and likewise rainfall events
Eligible Event Date	The date on which the highest Event Parameter for the Eligible Event occurs
Triggering Event	An Eligible Event with a highest Event Parameter equal or greater than the Trigger Threshold
Trigger Threshold	For cyclone—10-minute sustained wind-speed of at least 115 km/h For rain—peak 24-hour aggregate rainfall of at least 190 mm Both subject to change based on final trigger structure

Event Limit	TBD, same limit for both cyclone and rainfall events—if both trigger then highest pay-out between the two applies (not both)
Aggregate Policy Limit	TBD, shared between cyclone and rain
Triggering Event Date	For cyclone—1800 UTC on the day following the date of the final Public Advisory issuance by the Reporting Agency for a Covered Event For rain—the end of the 24-hour period which is the peak 24-hour aggregate rainfall period for a specific rainfall event
Date Convention	A 24-hour period starting at 00.00.00 and ending at 23.59.59
Pay-out Percentage	Note that this trigger / pay-out structure is indicative only and should be further refined / confirmed.

Wind Triggers

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Trigger Level	Payout amount (% of limit)	Wind Spd (km/h) Port Vila, Efate	Wind Spd (km/h) Luganville, Espiritu Santo	Wind Spd (km/h) Sola, Vanua Lava
10-yr RP	10%	115	121	119
30-yr **RP**	20%	128	132	130
75-yr RP	40**%**	160	164	162
100-yr RP	**100%**	210	219	215

Rain Triggers

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Trigger Level	Payout amount (% of limit)	24-hr Rainfall (mm) Port Vila, Efate	24-hr Rainfall (mm) Luganville, Espiritu Santo	24-hr Rainfall (mm) Sola, Vanua Lava
7-yr RP	**10%**	**195**	190	201
20-yr RP	**30%**	**253**	**242**	265
50-yr RP	**100%**	**312**	**298**	324

Claim Payment Amount	Pay-out Percentage multiplied by the Event Limit, subject to the Aggregate Limit
Claim Payment Date	Notification of pay-out eligibility should be available and can be sent out automatically within 3-5 days of an event, with payment occurring within one to two weeks
Calculation Agent	For cyclone—AIR Worldwide For rain—TBD

Table 3.11 Example Term Sheet for the proposed insurance product.

The conceptual model for this insurance product is shown in Figure 3.9. Access to the insurance product and financial support for some base level of coverage is provided by the government (through the relevant ministry) in return for adherence to fishing policies, monitoring activities, etc. Premium is paid by the government (for the base level of coverage) and may also be paid by the individual (for additional coverage) to the insurer that underwrites the risk and issues / administers the policies. The insurer may or may not participate as a risk-taker; if not, the insurance programme would need to be reinsured via PCRIC or the international markets. Each policy is attributed to a geographical area, and triggers are set such that each area has an equal probability of suffering an event at each trigger level. Relevant data sources (i.e. the PCRIC wind model for cyclone and the NASA Global Precipitation Mission data for rainfall) are constantly monitored, and once a trigger threshold is met, notification is provided to the policy holders, and pay-outs are available within a few days, which can be distributed in a variety of ways (preferably linked to other financial services such as banking).

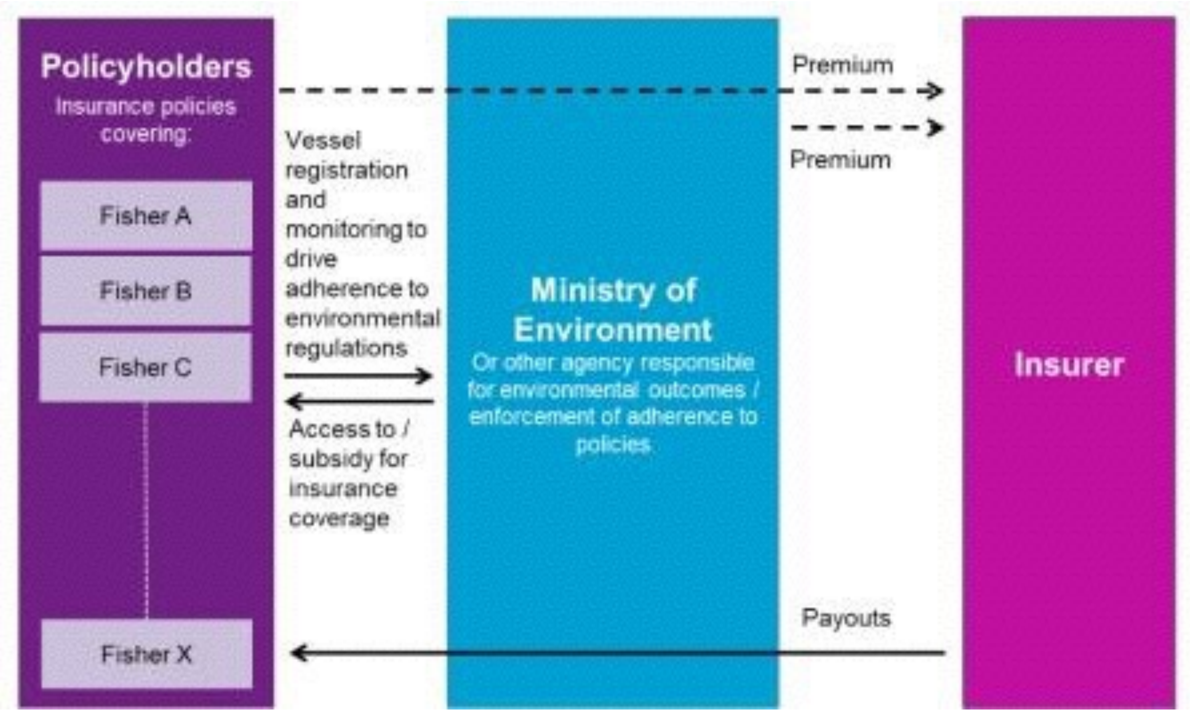

Figure 3.9 Conceptual model of the parametric climate risk insurance product provided as a reward to fisherfolk.

Potential pricing and use of funds

For the trigger thresholds (stated as a return period) and pay-out rates stated in the Term Sheet, the cost of a policy covering both wind and rain would be a little less than 10% rate-on-line, so for each coverage "block" of, say, VUV 25,000, the annual premium would be around VUV 2,500. This rate can be directly varied by adjusting the trigger thresholds and / or pay-out rates, but it is also subject to variability due to final administrative costs, which will depend on the overall scale of the product distribution (noting that a larger number of policies and a broader range of geographies both tend to lower the cost for each individual policy).

To reduce operational costs and increase efficiency, we suggest that the product utilises mobile technology to:

- Deliver pay-outs quickly via mobile money or via a notification that the pay-out can be collected from a pre-agreed financial institution; and
- Deliver early warning messages and preparedness advice, thus helping policy holders to minimise impacts, meaning in turn that any insurance pay-out will go further towards rebuilding livelihoods.

We do not envisage any controls on use of funds from pay-outs—the assumption is that covered persons will be impacted in some way when a triggering event occurs, and the value of quick payment would be lost if use of funds is restricted.

3.3.3 Risk mitigation and financing impact

This concept addresses both risk to Pacific Ocean health and climate resilience of coastal communities. Implementation of sustainable fishing practices, which directly enhance ocean health, is enabled through bringing artisanal fisherfolk into the formal economy and into compliance with management and policies which underpin sustainable fisheries management. Additionally, through the provision of insurance coverage, participating small-scale fisherfolk and, therefore, their communities have increased resilience to climate shock events, as well as the opportunity to build that resilience through purchasing more insurance and through accessing other financial services which were previously unavailable to them.

This concept does not address the generation of financial capital for marine protected or managed areas in particular, although the financial incentivisation of enhanced compliance by artisanal fisherfolk should reduce or eliminate unwanted fishing activities in MPAs.

3.3.4 Feasibility assessment

In Table 3.12, we provide a commentary on each of the six key feasibility criteria that we think most relevant to the deployment of a parametric insurance solution. Each of these is further discussed in the Guidance Document for this proposed insurance programme.

Feasibility Criteria	*Vanuatu Case Study*
Legal and regulatory barriers	Local legal and regulatory infrastructure in Vanuatu should be sufficient to enable this product to be made available relatively quickly, once a local insurer is identified to be the primary carrier and administrator.
Funding of premium	We envisage funding of premium by government, in return for initial and ongoing compliance by recipients to specific measures designed to improve sustainability of fisheries and ocean / coastal health. We note that the Government of Vanuatu will likely require premium support from international donors; due to the climate adaptation elements of the proposed livelihood protection programme, as it increases the financial resilience of vulnerable households to adverse climate shock events, there is a case to be made for international climate finance support. Availability of some base level of coverage may also be linked to provision of

	other financial services, enabling documentation of catch value and establishment of a financial history. This in turn can unlock access to credit and a virtuous cycle in which payment of insurance premiums, as a resilience investment by individuals, becomes the norm.

Suitable underwriting and settlement data availability	Several data options for wind product design are already available, one based on historical track and intensity data and the other based on the PCRIC wind model (which would require the involvement of PCRIC in some way, or sub-licensing of the model from PCRIC). For rainfall, we propose to utilise NASA Global Precipitation Mission data, which is freely available in real time for triggering, and is also available for 19 years or so of history, enabling underwriting to be undertaken to standards expected by global climate risk transfer markets.
Risktransferpossible at acceptable technical price	By using the parametric form of insurance, and by utilising primary data sources for hazards which are known to be acceptable to global climate risk transfer markets, we are confident that good technical pricing can be achieved. However, we caution that scale may be a barrier to achieving best possible pricing for two reasons. One is that the administrative costs for the local insurer, associated with product distribution and policy management, will be relatively higher the smaller the scale of the programme. There other is that relatively fewer markets will be interested in underwriting very small volumes of risk, particularly if there are no existing relationships between domestic insurer(s) and the global reinsurance market. Best pricing is therefore likely to be achieved by using a domestic insurer already connected to the global risk markets and / or involving the regional risk pool, PCRIC, in the transaction to bring scale and regional diversification.
Effective use of pay-outs	This product is envisaged as being distributed as a reward for sustainable behaviour, and that behaviour would need to be established and monitored to allow access to the product. Restricting the use of pay-outs might diminish the value of the

	product to the covered individuals, would almost certainly delay use of funds so impacting on their value as livelihood protection, and would also require ongoing monitoring, which would add significantly to cost. We propose, instead, that a softer approach is used, such that wise use of pay-outs is encouraged through broader capacity building around financial inclusion and use of financial services and products.
Unintended outcomes	As with all parametric products, basis risk is present, which can lead to either no payment when there has been some impact to an individual due to a climate event or to a payment when there has been little or no impact. Given that the triggering of parametric products is fully objective and based on the intensity of the hazard, basis risk at the individual level can be the reasonable result of better—or worse—risk reduction behaviour in the face of either general or specific capacity building and / or warnings. In such cases, the outcomes are actually intended, and can be used for peer learning. In other cases, basis risk, both positive and negative, will need to be managed through ongoing capacity building at the community level, alongside a cycle of product improvement which needs to be an integral part of the insurance programme.

Table 3.12 Discussion of key feasibility criteria for the Vanuatu case study

4. Guidance Document Report

In this guidance document, we provide recommendations and next steps to implement each of the three potential insurance product concepts detailed in the Risk Report and Concept Design Report. While these next steps will focus primarily on the implementation of the three specific use-cases in each respective location—Fiji, Palau, and Vanuatu—previously identified, we wish to emphasise that all three concepts have potential utility broadly across most, if not all of, the POFP11 countries.[44] Therefore, recommendations will also apply to next steps more generally, as they could be pursued more broadly across the Pacific at the country or regional level.

The following report elaborates next steps and requirements for each concept regarding:

- Data modelling;
- Research;
- Policy;
- Partnerships;
- Marketing; and
- Stakeholder awareness.

4.1 Concept 1: Parametric Insurance for Blue Infrastructure

The pilot use-case developed for the 'parametric insurance for blue infrastructure' concept is a parametric cyclone insurance for the Great Sea Reef (GSR) in Fiji. There are two options regarding the deployment of this cover presented in the Concept Design report, and the following Guidance Note will outline the next steps required to implement an insurance policy.

4.1.1 Next Steps and Requirements

This concept, using established parametric insurance concepts to capture risk of damage to coral reefs from cyclones, is far advanced. As detailed in the feasibility analysis for this concept, implementation of a parametric insurance policy covering cyclone damage to the GSR would have little to no legal or regulatory barriers, and there is sufficient data to support product underwriting and settlement, making a product immediately deployable from a technical perspective. However, more extensive work is needed regarding the source of premium finance and the use and distribution of pay-outs, which will largely depend on building out the partnerships and stakeholder awareness required to i) make the case for the use of insurance for blue infrastructure in the first place; and ii) develop the necessary institutional

44. The datasets underpinning the insurance product designs are available at the same resolution and quality, both historically and in real time, across the entire POFP11 set of countries.

arrangements with an appropriate policy holder to allow for the financial flows of the insurance contract and for planning and execution of post-event response (i.e. utilising the pay-outs).

Specific next steps will fall into two categories, depending on whether action is required on the demand or supply side of insurance product implementation.

- Actions on the demand side of an insurance product covering the GSR will be taken by the end-user(s) of the financial instrument, and roles here include:
  - The policy holder;
  - The source of premium finance; and
  - The beneficiaries of pay-outs.
- Actions on the supply side of an insurance product covering the GSR, on the other hand, will be taken by the sellers / insurance industry and roles here include:
  - Risk advisors;
  - Insurance intermediaries / brokers; and
  - Insurers / risk takers.

Considering both the demand and supply sides of the proposed product, next steps regarding the final design and placement of an insurance policy covering the cyclone risk to the GSR are described according to research and data modelling, policy, partnerships, marketing, and stakeholder awareness requirements.

Research and Data Modelling

On the demand side, additional research and data modelling is needed to finalise the coverage requirements and product structure.

Specifically, a greater understanding and definition of the costs of post-cyclone response activities on the GSR is needed in order to determine the ideal coverage parameters (i.e. the policy and event limits and trigger / pay-out structure).

The following research is required to determine the cost of emergency response on the GSR following a cyclone in order to quantify the appropriate amount of coverage and pay-out formula associated with various cyclone intensities / trigger parameters:

- Describe reef damages caused by cyclones at stepped impact categories (i.e. various storm intensity thresholds, e.g. category 3, 4, and 5);
- Determine response activities at each level of impact category; and
- Determine the cost of response activities at each level of impact category.

This research would allow the following cost matrix to be completed:

Storm severity / reef damage category	Response activities	Cost of response activities
Category 3 cyclone / moderate reef damage	Rapid assessment of damages	
	Primary response	
	Total = A	***A / C = Percent of event limit paid-out at this trigger threshold***
Category 4 cyclone / intermediate reef damage	Rapid assessment of damages	
	Primary response	
	Total = B	***B / C = Percent of event limit paid-out at this trigger threshold***
Category 5 cyclone / severe reef damage	Rapid assessment of damages	
	Primary response	
	Total = C	***C = Event Limit, which would be paid-out at this trigger threshold***

Table 4.1 Cost matrix for reef damage response, used to set insurance product event limit and pay-out formula / trigger structure.

The event limit would then be set in accordance with the cost of response at the severe level of impact category (***C*** in Table 4.1). Then the pay-out formula would be set according to the relative cost of response at the various impact categories. So, the stepped trigger thresholds at the various impact categories would be structured to pay-out a percentage of the event limit as represented in Table 4.1. Further, the policy limit would be set based on the likelihood of multiple triggering events over the policy period and the cost of a second or further response(s).

It is worth noting one more area of research, which, while not strictly required to implement a reef insurance product, would add to the credibility regarding the use of reef insurance in general.

Additional research building the evidence base around the effectiveness of early response to aid reef recovery and deliver positive benefits to reef health would help build the case for, and therefore encourage the uptake of, the financial mechanisms (i.e. insurance products), which can provide timely and predictable funding for these response activities.

On the supply side, the Concept Design report (and accompanying technical annexes) presents two options for technical product design, both of which require no additional research or data modelling for the placement of an insurance policy with risk markets.

The research regarding cyclone hazard, and especially the probabilistic understanding of the risk of events, in Fiji is well accepted by the scientific community and insurance industry alike. Further, the pricing and claims settlement for the proposed product rely on primary data sources for cyclone hazard that are known to be acceptable to global climate risk transfer markets. It should be noted, though, that one of the approaches uses data which is held within PCRIC, the regional catastrophe risk pooling mechanism, and could not proceed without PCRIC's permission.

Policy

On the supply side, as stated in the Concept Design Report, regulatory authorisation for the proposed product is likely to be straightforward.

Insurance regulation in Fiji is undertaken by the Reserve Bank of Fiji (RBF), which has been very supportive of implementing innovative parametric insurance coverage in Fiji, so we do not view the reef insurance product as being problematic in terms of licensing. Next steps will require engagement with the RBF, however, to confirm.

Where policy is less advanced, however, is on the demand side, where a next step is needed to integrate natural infrastructure into regional, national, and sub-national level risk management strategies.

Because existing disaster risk management policies and frameworks do not recognise the value of natural assets as public infrastructure in need of both ongoing maintenance as well as restoration following damaging events, they are often overlooked in post-event response. Therefore, exacerbating the cyclone-driven threat to reefs and dependent populations, the lack of contingency plans and clear emergency response protocols hinders communities' ability to implement activities which could repair / restore their reefs. It is crucial that as the climate resilience of hard infrastructure is developed in Fiji, blue and green infrastructure is a part of that discussion. Just like grey public infrastructure, it is imperative that coral reefs be understood as valuable infrastructure assets and embedded in Fiji's broader risk management strategy, supported by financial planning.

While insurance for the GSR could be implemented by the public sector, conservation organisations, and/or communities outside of developments in the wider policy environment in Fiji and the Pacific, it will be much stronger if integrated into broader policy focusing on the climate resilience of Fiji and its communities. Therefore, to support the inclusion of the GSR in the comprehensive risk management strategies of Fiji (or indeed reefs in general in the climate risk policies across the Pacific region), the development and implementation of policies and/or legislation to include the GSR, or blue infrastructure such as reefs and mangroves in general, in national or regional level climate risk assessments and response protocols should be explored.

At the regional and country levels there are no specific policies or regulatory frameworks that indicate that funds may be available for reef restoration. There are some sources of funding that could potentially be used for reef restoration following industrial events such as ship groundings or oil spills, and natural events such as storms that include ongoing projects funded by multilateral organisations and the national environmental funds, but funding restoration is not mandatory. In addition, legislation that restricts spending of funds derived from damages to reefs for restoration is, to our knowledge either non-existent or insufficient. Consequently, funds are 'lost' in the General Treasury at the expense of ecosystems and coastal security. Regulations and administrative procedures that protect and track funds intended for conservation are also insufficient and are sometimes ignored.

Additionally, and more specifically, we recommend the development and implementation of a specific climate risk management framework for the GSR as a next step to complement any potential implementation of this insurance concept. This climate risk management framework should include policies such as local response protocols, guidelines / regulations for reef response and restoration actions, and the financial planning required to fund those activities (which could include insurance), all of which could be implemented through partnerships discussed in the next section.

Partnerships

On the demand side, an appropriate policy holder of the insurance must be confirmed, and partnerships should be established to collect and aggregate premium finance and form the institutional arrangements required for the effective management of pay-outs.

Partnerships between the national and sub-national level agencies, institutions, and departments responsible for the conservation, maintenance, and restoration of the GSR, as well as local communities, will be critical in the implementation of an insurance product. We are aware that the GSR is the focus of a major initiative led by WWF Pacific in collaboration with the Government of Fiji, which aims to bring a systems approach to effective management of the marine and terrestrial environments that impact the reef. The partnerships developed under this programme are likely to intersect with the partnerships required for the implementation of this insurance concept.

The identification of an appropriate policy holder for the proposed reef insurance is a necessary next step in the implementation of this concept. There is currently no single institution which can immediately act as the policy holder; therefore, there is no organising force to align all of the additional partnerships necessary for product implementation. The policy holder should be the entity responsible for coordinating the reef response, and therefore the implementation of the activities funded by potential pay-outs. This could be a government department such as the Ministry of Environment, a not-for-profit conservation NGO, and / or a national, local, or community organisation. The Fiji Locally Managed Marine Area (FLMMA) network could be a potential partner as policy holder, and engagement with FLMMA should be pursued.

Regarding premium finance, initial support through grant funding as part of the broader GSR programme funding envelope would be highly advantageous, with sustainability of premium funding based on the shared benefits of an intact and healthy reef and mutual contributions from derived value across public and private sectors. In the long term, partnerships between beneficiary groups of the reef should be formed to finance the cost of cyclone risk to the GSR (by contributing to insurance premiums), which is also a risk to the beneficiaries. These beneficiary partners are in the public and private sectors, including the local coastal communities. Engagement with the tourism and fishing industries will be critical in identifying potential private sector sources of premium finance, as well as engagement with the government to recognise the risk to the GSR as a risk to public infrastructure (*natural* public infrastructure, that is).

Finally, regarding pay-out management, it will be critical to develop partnerships for the effective distribution and use of pay-outs. Insurance pay-outs from rapidly disbursed parametric insurance can be used for a variety of purposes, including clean-up and early restoration efforts; however, effective partnerships are required for the implementation of these activities. The policy holder will need to establish partnerships with organisations that they can channel pay-outs to in order to deploy response teams locally, and/or they will need to partner with local communities to execute response activities.

These partnerships must include those stakeholders required to inform and implement contingency planning and emergency response protocols. These stakeholders will include those from the conservation community more broadly and the local communities on the GSR. For example, response activities can be pre-planned and undertaken by the local communities, and community members can be trained in emergency response actions and reef restoration. The actual operation structure for local response actions after a cyclone must therefore be determined in consultation and should include coordination at the national and provincial level to effectively organise necessary actors and make sure response is timely and effective and inclusive of local women and men along the GSR.

Additionally, the implementation of the proposed insurance for the GSR could directly build the financial climate resilience of the communities. For example, community responders could receive payment for their work implementing post-cyclone response activities, which would provide them with income replacement / post-disaster liquidity in complement to the indirect benefits of a restored reef. Further, the actual funding of emergency response activities, and especially the pre-funding of these activities at the contingency planning phase, greatly increases the chances of timely and effective implementation.

In conclusion, the next steps regarding the use of the pay-out will require:

- The identification of the policy holder;
- The development of contingency plans and a cyclone response protocol for the GSR, identifying necessary partnerships;
- The identification of the capacities and needs of the GSR communities to adopt and carry out the response;
- The identification of the processes required to build and train the necessary community of responders; and
- The formalisation of the institutional arrangements and financial channels to implement an insurance pay-out to fund reef response.

On the supply side, the placement of an insurance policy for the GSR will require partnerships with and between insurance industry actors, including insurers, intermediaries, and hazard information providers.

A key next step will be the engagement of an insurance intermediary to represent the interests of the policy holder in the procurement of insurance coverage. The key partnerships required for product implementation / placement, which the intermediary will establish, are:

- **Local insurers.** Partnership with a local insurer to underwrite the insurance policy will be necessary. The local insurer can either act as a front and pass all risk onto international risk markets, or retain some of the risk.
- **International insurers**. As the proposed insurance is a catastrophe risk policy, partnerships with international (re)insurance markets will be necessary to ensure lowest pricing of risk transfer.

- **Hazard information providers**. It will be necessary to establish a relationship with a calculation agent to formalise real-time trigger calculation processes.

One particular partner worth noting on the supply side is PCRIC, the regional public-good risk pooling facility in the Pacific, which offers insurance coverage to Pacific Island Countries for Tropical Cyclone, Earthquake, and Tsunami. As discussed in the Concept Design Report, PCRIC has established good access to the international markets for parametric catastrophe risk. PCRIC is a captive insurer domiciled in the Cook Islands and backed by a multi-donor trust fund (MDTF) supported by the governments of Germany, Japan, the US and the UK. By virtue of diversification and concessional capitalisation finance from the MDTF, the insurance premium cost for each country is lower than it would otherwise be, and underwriting profits are held within the pool itself, to the further benefit of its members.

Marketing

Next steps regarding insurance product marketing should be undertaken by the engaged insurance intermediary. The intermediary will present coverage requirements and technical product design to a range of risk markets to secure the best price for the proposed product. The risk analytics presented in the Concept Design Report provide a baseline for technical pricing.

We are confident that good pricing can be achieved due to using the parametric form of insurance, which is familiar to global risk transfer markets. Additionally, this particular risk should be fully diversifying for a number of markets. However, we caution that scale may be a barrier to achieving best possible pricing because relatively fewer markets will be interested in underwriting very small volumes of risk, particularly if there are no existing relationships between domestic insurer(s) and the global reinsurance market. Best pricing is therefore likely to be achieved by using a domestic insurer already connected to the global risk markets and / or involving the regional risk pool, PCRIC, in the transaction to bring scale and regional diversification.

Stakeholder awareness

Stakeholder awareness will be particularly important to raise on the demand side, as coverage for reefs is a very recently developed application of insurance.

Next steps regarding stakeholder awareness will be absolutely critical, as insurance is a novel financial instrument in the conservation community, and there is currently little understanding of this type of financial risk management mechanism for natural infrastructure. For example, while the existing reef insurance in Quintana Roo, Mexico has generated some awareness of the potential for the use of insurance to manage cyclone risk to reefs, there is still a lot of work to be done to raise the level of understanding to implement these types of financial mechanisms.

We recommend that a focal point for communication (and training / advice) regarding insurance applications to risks to natural capital be identified for the GSR, at the national level, or regionally. This focal point would be mandated to engage with the relevant partners identified to raise stakeholder awareness and build capacity to implement a potential risk management strategy for the GSR and natural infrastructure beyond. Preferably, this would be in an official capacity.

Next steps for the GSR product in particular include:

- Engagement and communication with conservation organisations working on the GSR to understand their needs when it comes to cyclone risk to the reef and communicate the potential for insurance to mitigate risk those risks;
- Communication with beneficiaries of the ecosystem services of the GSR regarding the cyclone risk to the GSR to help them understand and quantify the risks they currently hold; and
- Familiarisation of the potential end-users of this insurance with general risk management and insurance concepts.

We also recommend the clear communication of the case for the implementation insurance for blue / green infrastructure such as the GSR. Pre-arranged risk financing can significantly contribute to increased resilience of marine ecosystem / ocean health by:

- Addressing a post-event funding gap by providing a framework and financing mechanism to **clarify risk ownership** and facilitate the collaboration of multiple stakeholders;
- Providing a **predictable** source of funds, allowing local communities and government to incorporate natural capital into post-event response contingency planning;
- Providing a **timely** flow of funds to carry out immediate, post-event response, speeding recovery; and
- Ultimately, **replacing critical income supporting ocean health outcomes and/or restoring ecosystem services** provided by this natural infrastructure, thus generating economic value by reducing the cost of impairment of such services.

We also recommend highlighting the value of structured management of the risks to the GSR beyond (and before) the potential value of risk transfer as a financial mechanism. For example, raising awareness around the value of developing contingency plans and response protocols will be valuable in itself.

Finally, management of expectations is critical to help ensure that both the circumstances (i.e. scale of cyclone impact) which trigger pay-outs and the use of pay-out funds are fully understood.

On the supply side, stakeholder awareness should be part of insurance marketing activities, but could also be undertaken more broadly.

For example, next steps could include engagement with local insurance markets in Fiji as well as engagement with PCRIC on the potential to offer an insurance product covering cyclone risk to reefs.

4.2 Concept 2: Cover for Business Interruption of the Blue Economy from Carbon Pollution

The pilot use-case developed for the 'cover for business interruption of the blue economy from carbon pollution' concept is insurance for coral bleaching in Palau based on a sea surface temperature (SST) index. There are two potential applications of this cover presented in the Concept Design report, and the following section will outline the next steps required to implement a policy.

4.2.1 Next Steps and Requirements for the Specific Use-Case

This concept requires both significant technical work to establish viability as an insurance product and significant political engagement to generate demand for its use. This is because it addresses the risk of shock events, in the form of ocean heatwaves, which are driven very directly by slow-onset global warming and climate change. Therefore, the forward-looking analytics required to be able to quantify the risk (and price an insurance product) require the use of data with a high degree of uncertainty embedded in both climate models themselves and in the future carbon emissions pathway the world follows. Further, even if there is an analytic methodology, which allows the quantification of this risk with appropriately limited uncertainty, making risk transfer a reasonable option (from a relative cost perspective), it may emerge that in many areas, the risk of bleaching is just too high to make insurance viable. Despite these challenges, we believe this concept worthy of further investment and exploration, given the long-standing desire for testing of insurance tools and products to quantify and address long-term climate change impacts, a desire particularly strongly communicated by the Pacific island nations in the context of the global climate change negotiations and agreements under the UN Framework Convention on Climate Change (UN-FCCC).

Specific next steps regarding the placement of an insurance policy, or other risk financing mechanism, addressing the risk of marine thermal stress to the Ngemelis Island Conservation Area, where two major pillars of the tourism industry, diving on coral reefs and visiting Jellyfish Lake, are at direct risk, threatening significant impact to the economy of Palau and the livelihoods of many of its citizens, are described according to research and data modelling, policy, partnerships, marketing, and stakeholder awareness requirements.

Research and Data Modelling

The next steps regarding research and data modelling include a large programme of technical work. A significant data analysis programme is required to evaluate the feasibility of insurance as a financial risk management tool when it comes to risks driven by chronic, slow-onset climate change in general. While the settlement data required for an insurance product is readily available (via the NOAA Coral Reef Watch product suite, as described in the Concept Design Report), underwriting data requires significant work, as the historical record is not a sufficient basis for pricing this risk. This is the most significant challenge in implementing this concept.

The underwriting process to price risk requires the quantification of the risk of marine thermal stress events which result in coral bleaching, and developing an understanding of the subsequent impact on the Blue Economy on which so many Pacific island nations depend, and, therefore, will have wider benefits beyond the development of a potential insurance product. The methodologies employed by the insurance industry (including both traditional catastrophe risk and life insurance) to quantify risk provide the metrics that will support the development of structured, evidence-based risk management frameworks and protocols. Therefore, we recommend that this research and modelling programme is framed in terms of a larger risk analysis and understanding exercise, rather than as an insurance product development project. We also recommend that, while it will be prudent to begin this technical work by considering a narrow set of pilot geographies, the broader regional application should be kept in mind.

Next steps to quantify the risk which marine thermal stress events pose to Pacific island economies in probabilistic and financial terms encompass the following:

1. **Hazard**: quantitative assessment of the likely frequency and severity of marine thermal stress events in the future.

   A marine thermal stress hazard assessment will require the development of a probabilistic, forward-looking model of SST and an associated index representing the risk of coral bleaching. This is the most significant research and data modelling challenge to this concept (and indeed to gaining a more comprehensive understanding of the risk). The historical record of SST is good in that a reliable dataset exists; however, the historical record in itself is not sufficient to quantify the risk of marine thermal stress events into the future. A predictive model of sea surface temperatures will require the integration of multiple factors from general circulation models (GCMs) and must find a way to tackle the uncertainty around the dominant driver of future SST, namely global greenhouse gas emissions.

2. **Exposure**: natural asset database.

   The compilation of a database of all reefs (as a start, but could include other natural assets as well), which support activities in the Blue Economy, will be required to inform an understanding of *what* and *how much* is at risk. This natural asset database should include geographic and ecological data on the reefs as well as financial information on reef-related revenues and income This financial information should be higher resolution than total ‘value’ to economic activity in general and tagged to specific financial flows where possible.

3. **Vulnerability**: natural asset fragility functions.

   An understanding of the interaction between the exposure (the reefs) and the hazard (sea surface temperatures) requires the development of fragility functions, which relate the assets in the natural asset database to the relevant hazards, i.e. relating various sea surface temperature conditions to various levels of reef impacts, from mild bleaching to widespread mortality.

4. **Risk**: exceedance probability curve.

   Finally, the integration of the hazard, exposure, and vulnerability components will result in exceedance probability curves, which will describe the probability of various levels of reef impacts over a given period of time.

The four steps above are the next steps required for a reef risk assessment, which will provide a quantitative understanding of the risk and inform any risk management strategy. This risk assessment can then inform the underwriting of an insurance policy. However, it is worth noting that achieving an appropriate level of certainty around forward-looking risk analytics on SST to enable private markets to participate in risk-taking at an acceptable technical price will be a challenge. And risk analysis may reveal that the risk is too high for insurance to be an efficient financial risk management instrument. However, we believe that this specific concept provides a unique opportunity to overcome this challenge, thereby unlocking a tool with great potential to support blue economy development across the Pacific.

Policy

In terms of policy, we recommend that the next steps regarding this insurance concept, and even more significantly, the broader risk management methodologies and capabilities of insurance-related risk quantification and understanding, be considered as part of the ongoing work of the small islands of the Pacific and beyond on the global climate policy stage. Pacific island nations are particularly vulnerable to the effects of anthropogenic climate change caused by atmospheric carbon pollution, and they have therefore been extremely active in climate negotiations and policy.

Additionally, there is a rapidly growing of awareness around increasing climate risk, and an urgent need for practical tools to manage the consequences through building resilience, which has catapulted natural disaster risk management to the top of the global economic agenda. For example, the World Economic Forum's Global Risk Outlook for 2019 places environmental risks at the top of its list, the first ever G20 insurance forum was held late last year in Bariloche, Argentina, and the Sustainable Development Goals (SDGs) recognise risk and the need for resilience at a macro level.

The post-2015 development agenda has also embraced disaster risk management and financial protection as key elements for building resilience and securing development gains. For example:

- The Sendai Framework for Disaster Risk Reduction, adopted by UN Member States in 2015, guides global efforts to prevent new and reduce existing disaster risk through 2030 and highlights financial protection as a key element of resilience.
- The Addis Ababa Action Agenda, adopted in July 2015, lays out the level of ambition for financing the Sustainable Development Goals (SDGs), which were adopted in September 2015. Climate and disaster resilience are mainstreamed across the SDGs and their associated targets, ensuring that global development priorities over the next 15 years will integrate climate and disaster risk management considerations.
- The Paris Agreement of the UN-FCCC, which entered into force in October 2016, recognises, in Article 8, the need for comprehensive risk assessment and management, including the use of insurance, to address loss and damage from climate change.
- The World Humanitarian Summit took place in May 2016, where a structured risk management approach including risk financing was discussed as an important tool in 'fixing' the global humanitarian system.
- The InsuResilience Global Partnership (IRGP) initiative aimed at increasing climate risk insurance coverage by 500 million vulnerable people in the developing world by 2025.

Adding to these ongoing efforts and initiatives, significant next steps are required at the international policy level in order to implement any potential financial risk management instrument (be that insurance or another risk financing mechanism) for marine thermal stress events. As anthropogenic climate change is a significant driver increasing the risk of marine thermal stress events in the future, we believe that this product will only be viable if Annex I countries, under the UN-FCCC, support concessional coverage of this risk through climate finance. The "polluter pays" principle is well established under the UNFCCC, and this risk financing concept allows for premium payments to be made on a regular basis while pay-outs would only occur when specific thermal stress events (which are inherently linked to carbon pollution) occur and lead to inevitable impacts on the economy of Palau (or other covered country) and its ability to continue to provide services to its population, as well as stewardship of the marine environment (a benefit to the local population and global commons).

The Palau case study should be developed to provide a technical focal point to international discussions around climate policy and the mitigation of and adaptation to future slow-onset climate risk directly related to carbon pollution. The quantification of the risk of SST rises associated with global warming, as well as an understanding of the future financial impacts of more extreme marine thermal stress events causing damage to marine ecosystems and ocean health, provides a concrete, evidence-based view of the financial liabilities of Pacific Island Countries, which they will be required to manage; it also provides the science required to inform the future deployment of climate finance to support in the adaptation to the risk which the Pacific island nations face.

The Pacific is strong as a region, and cooperation between nations promises to raise individual countries' voices higher as part of the larger collective. Together, leverage on the international stage includes policies related to international visitors / visas and fishing licences. We therefore recommend the development of the risk analytics underpinning the proposed insurance concept across the Pacific, so the region can make their case for support in managing their risk in unison.

It should be noted that this concept does not necessarily require risk capital for implementation; the rules-based approach could be used to control pay-outs from a traditional source of capital such as a contingency Trust Fund, if risk markets demand a high uncertainty load on premium or if the risk is simply too high for risk transfer to be economically efficient.

Should a market-based pricing of risk transfer not be acceptable to the Annex I countries, then their own capital could be set aside in a Contingency Fund (with ongoing top-up, at risk-appropriate levels, to maintain the fund balance, meaning contributions to fund replenishment should be based on progress towards carbon emissions reduction targets), with the same parametric rules dictating outflows from the Fund, bringing objectivity and discipline to the operations of the Fund.

Additionally, by providing rules-based finance to initial pilot countries (of which Palau could be the first), the Fund could provide the mechanism by which to expand to support a regional portfolio, pooling risk across the Pacific island countries and, if it becomes financially efficient over time (e.g. with advances in climate science or international commitments on mitigation), potentially leveraging and securing its capital by transferring tail risk of severe events to international risk markets (potentially through the Pacific Catastrophe Risk Insurance Company; PCRIC).

An example structure of such a reef risk pool is depicted in Figure 4.1.

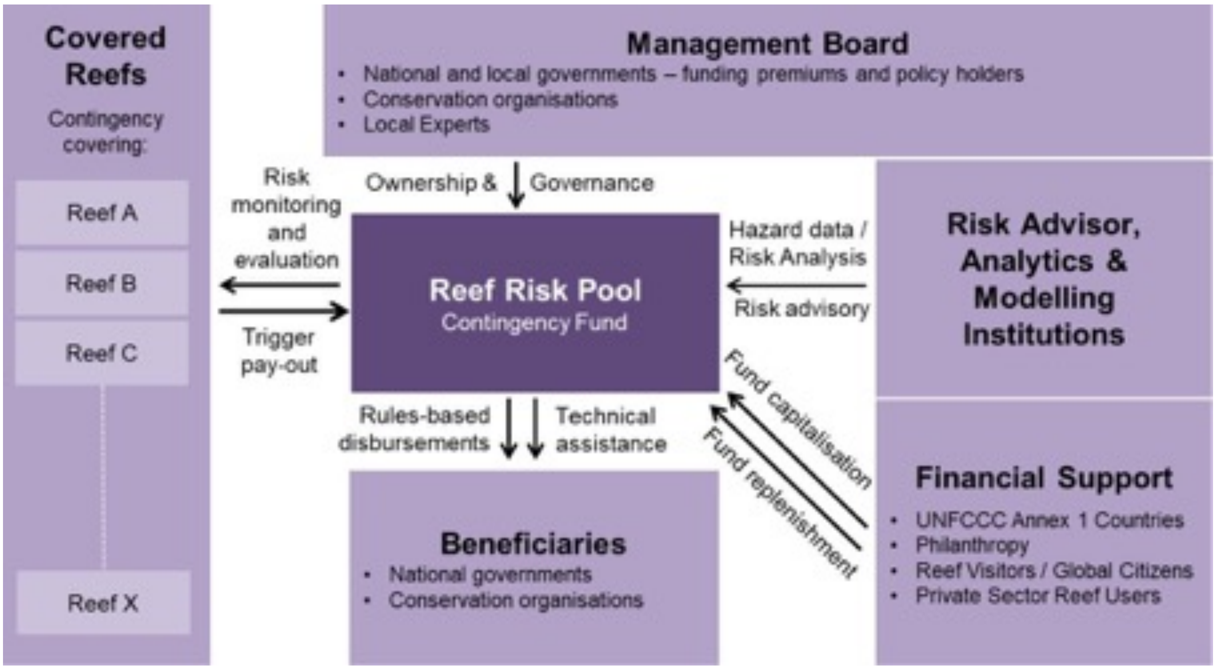

Figure 4.1 Illustrative reef risk pool structured around a contingency fund.

If insurance is a plausible option, an example structure including risk transfer is depicted in Figure 4.2.

Figure 4.2 Illustrative reef risk pool, including risk transfer.

Partnerships

As discussed, regional cooperation will be key to the potential implementation of a financial risk management instrument for marine thermal stress events, as it is likely only through regional cooperation that premium finance may be secured. It may be most appropriate to explore these regional, political partnerships once the necessary feasibility assessments are conducted from a technical perspective. Either form of a risk pool illustrated above would offer a platform for collaboration regionally and internationally.

On the technical product / mechanism design side, key partners will include academia and public science, as well as risk management experts and risk markets (i.e. re/insurance companies) themselves. The technical challenges require a broad suite of expertise, and potential risk takers on any potential insurance transaction should be engaged at an early stage of product development in order to establish whether risk transfer will be technically and economically feasible. PCRIC also will be a key regional partner if risk transfer is explored. A key next step to establish these necessary partnerships should be a formal feasibility assessment in which these partners are consulted and convened.

When it comes to the use of pay-outs, partnerships between the government and conservation organisations are already strong in Palau, as national and local governments collaborate with local and international conservation, tourism, and development partners through the Protected Areas Network. These partnerships are critical to the effective use of pay-outs, and if this concept is to be explored regionally, similar cooperation should be present or developed in other countries of focus.

Marketing

While this product still requires significant technical work to assess feasibility as an insurance instrument, product marketing and engagement with potential risk takers should be undertaken alongside product design and development, once technical feasibility is initially established.

Stakeholder awareness

Next steps regarding stakeholder awareness should follow the technical feasibility assessment phase. The results of a feasibility study should be published and widely distributed.

Regional institutions such as PIFS, SPREP, and SPC should be engaged to explore the best platforms for regional awareness. Additionally, international platforms such as the V20 and IRGP should be engaged and consulted. Finally, the UN-FCCC Secretariat should also be engaged, as they have an expressed interest, within the Adaptation section, in further development of insurance tools and products to help manage slow-onset climate risk.

It is critical to note that a key unintended outcome could be to have raised expectations that this approach could be a catch-all for slow-onset climate risk in large ocean states. Identifying and quantifying such risk is extremely useful in shining a light on the direct and tangible economic consequences, but ultimately, responsibility must be accepted and funds must flow to finance a solution, either using actual risk transfer mechanisms, or using more traditional financing mechanisms controlled by the tools of insurance which bring discipline and objectivity.

4.3 Concept 3: Insurance as Reward

The pilot use-case developed for the 'insurance as reward' concept is a parametric livelihood protection for climate risk to coastal communities in Vanuatu. The insurance would be specifically for fishing communities in Vanuatu, where access to coverage would be provided as a reward for the implementation of improved fishing practices. The proposed insurance programme covers two perils, cyclone and extreme rainfall. The concept itself is further detailed in the Concept Design Report, and the following Guidance Note will outline the next steps required to implement this concept.

4.3.1 Next Steps and Requirements for the Specific Use-Case

This concept is well-developed in terms of the administrative and operational requirements, given that it can build on experience from the Caribbean and relevant preparatory work completed in the Pacific. On the technical and analytical side, it is also well-advanced, despite some further work required related to the extreme rainfall coverage. Where significant work is still required is on the actual implantation of local administration and operationalisation elements of a parametric insurance programme in Vanuatu. This proposed insurance programme also relies on public funding of premiums, which is most likely to materialise within a broader development project focussing on coastal community climate adaptation.

As with the Insurance for Blue Infrastructure concept (Concept 1), and since this concept is similarly technically advanced, specific next steps will fall into categories, depending on whether action is required on the demand or supply side of insurance product implementation.

- Actions on the demand side of an insurance product offered to incentivise sustainable practices will be taken by the end-user(s) of the financial instrument, and roles here include:
  - The policy holder;
  - The source of premium finance; and
  - The beneficiaries of pay-outs.
- Actions on the supply side of an insurance product offered to coastal communities, on the other hand, will be taken by the sellers / insurance industry and roles here include:
  - Risk advisors;
  - Insurance intermediaries / brokers; and
  - Insurers / risk takers.

Specific next steps regarding the implementation of a livelihood protection programme covering the acute climate risk to low-income households in Vanuatu are described according to research and data modelling, policy, partnerships, marketing, and stakeholder awareness requirements.

Research and Data Modelling

On the demand side, further research and data modelling is recommended to refine the optimal product structure, coverage amount, and pay-out rates.

While the coverage has been designed in ‘blocks’ to allow flexibility of coverage amount (so each ‘block’ of coverage is purchased for a fixed premium, and each provides pay-outs at the same trigger levels, with the purchase of a second block of coverage doubling the initial amount, the third block tripling it, etc.), further research is needed to define the trigger levels and pay-out formula.

The proposed livelihood protection coverage uses indices of cyclone intensity (through wind speed) and rainfall amount (daily peak rainfall), associated with a pay-out formula at different thresholds. Since the proposed trigger thresholds and pay-out structure are indicative, more research is required in order to establish the index as a good proxy for impacts and losses (including to physical assets as well as to income from paid activities) caused by climate shock events at the household level. For example, input from both the government and beneficiaries, as well as research on past event needs assessments, should all contribute to determine the final structure of the triggers.

On the supply side, while the cyclone risk analytics and data modelling are well-advanced, extreme rainfall data modelling using the most recent satellite-based data needs to be completed.

The research regarding cyclone hazard, and especially the probabilistic understanding of the risk of events across the Pacific is well accepted by the scientific community and insurance industry alike. Further, the pricing and claims settlement for the proposed product rely on primary data sources for cyclone hazard that are known to be acceptable to global climate risk transfer markets.

However, additional technical research and data modelling work is required on the extreme rainfall insurance product design. We recommend to utilise NASA/JAXA Global Precipitation Mission (GPM) data, which is freely available in real time for triggering, and is also available for around 19 years of history, enabling underwriting to be undertaken to standards expected by global climate risk transfer markets.

While the use of GPM data for real-time triggering does not require any additional research and data modelling, specific next steps regarding rainfall risk analytics to complete product design from an underwriting perspective include:

- Gathering GPM data and establishing trigger levels for rainfall based on historical records; and
- Burn analysis using historical records to inform product underwriting.

Policy

On the supply side, as stated in the Concept Design Report, regulatory authorisation for the proposed product is likely to be straightforward.

Local legal and regulatory infrastructure in Vanuatu should be sufficient to enable this product to be made available relatively quickly, once a local insurer is identified to be the primary carrier and administrator. Insurance regulation in Vanuatu is undertaken by the Vanuatu Financial Services Commission (VFSC) and next steps will require engagement with the VFSC to confirm that parametric livelihood protection product would not face licencing challenges.

Policy next steps on the demand side include a trio of requirements: the recognition of the value of *ex ante* risk financing arrangements in climate and disaster risk management policies, the continued implementation of existing financial inclusion policies, and the integration of incentives at the community level with coastal marine environment policies and regulations.

Ex ante Risk Financing

Governments have always played a central role in emergency relief, recovery, and reconstruction in the aftermath of catastrophe shocks, such as the cyclones and extreme rainfall events addressed by the proposed programme. During and directly after one of these climate shock events, the government and, for developing countries such as Vanuatu, international partners, provide emergency relief to the affected population, for example distributing food or cash aid to households and individuals.

The post-2015 development agenda has embraced disaster risk management and financial protection as key elements for building resilience and securing development gains.[45] Therefore, there is policy in place to support the implementation of insurance to support community and government resilience to climate risk, as a way to pre-finance this role that the government and international partners play in the response to climate shock events. By providing insurance and inviting the topping up of that insurance by individuals, the government can bring discipline to its own management of natural catastrophe risk (and the duties of care and contingent liabilities it holds) and enable individuals and communities to begin to take on some of the risk burden themselves.

Therefore, we recommend that the recognition of the value of insurance (and other *ex ante* financing arrangements) be integrated into climate and disaster management policies at the national and international level. This should be done through engagement with and between the national government and the development and humanitarian communities and should include policies concerning the recognition of the cost of these climate shock events to communities and the financing of that risk, which currently falls to governments and international partners, in advance (e.g. through the subsidisation of insurance premiums).

Financial Inclusion

The Vanuatu National Financial Inclusion Strategy 2018 – 2023 is the policy document that provides the road map to Vanuatu's financial inclusion journey. It offers an excellent platform to engage with the national government and international partners, encouraging a strategic policy discussion around the extension of preferential access to insurance as incentive for adherence to environmental policies in

45. Including, for example, the Paris Agreement of the UN Framework Convention on Climate Change, which recognises, in Article 8, the need for comprehensive risk assessment and management, including the use of insurance to address loss and damage from climate change; The Sendai Framework for Disaster Risk Reduction, which guides global efforts to prevent new and reduce existing disaster risk through 2030 and highlights financial protection as a key element of resilience; and the Addis Ababa Action Agenda, which lays out the level of ambition for financing the Sustainable Development Goals (SDGs), where climate and disaster resilience are mainstreamed, ensuring that global development priorities over the next 15 years will integrate climate and disaster risk management considerations.

coastal communities. Therefore, next steps include engaging with those partners working on financial inclusion in Vanuatu and the wider Pacific region to align the proposed programme with existing policy in this space.

Environmental Policies and Regulation

It is a critical design feature of the proposed programme that preferential access to the proposed insurance coverage be aligned with environmental policies and regulation in order to deliver ocean health outcomes through the product. Therefore, next steps require engagement with and the development of the practical implementation road-map for those policies, including the monitoring and enforcement mechanisms, to ensure ocean health objectives are integrated into the programme structure. Vanuatu's National Ocean Policy from 2016 provides the roadmap here.

Partnerships

In order to provide a high level view of where the development of partnerships will be required in order to implement the proposed programme, Figure 4.2 depicts the roles involved.

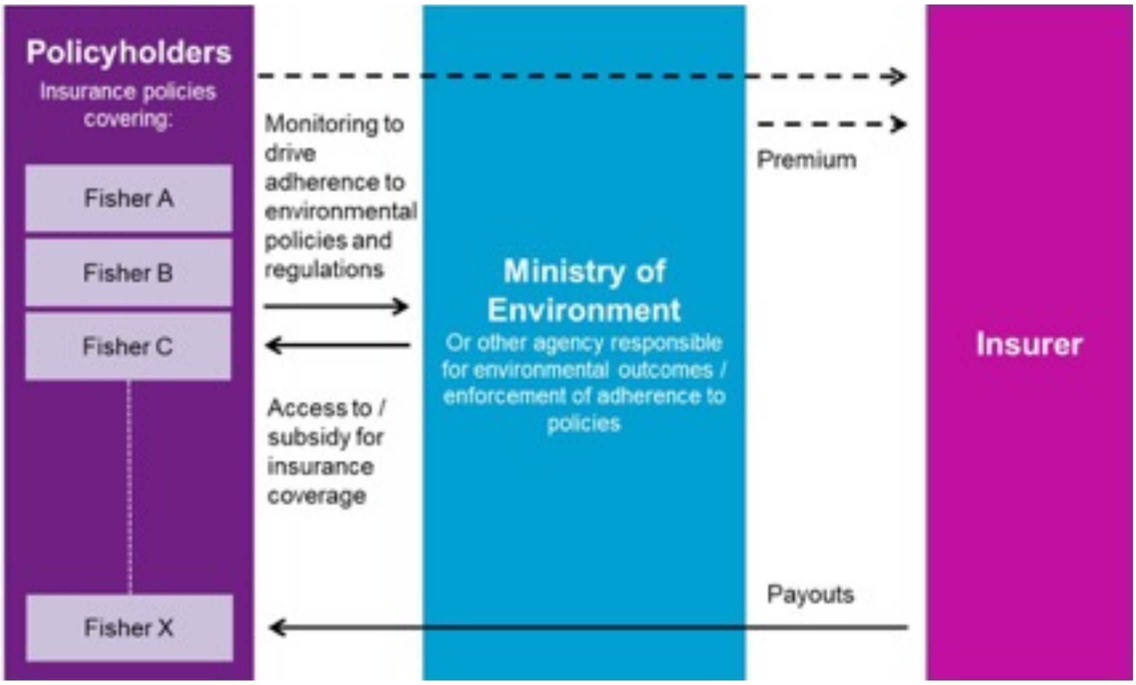

Figure 4.2 Conceptual model of insurance programme implementation.

On the demand side, partnerships must be established to identify premium finance, establish the institutional relationships required to operationalise the exchange of concessional insurance for adherence to environmental policies, and build financial literacy at the policy-holder level.

There are two levels of requirements on the demand side: there is the government, which will subsidise the base level of coverage to incentivise individual policy-holders to adhere to environmental policies, and then there are the policy-holders themselves. The establishment of partnerships will be required on both sides, mainly to finance premium and operationalise the 'insurance as reward' on the government side and to build financial literacy and capacity to use insurance on the policy-holder side.

At the level of the government, partnerships should be established between the Ministries of Finance, Environment, and Fisheries, as well as with the international conservation, development, and humanitarian communities. One of the main thrusts of engagement between the Government of Vanuatu and the international development community (especially partners working in disaster risk and climate finance) and the conservation community, and especially funders from both such as the Global Environment Facility, the Green Climate Fund, and the InsuResilience Solutions Fund, will be to develop a premium financing strategy.

A critical next step for the implementation of this particular insurance concept, therefore, is the establishment of a premium financing strategy. This would identify the partners to support short- and long-term premium finance.

In the short-term, while we envisage funding of premium by the government, we note that the Government of Vanuatu will likely require premium support from international donors; due to the climate adaptation elements of the proposed livelihood protection programme, as it increases the financial resilience of vulnerable households to adverse climate shock events, there is a case to be made for international climate finance support. There is also a case to be made for international conservation finance support, due to the link with environmental policies and regulations. These partnerships should be explored in a 'short-term premium finance strategy' development and engagement phase.

The initial, short-term premium subsidisation (from international donors) will cover the government and beneficiary community against adverse climate impacts and incentivise increased adherence to environmental policies, directly contributing to their climate resilience and sustainability, for a set period of time. Offering concessional insurance at this stage, as a proof of concept, will be beneficial to the uptake of the insurance in the long-term because it allows communities to gain familiarity with insurance as a mechanism, proves the process of administration and product roll-out, and (if a climate event occurs and a pay-out is made) proves how insurance works. Pay-outs not only demonstrate that insurance works in practice not just in theory, but will enable testing and refinement. Additionally, a subsidised proof of concept period will allow for the establishment of preferential access based on adherence to sustainable policies.

In the long-term, a different set of partners should be engaged to develop a sustainable premium finance strategy. This will explore the universe of funders of premiums in the long-term and will require community—at both the household and enterprise level—government, and donor engagement. We therefore recommend a next step to explore the combination of multiple sources from government, business, and individuals to share the risk and contribute to the purchase of coverage that benefits multiple stakeholders. This kind of blended finance arrangement—combining finance at the community level with other sources with the ability to pay—will be the long-term sustainable option for this programme. The building out of a long-term premium financing strategy (including elucidating the institutional arrangements required to execute a blended finance solution) will require an analysis of the potential sources of funding for the sustainability of the proposed insurance programme, as well as an outline of suitable mechanism(s) for collection and aggregation of premiums, holding of an insurance contract, and management of pay-outs. By providing insurance and inviting the topping up of that insurance by individuals, governments can both bring discipline to their own management of natural catastrophe risk (and the duties of care and contingent liabilities they hold) and enable individuals, communities, and enterprises to take on some of the risk burden themselves.

Additionally, potential implementation of the proposed livelihood protection programme requires the development of the institutional and other practical arrangements necessary for the offering of insurance as a reward for sustainable practices / environmental stewardship. This will include a large component engaging with government as well as civil society to gauge support, consulting on the most effective and desired outcomes of incentives and understanding the process of reporting / tracking adherence to proposed sustainable practices, which would be required to access concessional finance, and the processes necessary to implement. Partnerships between the national and sub-national level agencies, institutions, and departments responsible for the monitoring and enforcement of environmental policies and regulations, as well as local communities, will be critical in the implementation of an insurance product in order to make the exchange of coverage for adherence to policies real (and not just 'on paper'). There must be a way to monitor policy-holders' actual, real-time or near real-time (so, say, through random checks) adherence to the policies, which will require a clear communication / reporting protocol between those responsible for monitoring and enforcement (likely fisheries and environment roles) and those responsible for providing the access to insurance coverage (likely finance roles). Therefore, next steps include the formalisation of this partnership and the set-up of this protocol.

At the level of the policy-holders, partnerships must be built with those organisations working on financial inclusion in the region and specifically in Vanuatu and the communities themselves.

There is a lack of financial literacy among members of coastal small-scale fishing communities, which will need to be addressed as a next step towards the implementation of a livelihood protection programme for these end-users. Therefore, partnerships with wider financial inclusion initiatives should be established, and the next steps for this particular programme should coordinate with those partners already operating in this space in order to effectively leverage their progress to date and build on ongoing community engagement.

Further, while we envisage individuals to be the policy holders for the proposed programme, partnerships to maintain beneficiary information will be critical to the administration of the policies, especially as it pertains to claims management should a triggering event occur. A key partnership between the government and the local insurer will therefore be required. The government could, for example, maintain the beneficiary list by monitoring adherence to environmental policies, and the insurer would manage pay-outs based on that list.

On the supply side, the implementation of a livelihood protection policy in Vanuatu will require partnerships with and between insurance industry actors, including insurers, intermediaries, and hazard information providers, and the government offering premium subsidisation and maintaining the beneficiary database, as well as with the policy holders / insurance beneficiaries themselves.

The main partnerships required on the supply side will pertain to programme administration and claims and pay-out management.

First of all, a critical next step will be to identify the local insurer to administer policies. A calculation agent must also be identified, so that relevant data sources (i.e. the PCRIC wind model for cyclone and the NASA/JAXA Global Precipitation Mission data for rainfall) are constantly monitored, and once a trigger threshold is met, notification is provided to the policy holders, and pay-outs are available within a few days, which can be distributed in a variety of ways (preferably linked to other financial services such as banking).

We envisage administrative processes to be embedded within the private sector, with PCRIC potentially able to reinsure the primary insurance company issuing the policies or directly insure the government for the first "block" of insurance for each individual. The process needs to be scalable and able to accommodate direct purchase of top-up coverage by individuals alongside the main government-purchased coverage. The insurer may or may not participate as a risk-taker; if not, the insurance programme would need to be reinsured via PCRIC or the international markets.

The engagement of an insurance intermediary would be a useful next step to represent the interests of the policy holder in the procurement of insurance coverage. The key partnerships required for product implementation / placement, which the intermediary will establish, are:

- **Local insurers.** Partnership with a local insurer to underwrite the insurance policy will be necessary. The local insurer can either act as a front and pass all risk onto international risk markets or retain some of the risk.
- **International insurers**. As the proposed insurance is a catastrophe risk policy, partnership(s) with (an) international insurer(s) will be necessary to take this level of risk.
- **Hazard information providers**. It will be necessary to establish a relationship with a calculation agent to formalise real-time trigger calculation processes.

To reduce operational costs and increase efficiency, we suggest that the product utilises mobile technology to:

- Deliver pay-outs quickly via mobile money or via a notification that the pay-out can be collected from a pre-agreed financial institution; and
- Deliver early warning messages and preparedness advice, thus helping policy holders to minimise impacts, meaning in turn that any insurance pay-out will go further towards rebuilding livelihoods.

Marketing

Next steps regarding insurance product marketing should be undertaken by the engaged insurance intermediary. The intermediary will present coverage requirements and technical product design to a range of risk markets to secure the best price for the proposed product. The risk analytics presented in the Concept Design Report provide a baseline for technical pricing.

We are confident that good pricing can be achieved due to using the parametric form of insurance, which is familiar to global risk transfer markets. Additionally, this particular risk should be fully diversifying for a number of markets. However, we caution that scale may be a barrier to achieving best possible pricing because relatively fewer markets will be interested in underwriting very small volumes of risk, particularly if there are no existing relationships between domestic insurer(s) and the global reinsurance market. Best pricing is therefore likely to be achieved by using a domestic insurer already connected to the global risk markets and / or involving the regional risk pool, PCRIC, in the transaction to bring scale and regional diversification.

Stakeholder awareness

Stakeholder awareness will be particularly important to raise on the demand side, as community familiarity with insurance, and financial products in general, is low. Additionally, stakeholder awareness will be critical to form the partnerships required to identify and access short- and long- term premium finance.

We recommend that a wide campaign of financial literacy training be undertaken as a next step in the potential implementation of a livelihood protection scheme for low-income communities. This training should engage all stakeholders currently working on financial literacy in the Pacific to facilitate effective collaboration and leveraging of ongoing initiatives.

As with all parametric products, basis risk is present, which can lead to either no payment when there has been some impact to an individual due to a climate event or to a payment when there has been little or no impact. Given that the triggering of parametric products is fully objective and based on the intensity of the hazard, basis risk at the individual level can be the reasonable result of better—or worse—risk reduction behaviour in the face of either general or specific capacity building and / or warnings. In such cases, the outcomes are actually intended, and can be used for peer learning. In other cases, basis risk, both positive and negative, will need to be managed through ongoing capacity building at the community level, alongside a cycle of product improvement which needs to be an integral part of the insurance programme.

Additionally, potential contributors to premium subsidies should be engaged early to explore requirements in accessing climate or conservation finance to support the implementation of this programme.

On the supply side, stakeholder awareness should be part of insurance marketing activities, but could also be undertaken more broadly.

For example, next steps could include engagement with local insurance markets as well as engagement with PCRIC on the potential to administer or underwrite a livelihood protection policy.

Glossary

Basis risk: In risk transfer instruments, the financial risk associated with the imperfect correlation between the financial liability transferred through contractual obligations of a risk transfer policy and the reasonably expected coverage against actual losses incurred by a policy holder.

Budget allocation: An amount of funding set aside to cover specific planned expenditures.

Contingency fund: A reserve fund designated for financing shock impacts and losses.

Contingent liability: A potential future expenditure.

Disaster risk management: The systematic process of using administrative directives, organisations, and operational skills and capacities to implement strategies, policies, and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster risk reduction: The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, reduced vulnerability of people and property, anticipatory management of land and the environment, and improved preparedness for adverse events.

Ex ante: Latin for 'from before.' In the context of risk management, *ex ante* means that arrangements are made before a shock event occurs.

Ex post: Latin for 'from after.' In the context of risk management, *ex post* means that arrangements are made after a shock event occurs.

Indemnity insurance: An insurance policy that pays claims based on actual damage and economic losses incurred by the policyholder.

Index insurance: An insurance policy that pays claims based on an index. Indexes are typically designed to be a good proxy for losses and/or costs incurred by the policyholder.

Moral hazard: In the context of insurance, the potential for an insured's behaviour to influence the extent of damage that qualifies for insurance pay-outs.

Parametric insurance: A risk financing instrument that does not indemnify a loss, but agrees *ex ante* to make a payment upon occurrence of a certain intensity of hazard event.

Risk transfer instrument: A contractual instrument, such as an insurance contract, that passes financial liability associated with the occurrence of a defined event from one party to another.

Trigger: In parametric or index insurance, the event, or intensity of hazard, that invokes the contractual obligation of a particular insurance policy.

Underwriting: The process of issuing an insurance policy, thereby accepting a liability and contractually guaranteeing payment in case a defined event occurs.

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Technical Annex 1: Concept 1 Notes

For the “Option a” solution for Product Concept 1, cyclone input data is from the IBTrACS v4 dataset,[46] filtered to take storms only from 1955 (Figure A1.1). Four sources of wind speed are available—WMO (RMSC Wellington until 1992, then RSMC Nadi), US JTWC, and two NOAA databases which have some historical data not in either of the other two records. We have included all storms which appear in at least one of these datasets, and where storms feature in multiple datasets, we have taken the peak wind speed for each segment of that storm from across all datasets as the peak wind speed value in the subsequent analytics. This leads to the potential for inconsistency within the set of track segments for a particular storm (which is not a problem from an analytical perspective) and also leads to likely over-estimation of peak wind speed.

A qualitative analysis suggests that the historical record for the Pacific back to 1955 is complete for more intense storms and / or for storms which impact on inhabited islands, both of which apply to the trigger criteria for the Option a design, so that we believe the as-if historical analysis of triggers and therefore pure risk quantification is reasonable and somewhat conservative.

Table A1.1 provides the definition of category level of cyclones as used in the South Pacific including by the Nadi Regional Specialised Meteorological Centre which is the WMO-mandated cyclone monitoring and reporting agency for Fiji.

Fiji Category	Peak 10-min wind (kt)	
	Start	End
0	0	33
1	34	47
2	48	63
3	64	85
4	86	107
5	108	161

Table A1.1 Definition of cyclone Category used in Fiji.

46. https://www.ncdc.noaa.gov/ibtracs/

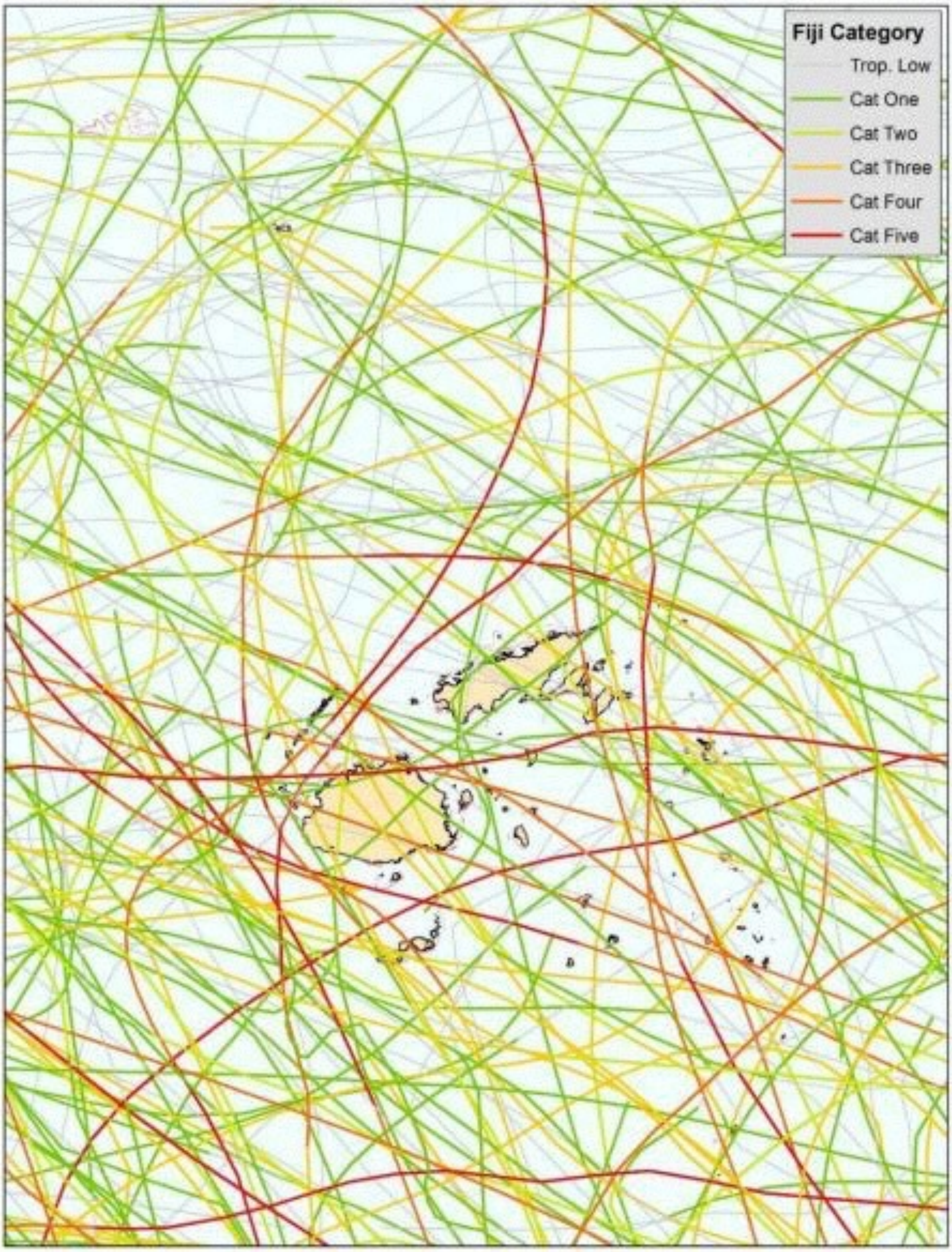

Figure A1.1 Cyclone tracks and track segment intensity for the vicinity of Fiji, from the filtered IBTrACS dataset described in the text.

Technical Annex 2: Concept 2 Notes

Coral Reef Watch Product Description

The Coral Reef Watch (CRW) product suite (v3.1 is current)[47] is derived from NOAA / National Environmental Satellite, Data, and Information Service's (NESDIS) operational daily global 5km geostationary-polar-orbiting (Geo-Polar) Blended Night-only SST Analysis.[48][49] Night-only SST measurements are used to avoid potentially significant effects of diel variation in SST and to better represent temperature anomalies at the depths corals are found.

A new daily climatology for v3 of CRW was derived from a combination of the NOAA/NESDIS 2002-2015 reprocessed daily global 5km Geo-Polar Blended Night-only SST Analysis, and the 1985-2002 portion of the daily global 5km SST reanalysis of the Operational SST and Sea Ice Analysis (OSTIA) system, produced by the United Kingdom Met Office. The climatology covers the 28-year period 1985-2012.[50]

The maximum monthly mean (MMM) climatology is based on an SST climatology that is, for each location, the warmest of the 12 climatological monthly mean temperatures (i.e., the maximum of the monthly mean SST climatology).

HotSpots are positive-only anomalies, derived by subtracting the MMM from each daily SST value. They identify daily thermal stress.

The Degree Heating Week (DHW) dataset provides a measure of accumulated thermal stress experienced by corals and is a better predictor of bleaching than HotSpots. It is calculated by summing HotSpots of 1 °C or greater from the preceding 12-week period; the DHW has been directly correlated with bleaching occurrence and severity.

ENSO Index Description

We have used the MEI v2 ENSO index[51] as the ENSO state indicator for Palau.

47. Liu, G. et al. (2017) NOAA Coral Reef Watch's 5km Satellite Coral Bleaching Heat Stress Monitoring Product Suite Version 3 and Four-Month Outlook Version 4. Reef Encounters, Vol. 32, No. 1
48. https://www.star.nesdis.noaa.gov/sod/mecb/blended_validation/index.php
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50. https://coralreefwatch.noaa.gov/product/5km/index_5km_sst.php
51. https://climatedataguide.ucar.edu/climate-data/multivariate-enso-index

Programme Annex 1: Stakeholder Consultations, May 2019

The following Programme Annex compiles the Pacific Ocean Finance Program—Insurance (POFPI) team's notes and impressions from a three-week stakeholder consultation process in the South Pacific. Simon Young and Jacq Wharton arrived in Nadi, Fiji on Wednesday, 1 May 2019. Subsequently, Simon travelled to Auckland, New Zealand and Apia, Samoa, while Jacq travelled to Suva, Fiji, Port Vila, Vanuatu and Honiara, Solomon Islands.

We highlight first and foremost that the Pacific Ocean Finance Program (POFP) carries the most weight with stakeholders as a whole—or, put differently, the programme is more than the sum of its parts.

The overall, multi-faceted programme to improve ocean health through the development of financial tools and mechanisms applicable to the Pacific Islands region in particular offers a powerful narrative:

- The oceans are key absorbers, buffers, and potential multipliers of climate risks;
- Natural capital like reefs, mangroves, and dunes, as well as healthy ecosystems like estuaries, and forests provide valuable ecosystem services; and
- When the value of the ecosystem services of this "blue / green infrastructure" can be measured, the quantified financial value provides a strong and compelling case for investing in healthy ecosystems by financing their maintenance, conservation, and management.

Once this fundamental aspect of the POFP is established, it is much easier to connect the dots on why particular financing mechanisms may be useful and worth exploring.

We would also highlight the following as key impressions that we will be fully taking into account moving forward with the POFPI project:

- *Expectation management vs. case study development*: Many of the counterparts we arranged to meet with were aware of conversations around insurance and climate change in the Pacific Island context, largely related to the climate CoP negotiations, which created both opportunity to advance ideas, but also a key challenge in terms of managing expectations of what insurance can deliver, both generally and particularly in the ocean health context (where insurance applications are at a very early stage of development globally).
- *Country interest vs. country capacity*: We consistently found a high level of interest in the project and its potential, but were not always able to identify, or meet with, the right people, if there are indeed 'right people', particularly at the government level. Existing capacity appears overstretched and is not expanding at the same rate as the prominence of ocean / coastal health and risk issues — and connected blue economy concepts and discussions.
- *Proliferation of initiatives*: We were prepared to learn about projects and initiatives in the broad ocean health space that we were previously unaware of, but the scale of proliferation was still surprising. This may have been a coincidence in terms of the timing of our visits, and we took

whatever advantage we could of being in the right place at the right time, but we steadily built an impression of a space which is expanding along parallel but separate paths more quickly and broadly than can be reasonably coordinated either at the national level or through international organisations such as the UN and INGOs.

- *Narrowing down of case studies*: We felt that we made good progress towards consolidating our three key insurance application concepts, particularly in stress-testing them against real-world experience. We also identified solid potential case studies for two of the three concepts and made some progress on the third, although further engagement will be required to confirm this third case study.

POFPI Consultation Collateral

The below flyer was a key resource in providing an introduction to the POFPI aims and objectives. It was provided in pdf and printed “glossy” format.

Under the insurance workstream of the Pacific Ocean Finance Program, WTW is exploring the feasibility of insurance instruments to support Pacific ocean health and thereby increase the resilience of Pacific communities.

Ocean health is crucial to communities across the small island states of the Pacific Ocean. Coastal and island communities are particularly susceptible to climate pressures, and dependence on the blue economy means they are on the frontline dealing with the impacts of climate change and other negative anthropogenic effects on the marine environment.

Healthy oceans and coastal ecosystems provide prosperity and protection to coastal communities. Natural infrastructure such as reefs and mangroves provide coastal protection from storm impacts by absorbing wave energy and reducing storm surge inundation. They are the hatcheries and nurseries for fish populations, which provide a key source of nutrition for small islands. And they generate and protect the coastal land- and seascapes on which tourism revenue is dependent.

As more intense storms, floods, droughts, sea level rise, higher temperatures, and ocean acidification increase the vulnerability of coastal communities, threatening both lives and livelihoods, it is a key priority to strengthen the resilience of the ocean environment which supports them.

Why Insurance

Insurance is a tool to finance risk and build resilience to shock events, mitigating the impacts by arranging finance in advance. It can be more cost-efficient than other financial mechanisms, especially credit arranged after-the-fact, particularly for extreme risks. Pay-outs provide funding for recovery quickly after an event, and this predictability of funding allows for the development and implementation of contingency plans, which can further minimise negative impacts.

Incentivising Risk Reduction and Environmental Stewardship

Insurance can incentivise risk-smart behaviour and stewardship of the environment. Risk transfer generates greater risk awareness and recognises the real financial consequences of risk. Putting a price on risk creates the real incentive of potential reduced insurance cost, retained market value, and maintained access and use. Insurance mechanisms can be truly beneficial when they not only provide protection against the impacts of catastrophic events, but also incentivise local stewardship of the environment and the sustainable growth of the blue economy by providing a financial mechanism by which risk reduction activities are recognised.

Insurance can provide coverage and liquidity to respond to threats to ocean health and natural infrastructure. It can also de-risk investments in coastal ecosystems and their conservation.

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The Pacific Ocean Finance Program – Insurance (POFPI) aims to develop insurance products to:

- Protect investments in conservation;
- Provide immediate liquidity for early post-event response; and
- Increase the financial resilience of communities reliant on the blue economy and natural infrastructure assets.

Parametric Insurance of Blue Infrastructure

Coral reefs are severely impacted by wave action during hurricanes, and sediment, trees and other detritus cause even greater damage in the days and weeks after a storm. Reef recovery is greatly speeded and enhanced by rapid clean-up.

Parametric insurance is a financial mechanism that provides pay-outs based on the occurrence of an event rather than an actual loss. This allows rapid liquidity post-event, since there is no loss-adjustment process and events are defined by verifiable independent agencies.

This type of cover could protect coral reefs and mangroves, providing rapid funding to respond to damaging events such as cyclones and heavy rain through:

- Rapid reef clean-up (funding early response that increases reef recovery after cyclones, which in turn can incentivise planning for response)
- Rapid liquidity for waste and water infrastructure response to address impacts of run-off on ocean health
- Pay-outs could be used to give cash payments to fisherfolk to not fish or provide other social benefit support to ease post-cyclone stress on reefs (or mangroves)
- Could be a more general hedge against revenue interruption for MMA-type conservation business model – diving and visiting reefs will not be as attractive if a reef has severe impacts from a storm

Fisheries Support

Fisheries play a vital role in food security for the world's population and provide livelihoods to some of the poorest and most vulnerable communities. Yet fishing is a high-risk activity, with injury and loss of life all too common. Physical risks threaten assets such as boats, and volatile catch quantity and prices create high inter-annual income variability.

Destructive or damaging fishing activities also threaten the very resource these communities rely on. Supporting a resilient and sustainable fisheries sector is a key pillar for prosperity and long-term ocean health.

Preferential access to insurance products can be provided as a reward for registration and tagging and / or in exchange for adherence to responsible fisheries management. This can incentivise environmental stewardship, support sustainable fisheries, and increase the financial resilience of fishing communities.

Coverage could be through a microinsurance initiative or sovereign level insurance scheme, and could include:

- Life and health insurance;
- Vessel coverage; and / or
- Livelihood protection.

Early Climate Change Impact Finance

Coasts and islands are particularly susceptible to the impacts of climate change and resulting increases in ocean risk, many of the effects of which will be chronic and slow-onset, rather than acute and immediate. While insurance is typically most effective to mitigate the financial impacts of shock events, it can also protect against timing risk, in a life insurance-like model.

Coral reefs are particularly susceptible to changes in ocean temperature and acidification. Insurance that can mitigate the financial impact of damage to reefs can unlock sustainable investment on the coasts. It can also provide liquidity during a bleaching event, which can be used to fund activities to reduce pressure on reefs, allowing them to recover. An insurance programme could also serve as a mechanism to pool the risk of severe bleaching events to a range of stakeholders / across a wide geographical zone.

The rate of ocean warming or sea level rise can be measured and represented as an index, and, therefore, parametric insurance can be designed, triggering pay-outs if rates exceed pre-agreed thresholds.

WillisTowersWatson

Invitations and agendas for certain stakeholder consultation sessions can also be found embedded in the meeting notes below.

Nadi Consultation Notes

Asian Development Bank Annual Meetings

Our first set of consultations were around the gathering of Asia-Pacific leaders, technocrats and development partners on the occasion of the fifty-second Annual Meeting of the Board of Governors of the Asian Development Bank (ADB). This was the first such meeting held in a Pacific Island country, and therefore had a particular focus on issues related to the Pacific islands (something not always present at ADB meetings or in ADB activities more broadly).

ADBI Meeting

On 1 May 2019, the Asian Development Bank Institute (ADBI) hosted a regional workshop on the blue economy, disaster risk financing, and ocean infrastructure. This was an invitation-only side event to the ADB Annual Meetings and included representatives from academia, the private sector, and the public sector, both regional and international.

This was an extremely academic workshop; the format was three sessions in which an academic paper was presented followed by an academic review. It was a good example of all of the key buzzwords being taught and presented on, without much room for feedback or dynamic group discussion. Additionally, there were few Pacific Island country representatives. There were, however, representatives from Vanuatu and the Solomon Islands that we managed to continue conversations with over email and in person later in the consultation process.

This session highlighted the need to begin each one of our presentations with an introduction highlighting the interactive nature of our consultations. Participants were welcomed to interrupt with questions or comments at any time.

Insurance Development Forum Panel

On 2 May 2019, the Insurance Development Forum (IDF), hosted a seminar during the ADB Annual Meetings. The theme of the Seminar was "*Accelerating Private Sector Financing for Disaster Risk Management and Climate Resilience in the Asia Pacific Region*".

While this session was not specifically focused on ocean health or the Pacific Ocean Finance Program, with over 160 attendees, including senior representatives from international development organisations and ADB Member countries, it provided an excellent introduction to a number of senior stakeholders, as well as a pathway for introducing ocean finance and blue economy resilience as part of the wider discussion around climate resilience and disaster risk management.

The seminar highlighted the high levels of vulnerability to natural disasters and climate risks within the Asia-Pacific region and the need for greater innovation and partnerships to accelerate the flow of financing for disaster risk management and climate resilience. Specifically, the goal was to:

- Showcase successful cases of Disaster Risk Financing (DRF) solutions and innovative partnerships structured to support delivery;
- Explore opportunities for further alignment between risk financing and risk mitigation investments between various actors including Development Banks, Governments and private sector parties;
- Discuss risk sharing and risk transfer mechanisms and steps being taken by the insurance industry to accelerate financing for disaster and climate resilience; and
- Provide practical guidance on how the insurance industry can support strengthening of DRF systems in the Asia Pacific region.

The meeting brought together a range of leading experts and officials from both the public and private sector to share insights in line with the goals of the session. Leading the discussions were:

- Ms. Ekhosuehi Iyahen, Secretary General, IDF (Introduction)
- Dr. Bambang Susantono, Vice-President for Knowledge Management and Sustainable Development, ADB (Keynote)
- Dr. Simon Young, Strategic Advisor, Willis Towers Watson (Panel Moderator)
- H.E. Aiyaz Sayed-Khaiyum, Attorney-General and Minister for Economy, Public Enterprises, Civil Service & Communications, Fiji (Panel Discussant)
- Dr. Hongjoo Hahm, Deputy Executive Secretary, UN ESCAP (Panel Discussant)
- Ms. Sarah-Jane Wild, CEO, Pacific Islands at Tower Insurance & Board Member of PCRIC (Panel Discussant)

Simon Young moderated a panel discussion focussed on the needs of public and private sector financial resilience to natural hazards and extreme climactic events. One question of specific relevance to the POFP concerned the risk reduction benefits of healthy coastal ecosystems / mangroves in particular. H.E. Aiyaz Sayed-Khaiyum confirmed the Government of Fiji's support for mangrove restoration as a priority, citing government restoration projects as well as the Fiji Airways initiative to plant a tree for every take-off.

A key connection made as a result of Simon's moderation of this panel was via a side-bar discussion with Naoko Ishii, the CEO and Chairperson of the Global Environment Facility (GEF). The wider context the session provided, examining the applications of disaster risk financing and insurance as development tools, enabled a further discussion on ocean risk as it affects the Pacific region. This engagement is ongoing, as we are exploring ways of leveraging wider climate resilience discussions and the potential of risk financing mechanisms to complement ongoing initiatives focused on ocean health.

A broad takeaway from this panel and subsequent stakeholder consultations / discussions around risk finance to support ocean health was the continued need to make the case that:

- A structured risk management approach must consider environmental risk and resilience, since coastal ecosystems are truly valuable public assets; and
- Insurance can play a role in the resilience and restoration of healthy marine ecosystems in much the same way it can play a role in the resilience and restoration of other public infrastructure such as roads and bridges.

Therefore, it is crucial to connect the case for investing in healthy oceans with the case of the wider climate resilience agenda, i.e. that insurance mechanisms can support healthy public and private sector balance sheets by recognising and reducing the contingent liabilities associated with climate risk. Subsequent stakeholder consultation, therefore, included discussion around the alignment of POFPI with wider efforts in the climate resilience space, joining the dots between disaster and climate risk management and ocean health.

Individual Stakeholder Consultations

Stakeholder:	British High Commission
Date:	3 May 2019
Present:	Simon Young Jacq Wharton Melanie Hopkins (Melanie.Hopkins@fco.gov.uk)—UK High Commissioner and Head of the Pacific Network Jean-Paul Penrose (jp-penrose@dfid.gov.uk)—Development Counsellor, Pacific

The UK government is paying increasing attention to the Pacific, focusing particularly on fisheries and plastic pollution. Therefore, the UK High Commission is interested in initiatives supporting the blue economy. Melanie and Jean-Paul Penrose were supportive of the Pacific Ocean Finance Program as a whole and particularly interested in supporting the application of insurance mechanisms to risk in the fisheries sector.

The UK High Commission is organising H.E. Aiyaz Sayed-Khaiyum's (Attorney-General and Minister for Economy, Public Enterprises, Civil Service & Communications, Fiji) visit to the UK for London Climate Action Week, and it was discussed that Willis Towers Watson might host him in London to discuss Pacific regional resilience goals and the growth of a sustainable blue economy.

Further, Tuvalu are the Pacific Island Forum leaders in August, and the UK High Commission is supporting the development of their keystone narrative around resilience and finance. This is an

opportunity to embed the principles of the Pacific Ocean Finance Program, with a potential further link into the UN Secretary General's Climate Action Summit and the resilience theme (which the UK is leading on) and also the UK's own climate strategy (which covers both domestic and international aspects of climate policy and action).

UK DEFRA support for a potential Insurance Development Forum-led initiative to leverage the insurance industry to provide direct financial pressure (e.g. the withdrawal of insurance coverage) or collaboration on monitoring / enforcement against illegal fishing was also discussed.

Stakeholder:	Asian Development Bank
Date:	3 May 2019
Present:	Simon Young Jacq Wharton Charlie Benson (cbenson@adb.org)—Principal DRM Specialist Bruce Dunn (bdunn@adb.org)—Director, Safeguards Division, Concurrently OIC, Environment Thematic Group, Sustainable Development and Climate Change Department

The ADB launched an extensive commitment focusing on ocean health during the ADB Annual Meetings—a $5bn 'Healthy Oceans Action Plan.'

> The Action Plan for Healthy Oceans and Sustainable Blue Economies will expand financing and technical assistance for ocean health and marine economy projects to $5 billion from 2019 to 2024, including cofinancing from partners. It will focus on four areas: creating inclusive livelihoods and business opportunities in sustainable tourism and fisheries; protecting and restoring coastal and marine ecosystems and key rivers; reducing land-based sources of marine pollution, including plastics, wastewater, and agricultural runoff; and improving sustainability in port and coastal infrastructure development.
>
> (https://www.adb.org/news/adb-launches-5-billion-healthy-oceans-action-plan)

Bruce Dunn is leading this initiative, and we met with him and Charlie Benson, who leads on Disaster Risk Management and Finance projects. While there is still a gap between project finance and insurance / risk finance in the public sector, one of the key messages of POFPI—that blue / green infrastructure is similarly exposed to catastrophe risk as grey infrastructure, and therefore conservation and business planning in the blue economy must similarly plan for resilience—was the central reason for connecting with both the disaster risk finance team and environment and climate change colleagues at the ADB.

The ADB is supportive of initial concept designs and would like updates on any case studies / pilots.

Suva Consultation Notes

WWF Workshop

Stakeholders:	WWF, Government of Fiji, other local stakeholders below
Date:	6 to 8 May 2019
Present:	Jacq Wharton Vinesh Kumar (vkumar@wwfpacific.org)—WWF John Tanzer (jtanzer@wwfint.org)—WWF Carol Phua (cphua@wwf.org.au)—WWF Samantha Petersen (spetersen@wwfint.org)—WWF Alifereti Tawake (livingwealthsolutions@gmail.com)—Living Wealth Solutions Sarah Whitfield (Sarah.Whitfield@careint.org)—Care International Ove Hoegh-Guldberg (oveh@uq.edu.au)—University of Queensland Nunia Thomas (nuniat@naturefiji.org)—NatureFiji Sangeeta Mangubhai (smangubhai@wcs.org)—WCS Susana Waqainabete-Tuisese (swaqainabete-tuisese@conservation.org)— Conservation International Helen Sykes (Helen@marineecologyfiji.com)—Marine Ecology Fiji Cherie Morris (cherie.morris@usp.ac.fj)—USP Maika Tabukovu (maika.tabukovu@fnu.ac.fj)—FNU Makelesi Raciri (makelesi.raciri@govnet.gov.fj) Rusiate Valenitabua (rusiate.valenitabua@govnet.gov.fj)—Provincial Conservation Officer at Ba Provincial Council Office Wiliame Katonivere (wkatonivere@gmail.com)—Tui Macuata Taukei Bolatagane in the chiefly village of Naduri, Labasa Apisai Rinamalo (bissrinamalo@gmail.com)—Divisional Forestry Officer Shivanal Kumar (shivanal.kumar@economy.gov.fj)—Ministry of Economy Vineil Narayan (Vineil.narayan@economy.gov.fj)—Ministry of Economy Richard Veeran (richard.veeran@gmail.com)—Principal Fisheries Officer— Inshore Fisheries Management Department Jodi Smith (jodi@teca.community)—The Earth Care Agency Jiu Daunivalu (jiu.daunivalu@gmail.com) Francis Areki (fareki@wwfpacific.org)—WWF Pacific Unaisi Malani—Tagicakibau (umalani@wwfpacific.org)—WWF Pacific

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Monifa Fiu (monifafiu@gmail.com)

Charlie Whiton (CharlieW@vulcan.com)—Vulcan

Kelera Daumeke (kelera.daumeke@agriculture.gov.fj)—Department of Agriculture

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Isaac Rounds (irounds@conservation.org)—Conservation International

Eleni Tokaduadua (eleni.tokaduadua@govnet.gov.fj)—GoF

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John Morrison (john.morrison@wwfus.org)—WWF

Marc Oremus (moremus@wwf.nc)—WWF New Caledonia

Emma Do Khac (edokhac@wwf.nc)—WWF New Caledonia

Mine Pabari (mine.pabari@athariadvisory.co.ke)—Athari Advisory

John-Paul (JP) Jaudel (jp.jaudel@wwfus.org)—WWF
David McCauley (David.McCauley@wwfus.org)—WWF
Artika Singh (asingh@wwfpacific.org)—WWF Pacific
Akata Kikau (akikau@wwfpacific.org)—WWF Pacific

WWF convened this three day workshop to develop a project concept to support the resilience of the Great Sea Reef (GSR) and surrounding community specifically for funding from the Green Climate Fund. This brought together local, national, and international stakeholders to map out a proposal that would benefit communities and ocean health. Community and government representatives, conservation and private partners as well as technical experts brainstormed and discussed innovative strategies to respond to climate change challenges faced by communities along the GSR.

This presented an excellent opportunity to explore the development of an insurance concept for the GSR and projects associated with this WWF effort, and we agreed to focus on the GSR as a POFPI case study. It is worth noting the multiple threats to ocean health around the GSR:

Local threats include:

- Pollution from agriculture and coastal development (and poor drainage / waste water treatment);
    - This is exacerbated by deforestation from, e.g. unsustainable logging / forest fires
- Damaging fishing practices including over-fishing in near-shore fisheries; and
- Ecosystem degradation through tourism usage and lack of conservation actions.

Global threats include:

- Climate change induced ocean warming;
- Sea-level rise and acidification and their resultant stressors on ecosystems, fisheries, production of harmful algal blooms;
- Increased frequency and/ or severity of natural catastrophe events such as severe cyclones;
- Rainfall extremes impacting on near-shore and coastal ecosystems;
- Pollution from plastics and other marine debris, including oil and chemical spills;
- Illegal fishing in EEZs and overfishing in the open seas; and
- Deep sea mining.

However, the GSR also has a couple of key things going for it, which make it an excellent site for concept development:

- One of the most resilient reefs to climate change; and
- Fiji has a good, established land **and marine** tenure system;

Another key stakeholder in attendance was the Fiji Locally Managed Marine Area Network (FLMMA). FLMMA is a partnership of NGOs and government who develop and implement management plans in Fiji.

Jacq presented potential insurance concepts to the group, with the idea being that there could be two roles for insurance: protecting the ecosystems themselves and providing financial incentive to reduce impacts on ocean health.

It was agreed that the Great Sea Reef would be a case study site. The presentation for this consultation is provided in the attached pdf document titled 'OceanInsuranceWWF_190507.pdf'.

Fiji Hotel and Tourism Association

Stakeholder:	Fiji Hotel and Tourism Association, WWF
Date:	9 May 2019
Present:	Jacq Wharton Fantasha Lockington—CEO, Fiji Hotel and Tourism Association Kesaia Tabunakawai—WWF John-Paul (JP) Jaudel—WWF David McCauley—WWF Jodi Smith—The Earth Care Agency

WWF requested Jacq join a meeting they had scheduled with the tourism association to assist in the socialisation of the Great Sea Reef project. The association is supportive of efforts to improve marine health and does recognise that coastal ecosystems are of critical importance to their businesses. The FHTA CEO, Fantasha, had never thought of them as 'assets' before, and appreciated that terminology.

It is, however, worth noting that the FHTA feels they are doing their part to pay for the maintenance of these assets, since they are the main contributors to the Environment and Climate Adaptation Levy. A point of contention was raised in that they do not see the benefits of this Levy directly, and they are not sure how it is being used, despite requesting this information from the government. This is a point to be raised with the POFP team working on taxes and subsidies for investigation.

Pacific Island Forum Secretariat Consultation

Stakeholder:	PIFS, regional institutions, national governments
Date:	6 May 2019
Present:	Jacq Wharton *Awaiting receipt of register*

Invitation

You are invited to join a half-day session on the Pacific Ocean Finance Program – Insurance (POFPI), exploring the potential for innovative risk finance to support ocean health, marine ecosystem resilience, and the security and prosperity of Pacific small island communities.

Under the insurance workstream of the Pacific Ocean Finance Program, we are exploring the feasibility of insurance instruments to support Pacific ocean health and thereby increase the resilience of Pacific communities.

POFPI aims to develop insurance products to:

- Protect investments in conservation;
- Provide immediate liquidity for early post-event response; and
- Increase the financial resilience of communities reliant on the blue economy and natural infrastructure assets.

We recognise the significant importance of embedding risk financing and insurance into ongoing initiatives, and we hope to identify case studies where we can provide technical assistance and support through the design of complementary insurance concepts.

In particular, we would welcome your thoughts on potential insurance concepts currently under development, including:

1. Parametric insurance of blue infrastructure (e.g. coral reefs and mangroves) to provide rapid funding to respond to damaging events such as cyclones and heavy rain;
2. Insurance as a reward for adherence to fisheries management policies and / or vessel registration, particularly in the fisheries sector where preferential access to insurance products can incentivise stewardship of the marine environment; and
3. Early climate change impact finance to provide recovery support following severe and / or repeated coral bleaching events.

Please join the POFPI consultation to share perspectives on the potential of risk financing instruments (like insurance) to support Pacific ocean health and resilience goals in the region.

The morning will begin with a scene setting from OFP-OPOC and background on innovative risk financing mechanisms from the POFPI project team. Interactive Q&A will be encouraged throughout the session, and we look forward to your honest feedback on where insurance could be a useful financial tool.

Event Information

When

Friday, May 10 2019 9:00am – 12:00pm

Agenda

9:00am – Arrival and introduction, OFP-OPOC
- Setting the Scene

9:15am – POFPI presentation with interactive Q&A
- Introduction to risk financing
- Risks to Pacific ocean health
- Why risk financing and when is it useful?
- Initial product concepts
- Questions

10:00am – Break

10:15am – Discussion

Willis Towers Watson

Consultation Notes

Following the Forum Economic Ministers Meeting (FEMM), which PIFS convened the week of 6 May 2019, the Insurance and Bond teams of the POFP presented at a day-long PIFS consultation, hosted by PIFS and FFA / OPOC.

While we were expecting somewhere in excess of 20 people to attend, only ~10 actually attended. These were mostly people from the insurance and donor communities; however, there was a representative from the Government of Tuvalu, where there is a strong interest in insurance for climate impacts.

There was interest in the POFP as a whole, and the use of innovative finance to address ocean risk and support the sustainable growth of the blue economy.

This was the most formal presentation with little interruption and Q&A at the end.

Key climate risks to ocean health were identified as:

- Warming oceans and associated acidification;
- Sea level rise;
- Increased severity of storms;
- Extreme weather—excess rainfall and drought; and
- Increased exposure.

Further, the health of the Pacific Ocean is threatened by both local and global risks, many of which are increasing more quickly than ever before. Local threats include:

- Pollution from agriculture and coastal development;
- Damaging fishing practices including over-fishing in near-shore fisheries; and
- Ecosystem degradation through tourism usage and lack of conservation actions.

And global threats include:

- Climate change induced ocean warming;
- Sea-level rise and acidification and their resultant stressors on ecosystems, fisheries, production of harmful algal blooms;

- Increased frequency and / or severity of natural catastrophe events such as severe cyclones;
- Rainfall extremes impacting on near-shore and coastal ecosystems;
- Pollution from plastics and other marine debris, including oil and chemical spills;
- Illegal fishing in EEZs and overfishing in the open seas; and
- Deep sea mining.

Perhaps of most interest was the introduction to parametric insurance presented.

PIFS representatives provided valuable information about policy frameworks already in place regarding fisheries in the region. However, there remains a challenge in identifying any relevant insurance concepts for open ocean fisheries.

A key question was posed by a representative of DFID regarding the evidence base for the insurance concepts and their use in anger. It was highlighted that there are no pilots / case studies that illustrate insurance applications to ocean health (globally, not just in the Pacific). There was a concept developed by TNC in Quintana Roo, Mexico, which is helpful to reference, but it has not been placed yet, and even if it is, it will be a while to develop the evidence base of impacts. Insurance is a long-term investment (i.e. policies won't pay out every year), and while building up the evidence base is important, moving from concepts to pilots will be a necessary early step to kick start documentation of experiences and outcomes.

Auckland Consultation Notes

Conservation International

Stakeholder:	Conservation International
Date:	6 May 2019
Present:	Simon Young Olive Andrews (oandrews@conservation.org) Luca Mori (lmori@conservation.org)

CI have a substantial Pacific Islands operation, maintained over many years and including in-country representatives plus a regional office in Fiji. CI in NZ operates out of the University of Auckland, and the Executive Director for the New Zealand and Pacific Islands Programme, Sue Taei (staei@conservation.org), operates out of here (though she was working from home on the Samoa Ocean Strategy at the time of the visit).

Olive and Luca described in general terms the work of CI, the high level of interest and activities in conservation finance, and the increased discussion around risk and insurance. Publicly at least, a lot of their work is framed around the Pacific Oceanscape[52].

The Phoenix Islands Protected Area (PIPA), in Kiribati, was a CI-led initiative, and they are also active in Palau (a current GCF proposal is the latest iteration), on Tuna fisheries with FFA (also a current GCF proposal), and have a ridge-to-reef project either ongoing or proposed to GEF. They are also supporting the Government of Samoa in development of their Ocean Strategy.

Links to academia are strong—particularly with U of A—the following researchers came up as doing work that might be interesting:

- Eddie Beetham (PhD student, U of A)
- Johann Bell (Senior Director of Pacific Tuna Fisheries at Conservation International and a visiting Professorial Fellow at the Australian National Centre for Ocean Resources and Security)—working on Tuna adaptation to climate change[53].
- Emily Corwyn

We discussed work on mangrove conservation, which CI felt could be relevant in Fiji, Samoa (an MPA includes mangroves) and PNG. Customary tenure (Rat iwi—local rights) was also discussed in the context, particularly, of Fiji and Samoa—this is very important in conservation activities.

52.See https://www.conservation.org/where/Pages/pacific-oceanscape.aspx for more insights
53.e.g. https://epubs.scu.edu.au/esm_pubs/2102/

Two aspects of insurance in its broadest sense came up and will be investigated some more:

- Conservation organisations benefit significantly from being donated boat time—on yachts etc—but this benefit is diminished because boat owners cannot get—or have to pay extra for—insurance if the yacht is being used for research / conservation purposes.

- Deep sea mining is a big concern for the Pacific islands from a conservation perspective, and CI would be interested in exploring how insurance might be used to hold mining companies to account in terms of environmental outcomes. In this context, the 'unfriend coal' movement was discussed— and whether there were similar dynamics in the deep sea mining context.

In conclusion, CI are active—with some specific focus countries and in some specific conservation areas (tuna fisheries, some MPAs) and, as we already know, are interested in innovation around finance, including insurance. However, later meetings in Samoa revealed that CI's approach is seen by some as being too top-down and, as with all the big conservation INGOs, the glossies and World Ocean Summit presentations don't always tell the whole story.

Apia Consultation Notes

SPREP (Secretariat of the Pacific Regional Environment Programme)

Stakeholder:	SPREP (Secretariat of the Pacific Regional Environment Programme)
Date:	8 May 2019
Present:	Simon Young Espen Ronneburg (espenr@sprep.org)—Climate Advisor Filomena Nelson (filomenan@sprep.org)—Climate Adaptation Expert

Espen has been a fixture at the UN-FCCC negotiations since at least 2010 when Simon first met him — he represents the Pacific region and also plays a role with AOSIS (which includes the other SIDS globally) and the LDCs at the negotiations, and is particularly involved in adaptation and loss & damage. Other key SPREP staff with whom I'd hoped to meet were away from Apia—some in Suva—and it is generally the case that SPREP staff are on a plane an awful lot.

Key points related to POFPI work in particular:

- **Fisheries**: Discussed IUU and the possibility for regular marine insurance to influence better behaviour across the international fishing fleet. Heard that in general, regulated boats are behaving—SPC and FFA are doing a decent job—with data loggers installed and observers aboard, though resourcing this work is always a challenge and any ways that insurance of these boats could influence better reporting of IUU activity would be very useful (e.g. finding a way to reward compliant boats which also report non-compliance). Espen said that the biggest IUU challenge at present is Vietnamese boats operating illegally in Micronesia. He also mentioned the clean energy transition risk that would be facing the legal, regulated operators in the coming years—the costs associated with implementing decarbonisation of the fishing fleet is likely to drive people towards IUU.
- **PICCIF (Pacific Islands Climate Change Insurance Facility)**: This is the Tuvalu initiative, and SPREP is assisting Tuvalu—via PIFS—to review various aspects of the original concept. In particular, SPREP will be investigating why climate risk insurance is still so underutilised in the region and what new innovations in the insurance and data spaces could provide opportunities. SPREP will also be doing a case study on tipping points in terms of climate change impacts—and the potential for insurance to help manage the impacts of reaching such tipping points.
- **Rainfall runoff**: Filomena raised this as an issue for reef conservation in particular, making the point that climate change is likely to increase rainfall volatility, which in turn will increase the runoff and pollution challenges already facing reef conservation, superimposed on increasingly stressed reefs.
- **Palau**: Espen mentioned the recent challenge that had been faced by conservation efforts due to the diversion of the resources from the green arrival tax to other government priorities—this seems to have been reversed to some extent, but highlights the ongoing issues with maintaining the flow of domestic financial resources to conservation and climate change adaptation.
- **Pacific Resilience Mechanism (PRM)**: This initiative (which includes a Facility or Fund) brings together DRM and climate change adaptation, and is aimed at pooling adaptation / DRM projects across multiple islands and acting as a sort of 'retail' outlet for 'wholesale' GCF (and other climate-related) financing.

- **Mangroves**: It was highlighted that the relatively small area of mangroves in the individual PICTs (except PNG) made it unrealistic, currently, to do much with potential carbon credits due to the high cost of M&E and verification.
- **Data**: SPREP coordinates the Pacific Meteorological Council, which comprises all of the national met services across the PICTs—in addition to providing the secretariat and administrative function, it also coordinates the various scientific panels and the research agenda.

Government of Samoa

Stakeholder:	Government of Samoa
Date:	8 May 2019
Present:	Simon Young Peseta Noumea Simi (noumea@mfat.gov.ws)—CEO, Ministry of Foreign Affairs and Trade Francella Strickland (francella@mfat.gov.ws)—Assistant CEO, Ministry of Foreign Affairs and Trade Ueta Faasili (ueta.faasili@maf.gov.ws)—Fisheries Department

The meeting with Govt of Samoa officials was re-arranged several times, and ended up only including representatives from the Ministry of Foreign Affairs and Trade (MFAT) and the Fisheries division within the Ministry of Agriculture and Fisheries (MAF). Several people in the Ministry of Natural Resources and Environment were contacted before, during and after the meeting but none were available. This situation highlights possibly the key point to come out of this meeting—that the Govt of Samoa (which is generally felt to be better-resourced than many other PICTs) is over-stretched to breaking point in terms of dealing with the volume of projects, programmes and general interest in all matters relating to climate change, adaptation, and ocean health. They are reluctant to not accept visitors or show interest in new initiatives, but key officials are on the road constantly, particularly to Suva for regional meetings, workshops etc, but also internationally—and have little time to do their day jobs.

- Compliance for small-scale fishers was an idea which resonated—using insurance as an incentive but also potentially opening access to credit (Samoa Development Bank used to have a revolving fund for fisheries lending, but is not in good shape at the moment so no access to credit currently for small-scale fishers).
- Mention also made of research needed to open up new fishing grounds—may be a role for insurance to incentivise fishers to take the risk and try the new grounds.
- There were meetings going on simultaneously the day Simon was in Govt HQ on the Samoa Ocean Security strategy (the one CI are involved in developing), and on the definition of Samoa's EEZ (which is not, apparently, fixed in law).

The key takeaway from the visit with the Government was that they are not in a strong position to evaluate how ‘ocean financing’ at the regional level could be applied in Samoa, so that the application of insurance as part of ocean financing is also outside of their capacity to fully evaluate at present. This is not to say that a fisheries project would not be welcomed or supported—but it would likely need to be led by an INGO in partnership with the government, rather than by the government alone and / or by a regional public sector organisation (which would be reliant on local government input).

UNEP

Stakeholder:	UNEP
Date:	8 May 2019
Present:	Simon Young Sefanaia Nawadra (sefanaia.nawadra@unep.org)—Head, UNEP Pacific Office Kolone Tikeri (kolone.tikeri@un.org)—Administrative Specialist

The UNEP office in Apia is co-located on the SPREP campus—it is small and not particularly closely engaged in the ocean health finance / insurance space—UNDP is more closely engaged, but no one from UNDP was available for a meeting during the visit (despite multiple attempts to contact them through different channels).

Sefa used to work for CI, so was familiar with ocean and coastal conservation work generally, and will be a useful project resource. He cautioned that countries would likely have challenges in internalising the key characteristics of insurance, and the expectations would have to be closely managed. He also indicated that coordination across the region would be difficult, as it is with many things.

Key points of relevance:

- UNEP has been asked to support the Tuvalu PICCIF project, which has not really been going anywhere since a workshop in Samoa in June 2017 (which David Simmons of WTW attended).
- UK is putting new support behind ocean health and climate change initiatives, including a new report entitled “Pacific Marine Climate Change Report Card 2018”[54].
- Substantial resources will be available under GEF-7 for ocean programmes in the Pacific—but not yet clear whether lead will be with UNEP or UNDP.
- Sefa mentioned the Mamanuca Environment Society[55] as a good example of tourist-funded reef conservation (though it appears now that the resorts that used to fund MES may not be doing so to the same extent now).

1. https://climateanalytics.org/media/cefas_pacific_islands_report_card_final_amended_spreads_low-res.pdf
2. https://mesfiji.org/

- Sefa also mentioned Peter Seligmann, former CEO of CI, who founded another conservation organisation called Nia Tero[56]—who are doing work at the community level in the Pacific.
- Sefa indicated that Samoan conservation organisations (mainly the Samoa Conservation Society, with whom a meeting was requested but could not be arranged) work on terrestrial rather than marine issues, with the exception of the Samoa Voyaging Society[57]—the President of which is Schannel van Dijken, who is also the CI representative on Samoa and with whom a meeting was requested but Mr van Dijken could not accommodate.

National Pacific Insurance

Stakeholder:	National Pacific Insurance
Date:	9 May 2019
Present:	Simon Young Joanne Rasmussen (Joanne.Rasmussen@npisamoa.ws)—General Manager, NPI Saueleele Ah Wong—Branch Manager, Apia

Joanne is responsible for all of NPI's operations across the three countries it operates in, Samoa, American Samoa and Tonga. Saueleele is the Branch Manager in Apia. NPI is a fully owned subsidiary of Tower Insurance, and Joanne reports in to Sarah-Jane Wild, head of Pacific Operations for Tower based in Fiji.

NPI is the leading general insurer in Samoa, offering homeowners (which covers natural perils), commercial, motor and some marine (total loss only, and mainly pleasure boats—just a few small fishing boats—'alia'—are insured). The vast majority of non-commercial insurance is purchased because it is a requirement of a loan agreement (noting that there is no compulsory motor insurance in Samoa). There is no crop insurance or any other form of microinsurance, although a rival insurer, Apia Insurance, has just introduced a micro product for funeral expenses which is supported by the Pacific Financial Inclusion Programme of the UNDP and financially by the NZ government[58]. Personal and home loans are provided through the two main (Bank of the South Pacific (BSP) and ANZ) and two smaller local banks (Samoa Commercial Bank and National Bank of Samoa)– there is only a very small microfinance market, and no credit unions or similar organisations. There is a Fisheries Society, but that is a lobby group rather than a provider of financial services.

Main agricultural cash crops are Taro, Bananas and Cocoa although access to credit is very limited. Access to credit for fisherfolk is also very limited—some is made available through the two main processing companies, Apia Export Fish Packers being the biggest[59].

1. https://www.niatero.org/
2. https://gaualofa.com/
3. https://www.insurancebusinessmag.com/nz/news/breaking-news/government-to-fund-samoan-funeral-insurance-scheme-113686.aspx
4. A good review of the Samoa fisheries sector by FAO can be found here: http://www.fao.org/fishery/facp/WSM/en

NPI works mainly with BSP on cyclone preparedness, as BSP loans are referred to NPI for insurance. They have a scheme where the cost of getting a cyclone certificate (engineer's certification of suitability for insuring, required to buy insurance) is added to the loan amount. NPI stated that it would be a big help if the cost of the certificate could be granted (it currently costs 300 Tala, or US$110), and they are also keen to implement the 'Bronze' scheme being developed by the World Bank in association with Tower in Fiji.

NPI currently write insurance for government property—a central portfolio for buildings, then some ministries separately cover contents, equipment etc. Rumour has it that this insurance purchase is under review and consideration is being given to self-insuring.

The regulator in Samoa is the Central Bank, in American Samoa it is the Insurance Supervisor, and in Tonga it is the National Reserve Bank.

In summary, NPI staff were very open and helpful, and revealed a largely undeveloped private insurance market.

Cherelle Jackson

Stakeholder:	Cherelle Jackson
Date:	9 May 2019
Present:	Simon Young Cherelle Jackson (cherelle@iisd.org)

Cherelle is an independent climate change / environmental consultant and journalist—she grew up and was substantially educated in Samoa, and has a PhD from the Center for Samoan Studies at the National University of Samoa, with a thesis concerning sovereignty and security issues around the oceans and climate change for Samoa. She has in the past worked for CI (including on ocean health indexing) and still consults for IISD as a reporter on United Nations climate change negotiations.

Cherelle was a wealth of knowledge and information on local Samoan culture and society and its impact on and role in conservation and adaptation. The following notes capture key points she made:

- Project implementation at the community level (e.g. GEF small-grants programme, administered by UNDP) is through the indigenous village structure (Council of Chiefs, below which are the 'untitled men', the Committee of Women and, separately, the wives of the Titled Men (Chiefs))—and usually it is the Committee of Women who 'manage' projects, including opening and being signatories on bank accounts.
- The Church is the other concentration of power in each village—the village is responsible for church upkeep, paying for 'staff' and also contributing to the 'centre'—and this may be across multiple denominations.
- Conservation is led by government—not really integrated with the Church (though has been in Kiribati apparently)—and CI model of MPAs "hasn't really worked".

- Fishing and water use rights—village controls access, government ‘owns’ the water, but village has local jurisdiction.
- Ocean health index—the hotel association (with 80% of hotels in Samoa as members) has been very supportive and would be a good counterpart.
- Climate change adaptation at village level—tends to be natural rather than forced, though infrastructure upgrading under national projects has been important. Community adaptation isn’t captured in national reporting because activities are outside of government jurisdiction.

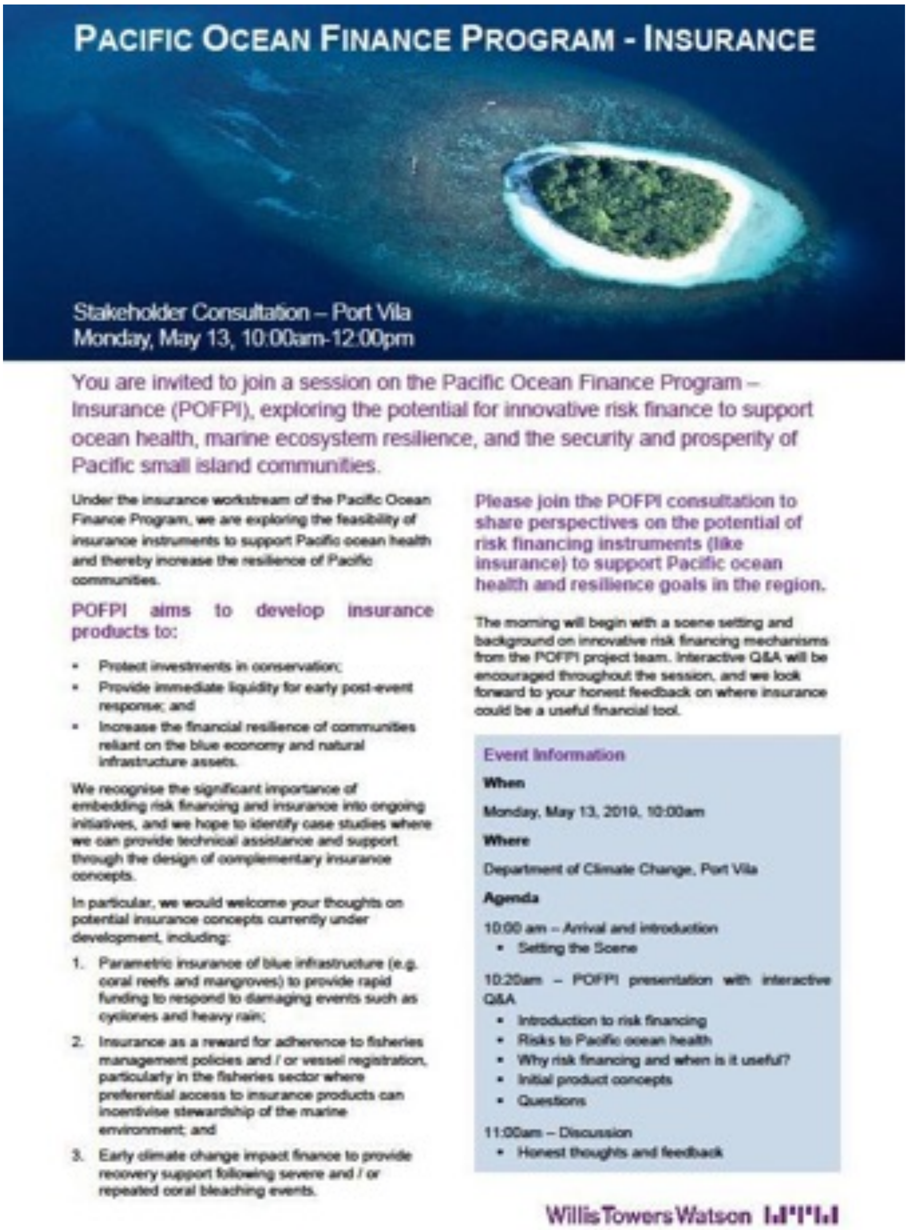
Overall impressions are that community-based action is a powerful force—particularly via the Church— but hard to shoe-horn into national and regional initiatives. Offshore fisheries are somewhat different (as village rights and custom only impacts on nearshore fisheries), and the hotel association may provide a strong force for reef conservation (but no obvious programme in place to piggy-back on).

Port Vila Consultation Notes

Government of Vanuatu

Stakeholder:	Government of Vanuatu
Date:	13 May 2019

Invitation


PACIFIC OCEAN FINANCE PROGRAM - INSURANCE

Stakeholder Consultation – Port Vila
Monday, May 13, 10:00am-12:00pm

You are invited to join a session on the Pacific Ocean Finance Program – Insurance (POFPI), exploring the potential for innovative risk finance to support ocean health, marine ecosystem resilience, and the security and prosperity of Pacific small island communities.

Under the insurance workstream of the Pacific Ocean Finance Program, we are exploring the feasibility of insurance instruments to support Pacific ocean health and thereby increase the resilience of Pacific communities.

POFPI aims to develop insurance products to:

- Protect investments in conservation;
- Provide immediate liquidity for early post-event response; and
- Increase the financial resilience of communities reliant on the blue economy and natural infrastructure assets.

We recognise the significant importance of embedding risk financing and insurance into ongoing initiatives, and we hope to identify case studies where we can provide technical assistance and support through the design of complementary insurance concepts.

In particular, we would welcome your thoughts on potential insurance concepts currently under development, including:

1. Parametric insurance of blue infrastructure (e.g. coral reefs and mangroves) to provide rapid funding to respond to damaging events such as cyclones and heavy rain;
2. Insurance as a reward for adherence to fisheries management policies and / or vessel registration, particularly in the fisheries sector where preferential access to insurance products can incentivise stewardship of the marine environment; and
3. Early climate change impact finance to provide recovery support following severe and / or repeated coral bleaching events.

Please join the POFPI consultation to share perspectives on the potential of risk financing instruments (like insurance) to support Pacific ocean health and resilience goals in the region.

The morning will begin with a scene setting and background on innovative risk financing mechanisms from the POFPI project team. Interactive Q&A will be encouraged throughout the session, and we look forward to your honest feedback on where insurance could be a useful financial tool.

Event Information

When

Monday, May 13, 2019, 10:00am

Where

Department of Climate Change, Port Vila

Agenda

10:00 am – Arrival and introduction
- Setting the Scene

10:20am – POFPI presentation with interactive Q&A
- Introduction to risk financing
- Risks to Pacific ocean health
- Why risk financing and when is it useful?
- Initial product concepts
- Questions

11:00am – Discussion
- Honest thoughts and feedback

WillisTowersWatson

Consultation Notes

Overall impressions of the Government of Vanuatu are very positive. The attendees were very engaged during the presentation, offering ideas on potential case studies and suggestions for product design.

Attendees noted that a key challenge for ocean health is waste management, particularly citing Port Vila harbour and sewage entering the water. They further identified unsustainable logging as a threat to the reefs and highlighted the need for a 'ridge to reef' approach. While insurance is unlikely to contribute to tackling these anthropogenic threats, it is worth noting that often the key risks are manmade, and these must be addressed through sustainable development and other innovative finance mechanisms / legislation / environmental safeguards.

Key threats where insurance could play a role were also identified:

- Crown of thorns starfish are of growing concern in Vanuatu, since they destroy corals. According to attendees, they flare up following heavy rains, which cause nutrient rich runoff to flow into the ocean, allowing the starfish to get out of control. The government has a good method of eradication, they just do not have sufficient funds in the aftermath of these rain events to respond quickly.
  - We could design a product to pay out based on a rainfall trigger, which would provide funds to the Ministry of Environment for crown of thorns eradication. This would require the establishment of the threshold where rains cause flare ups (i.e. in order to set the pay-out threshold, we would need to establish the amount of mm of rain linked to starfish infestation).
- When the idea of a potential pay-out designed to pay cash to fisherfolk following a windstorm to not fish on the reef (and therefore reduce pressure and allow it to recover more quickly) was discussed, the government cautioned against direct cash payments to the communities. However, a different idea for pay-outs was raised: to place FADs offshore and provide assistance to in-shore fisherfolk to get off the reef, which would have a similar effect without reducing access to a healthy source of protein following events that likely damage other healthy food (i.e. agriculture); and maintaining self-sufficient livelihoods.
  - In subsequent consultations, it was mentioned that following TC Pam, the Australian aid effort focused specifically on fisheries, which proved to successfully rehabilitate the sector in a relatively short amount of time.
- Mangroves were badly destroyed after TC Pam. Often, it is not a priority to replant. However, if insurance pay-outs (triggered by intense winds) were specified to go to mangrove restoration and replanting, it would allow the mangroves to rebound much more quickly.

Three other ongoing initiatives / sources of information were mentioned:

- A GCF blue carbon project in Vanuatu
- Coral Triangle Initiative

- A Pacific natural public asset database

It was noted that the Department of Environment sets up community conservation areas in Vanuatu. Also, the Environmental Protection Act has been instated, which provides legislation for the setting up of a conservation trust fund.

- A GEF5 project with FAO was mentioned to implement this.
- We discussed the critical benefits of conservation trusts—mainly the governance and environment-specific mandate.
- They are keen to get the coral that is more resilient to climate change in an MPA and discussed the marine spatial planning necessary.

The Department of Fisheries was also very interested in any value-add to fishing licences. They are currently trialling a system and would like any support on vessel tracking / emphasising safety at sea. A small-scale fisherfolk insurance scheme was discussed, to which they were very open, but lack expertise and would need subsidisation.

It is worth noting that the Vanuatu government certainly have the capacity to explore these concepts and are very capable and engaged; however, they have no room in their budgets for insurance (or many other things) that is not supported by donors.

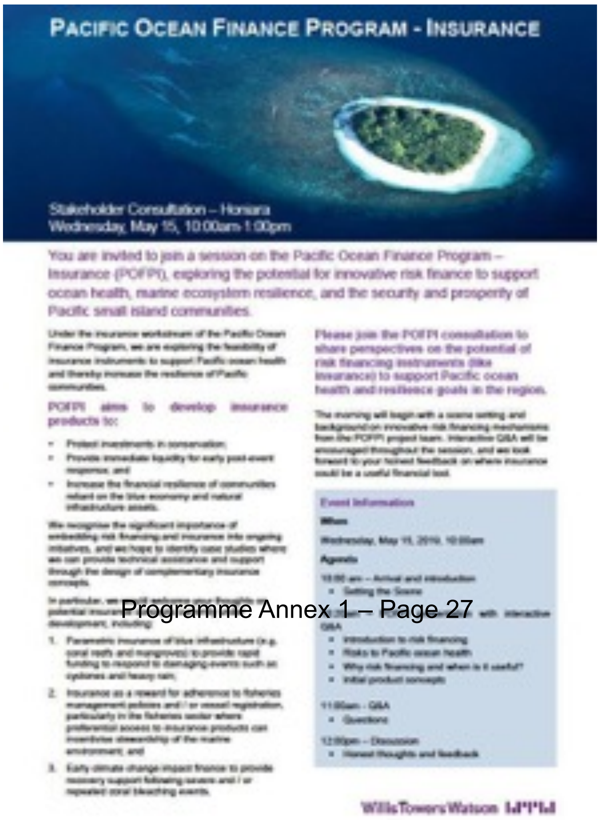
Honiara Consultation Notes

Forum Fisheries Agency and Government of Solomon Islands—Joint Consultation

Stakeholder: Government of Solomon Islands and Forum Fisheries Agency

Date:	16 May 2019			
Present:	Jacq Wharton			
	Rodney Beard	FFA	Fisheries Economic Adviser	rodney.beard@ffa.int
	Jan Oli Pitu	MFMR	Chief Fisheries Officer (offshore management)	jpitu@fisheries.gov.sb
	Rosalie Masu	MFMR	DD / Inshore	rmasu@fisheries.gov.sb
	Charlie Onahikeni	MOFT	Policy Analyst	conalhikeni@mof.gov.sb
	Lily Wheatley	MFMR	Fisheries Economist	lwheatley@fisheries.gov.sb
	Margaret Leoa	MOFT	Policy Analyst	mleoa@mof.gov.sb
	Hudson Ilala	MOFT	Policy Analyst	hilala@mof.gov.sb
	John H. Lasi	MOFT	Policy Analyst	jslasi.mof.gov.sb
	Tony Sullivan	FFA	Investment Manager	tony.sullivan@ffa.int
	Perry Head	FFA	DCS	perry.head@ffa.int
	Samantha Tuti	MFMR	PROP-C	samantha.tuti@fisheries.go
	Judy Arumae	FFA	PROP-C	judy.arumae@ffa.int

Invitation



Pacific Ocean Finance Program - Insurance

Stakeholder Consultation – Honiara
Wednesday, May 15, 10:00am-1:00pm

You are invited to join a session on the Pacific Ocean Finance Program – Insurance (POFPI), exploring the potential for innovative risk finance to support ocean health, marine ecosystem resilience, and the security and prosperity of Pacific small island communities.

Under the insurance workstream of the Pacific Ocean Finance Program, we are exploring the feasibility of insurance instruments to support Pacific ocean health and thereby increase the resilience of Pacific communities.

POFPI aims to develop insurance products to:

- Protect investments in conservation;
- Provide immediate liquidity for early post-event response; and
- Increase the financial resilience of communities reliant on the blue economy and natural infrastructure assets.

We recognise the significant importance of embedding risk financing and insurance into ongoing initiatives, and we hope to identify case studies where we can provide technical assistance and support through the design of complementary insurance concepts.

In particular, we [illegible] development, including:

1. Parametric insurance of blue infrastructure (e.g. coral reefs and mangroves) to provide rapid funding to respond to damaging events such as cyclones and heavy rain;
2. Insurance as a reward for adherence to fisheries management policies and / or vessel registration, particularly in the fisheries sector where preferential access to insurance products can incentivise stewardship of the marine environment; and
3. Early climate change impact finance to provide recovery support following severe and / or repeated coral bleaching events.

Please join the POFPI consultation to share perspectives on the potential of risk financing instruments (like insurance) to support Pacific ocean health and resilience goals in the region.

The morning will begin with a scene setting and background on innovative risk financing mechanisms from the POFPI project team. Interactive Q&A will be encouraged throughout the session, and we look forward to your honest feedback on where insurance could be a useful financial tool.

Event Information

When

Wednesday, May 15, 2019, 10:00am

Agenda

10:00 am – Arrival and introduction
- Setting the Scene

[illegible] with interactive Q&A
- Introduction to risk financing
- Risks to Pacific ocean health
- Why risk financing and when is it useful?
- Initial product concepts

11:00am - Q&A
- Questions

12:00pm – Discussion
- Honest thoughts and feedback

WillisTowersWatson

Consultation Notes

FFA and the Government of Solomon Islands (SI) have fairly different perspectives, but this was a useful consultation nonetheless. Key points from both:

- **Government of SI**: appears to have very tight budget constraints. They do support the idea of finance for ocean health; however, they will need external funding for any initiative in this space (and indeed many other spaces as well).
- **FFA**: Has an offshore mandate. FFA is interested in the possibility of insurance concepts that may hedge against slow-onset climate change impacts to pelagic fisheries; however, no relevant uses for insurance are apparent / it is likely that insurance is not the ideal finance mechanism here. FFA were extremely interested in whether insurance could be used to compensate countries against the effects of climate change on moving fish stocks or potential fish price shocks. It was reiterated several times that insurance and compensation are two different things. Insurance premiums will always be, in the long term, more expensive than the amount of pay-outs received. Insurance's value, however, is that it protects against shock events that cannot otherwise be absorbed easily, and therefore you are willing to pay a premium for that access to a larger sum of money if you should need it. This point—that insurance is for shock events and premiums will be slightly larger than pay-outs, averaged over the long term, is a critical insurance 101 point to make in any subsequent reports.

It was noted that the in-shore fisheries in SI are mainly subsistence, not commercial, and there is no licence requirement, which does not make it a good candidate for fisheries insurance. The attendees did, however, seem interested in potential agriculture microinsurance scheme that could be linked to sustainable practices.

There is one example of a legalised MPA—SI has one nationally declared marine protected area (Arnavons), which provides an endowment fund for managing the site. The partner here is TNC, and it is worth exploring whether insurance may be relevant to this fund.

The Government of SI (through the Ministry of Environment and Fisheries and partners) is also exploring large marine managed areas (e.g. Kavachi Seascape with WCS and Bismarck Solomon Seas Ecoregion with PNG).

It was also highlighted that under the new Solomon Islands Ocean Policy, the theme of sustainable financing is an important aspect. The wider POFP may be able to plug in here. Additionally, under the MACBIO Project, an economic valuation of the marine ecosystems was produced for SI. This does provide the policy case for why we should be investing in and maintaining healthy ecosystems.

SI also has established Protected Areas Trust Fund establishment provisions, and the GEF-5 project now in implementation in SI will be developing models for this establishment. It may be a good opportunity to start a conversation about how insurance can be a complementary instrument to other financial mechanisms.

It became clear that the Government of Solomon Islands has no budget for insurance / initiatives to support ocean health. They rely on donors for a lot of support in this space. To illustrate where priorities may be, government workers, for example, have no insurance whatsoever. It was raised that fisheries enforcement officers have no workers compensation insurance, and they are especially at risk at their jobs.

Our impression is that SI will very happily do what they can to secure funding or capacity building / technical assistance for ocean health, but it is not a government budget priority. The biodiversity in SI / the Coral Triangle means that they receive a lot of external assistance, and the REDD+ program for forestry acting as a carbon sink is also in SI, so if we explore a concept in SI, it will have to be in connection to an ongoing externally funded initiative. One big issue for SI marine ecosystems is unsustainable logging, though, so a REDD+ linkage may be worth exploring.

Programme Annex 2: Stakeholder Consultations, September 2019

The following report compiles the Pacific Ocean Finance Program—Insurance (POFPI) team's notes and impressions from a three-country stakeholder consultation process in the South Pacific. Dr Simon Young arrived in Nadi, Fiji on Wednesday, 28 August 2019, where he was joined by Michael Barkhausen, Head of Catastrophe Risk Modelling for Willis Towers Watson in Australasia and the Pacific islands. Subsequently, Dr Young and Mr Barkhausen travelled to Wellington, New Zealand and then Dr Young travelled on to Palau.

A variety of stakeholders were consulted both in general terms regarding the POFPI project and three insurance concepts developed and, in some specific cases (WWF Pacific in Suva, and all stakeholders in Palau), on individual concepts in detail. Collateral used included the POFPI flyer originally developed for the first stakeholder consultation in May 2019, a slide deck with some general background but concentrating on the three specific insurance concepts, and a late draft of the 8-page concepts summary report which is one of the deliverables for the POFPI project.

Despite our best efforts at meeting with key stakeholders on two of the three concepts (knowing that we would not be able to meet with key stakeholders on the Vanuatu concept), we were not able to meet with all relevant WWF officials in Suva regarding the Fiji concept (due to over-run of a field visit by key staff, and also the retirement of the head of WWF-Pacific), and were not able to get a meeting with officials from Koror State in Palau, a level of government where we believe the Palau concept to be relevant (in addition to the national government). In the cases of Fiji and Vanuatu, we concentrated significant resources during the first stakeholder visit on these two countries and getting feedback on the two relevant insurance concepts (by which time they were already well-formed), and have subsequently been in regular touch with various stakeholders.

Suva Consultation Notes

Consultations in Suva, Fiji, included the private sector, government (both relevant Ministry and regulator), and the NGO / conservation sector. With all three sectors, we were able to raise awareness regarding the insurance concepts developed and gather feedback on their applicability, both specifically in Fiji and more generally across the region.

Tower Insurance

Stakeholder:	Tower Insurance
Date:	28 August 2019
Present:	Simon Young Michael Barkhausen (WTW) Sarah-Jane Wild (sarahjane.wild@towerinsurance.com.fj), outgoing Head of Pacific Operations Paula Ter Brake (Paula.TerBrake@tower.co.nz), incoming Head of Pacific Operations Various Tower Insurance board members

Dr Young was invited to address the Board of Tower Insurance during their multi-day gathering in Suva, to share his knowledge of insurance innovations in the conservation, development, and humanitarian spaces globally, and to identify opportunities for replication and / or scaling up in the Pacific region. This included presentation of the POFPI concepts, which garnered considerable interest from board members and senior managers, both during and after the presentation, and during informal engagement on the margins of the board meeting. In particular, country managers responsible for operations in all 8 of the countries served by Tower expressed interest in the concepts presented, particularly the Vanuatu concept which they saw as having broad applicability both in terms of the target audience and the jurisdiction.

Separately from the board meeting, Dr Young and Mr Barkhausen met with both outgoing and incoming heads of Pacific Operations for Tower, providing further opportunity to explore private insurance market engagement to champion insurance innovations as well as provide direct administrative and risk-taking capacity.

Pacific Catastrophe Risk Insurance Company (PCRIC)

Stakeholder:	Pacific Catastrophe Risk Insurance Company (PCRIC)
Date:	29 August 2019
Present:	Simon Young Sarah-Jane Wild (sarahjane.wild@towerinsurance.com.fj), Director

Barry Whiteside (barrywhiteside1955@gmail.com), Director

Dr Young met with two of the board members of PCRIC, the regional sovereign parametric risk pool, to brief them on the status of the POFPI project and potential opportunities for the engagement of PCRIC. PCRIC is cited in the concept designs as an obvious ultimate risk taker for both of the products which are well-advanced as well as, potentially, the third, coral bleaching, product. It was recognised that PCRIC is keen to expand its product range to sovereigns (and, potentially, sub-sovereigns and other actors) and that its public-good modelling platform as well as cost-effective risk capacity would bring important benefits to roll-out of any and all of the POFPI insurance concepts. The PCRIC board members warned of certain constraints to its activities outside of the direct sovereign insurance space (due mainly to the terms of a grant agreement it has with the World Bank controlling access to donor funding), and to limitations on access to its risk models (due to initial design and access constraints), but they indicated that progress was continuing to be made on both issues, and also noted that PCRIC's ability to serve non-sovereigns was also being advanced.

Reserve Bank of Fiji

Stakeholder:	Reserve Bank of Fiji (RBF)
Date:	29 August 2019
Present:	Simon Young Michael Barkhausen (WTW) Various RBF officials including the Governor, Ariff Ali (ariff@rbf.gov.fj)

Dr Young and Mr Barkhausen met with the Governor of the RBF along with several members of his team. The RBF is the regulator of insurance activities in Fiji, and the Governor has been a strong advocate of expanding the use of insurance in Fiji, particularly amongst lower income populations and for supporting Fiji's strong climate risk management and adaptation agenda. The Governor and team were pleased to hear of the work being undertaken under the POFP umbrella generally, and were particularly interested in the insurance concepts. The RBF team was primarily focussed and asked questions around the applicability of all three concepts in Fiji, but the Governor was also interested in regional aspects, and stated that the RBF works closely with other insurance regulators across the Pacific region and would be willing to support regional discussions around regulatory issues as any or all of the insurance concepts are built out. The Governor noted that several climate risk insurance initiatives were active across the region, and urged coordination across these initiatives, particularly with PCRIC, the regional sovereign risk pool, and with the private sector.

Government of Fiji

Stakeholder:	GoF, Ministry of Economy, Climate Change Unit
Date:	29 August 2019
Present:	Simon Young Michael Barkhausen (WTW) Nilesh Prakash (nprakash001@economy.gov.fj), Director for Climate Change Vineil Narayan (vineil.narayan@economy.gov.fj), Climate Finance Specialist

The RBF Governor suggested that the team seek to meet with the climate change unit within the Ministry of Economy, where the mandate for exploring and implementing climate risk insurance mechanisms sits within the Government of Fiji. A short meeting was subsequently arranged, and the Director and one other member of the team in the climate change unit were briefed on the POFPI project and the three insurance concepts developed. There was insufficient time during the meeting for substantial feedback to be collected but the officials were keen to be further briefed as and when the concepts were finalised.

WWF Pacific

Stakeholder:	WWF Pacific
Date:	29 August 2019
Present:	Simon Young Michael Barkhausen (WTW) Francis Areki (fareki@wwfpacific.org), Conservation Director

Due to delay in the completion of a field visit by a number of members of the WWF Pacific team in Suva, only the Conservation Director was available to meet with Dr Young and Mr Barkhausen. He and others in the WWF Pacific team are involved in other tracks within the POFP project, and had already been in discussion with the WTW team on the three insurance concepts; indeed, the Fiji case study focuses specifically on supporting a broader coral reef health and coastal community adaptation project being developed by WWF Pacific. Mr Areki was interested also in the other two concepts presented, and indicated that he would share the materials provided across the WWF Pacific team.

Wellington Consultation Notes

Dr Young and Mr Barkhausen made use of a need to connect through New Zealand to visit with GNS Science and the NZ Government's Ministry of Foreign Affairs and Trade, both located in Wellington, and both active in the general development space in the Pacific islands.

GNS Science

Stakeholder:	GNS Science
Date:	30 August 2019
Present:	Simon Young Michael Barkhausen (WTW) Gill Jolly (G.Jolly@gns.cri.nz)—Earth Structure and Processes Manager Suzy Paisley (s.paisley@gns.cri.nz)—Planning and Risk Management / Social and Behavioural Science Team Leader

WTW has a long history of collaboration with GNS Science, including mot recently on disaster risk financing work for volcanic eruptions in the Pacific. GNS Science has also been actively advising the NZ Government on a strategy to support disaster risk financing in the Pacific. The POFPI project in general and specific insurance concepts in particular were presented and discussed and, while technical aspects of climate and ocean risk are somewhat outside of the general remit of GNS Science, there were many aspects of broader disaster risk management in the Pacific islands, and socio-economic barriers to insurance usage, that are common to core elements of GNS Science's work. The GNS team particularly noted the innovative nature of the proposed insurance concepts, and were very interested to learn of the potential breadth of application of parametric insurance tools, as well as the use of particular scientific datasets to underpin such products.

NZ Ministry of Foreign Affairs and Trade

Stakeholder:	New Zealand Government—Ministry of Foreign Affairs and Trade (MFAT)
Date:	30 August 2019
Present:	Simon Young Jonathan Kings (jonathan.kings@mfat.govt.nz)—Deputy Secretary Pacific and Development Group Llewellyn Robers (llewellyn.robers@mfat.govt.nz)—Divisional Manager, Economics and Environment—Sustainable Development Sector & Thematic Division Alex Shahryar-Davies (alex.shahryar-davies@mfat.govt.nz)—Lead, climate risk insurance

Dr Young met with the leader and senior members of the team within MFAT responsible for NZ Government development activities and partnerships in the Pacific islands. A briefing was provided on the disaster risk insurance landscape, with a particular emphasis on the innovations being supported by POFP. It was recognised by the MFAT team that such activities were directly relevant to a number of different areas of NZ engagement with the Pacific islands, including conservation, climate risk insurance, climate change adaptation and financing more generally, and their broad economic development agenda. They identified the importance of a regional approach and using existing regional institutions where possible, rather than creating new ones. They also indicated that they consider the Asian Development Bank as a key development partner in this space and likely channel for financial support of disaster risk financing generally in the Pacific region.

While there was no firm commitment to supporting future projects to implement any of the POFPI concepts, there is stated interest in being part of any discussions around such projects, particularly if they can be linked to projects and programmes already receiving NZ funding.

Palau Consultation Notes

Dr Young had only a short time in Palau so several desired meetings could not be scheduled during the available time. However, meetings with 6 separate institutions were held, all relevant to the POFP in general and to the Palau insurance concept in particular. Overall, there was a noticeably lower level of understanding of insurance in general and of its application to support conservation and ocean health in particular in Palau than in Fiji and other Polynesian and Melanesian islands which have played an active role in discussions around the regional disaster risk insurance facility (originally under the PCRAFI project and now established as PCRIC). That having been said, there is a very high level of activity in Palau supporting understanding of both acute and chronic climate hazards on the ocean and coastal environment and in particular on coral reef health, so the overall environment is conducive to rapidly building understanding regarding the potential role of disaster risk financing tools and products to support climate change adaptation and resilience.

The presentation for this consultation is provided in the attached pdf document titled 'OceanInsurancePalau_190903.pdf'.

Palau International Coral Reef Center

Stakeholder:	Palau International Coral Reef Center (PICRC)
Date:	3 September 2019
Present:	Simon Young Yimnang Golbuu (ygolbuu@picrc.org)—Chief Executive Officer

PICRC is a leading global scientific institution undertaking research on coral reefs in general—but with particular emphasis on issues pertinent to Palau, especially exploration of coral bleaching and cyclone impacts on coral reefs. PICRIC has been undertaking reef monitoring since 2001 and is an important validation partner to the NOAA Coral Reef Watch (CRW) programme (which provides the data set underpinning the coral bleaching insurance concept for which Palau is the case study).

Dr Young met with PICRC's CEO to introduce the POFP project in general and the Palau insurance case study in particular. Dr Golbuu was generally aware of the project, and had been introduced to climate risk insurance concepts via Dr Young during a workshop hosted by the International Coral Reef Initiative (ICRI) in December 2018. The specific case of developing a parametric index for coral bleaching was new to him, and he expressed a willingness to collaborate on the validation side of index development for Palau—noting that one of the bleaching events identified in the CRW data, in 2016, had only moderate impact on Palau's reefs. He also noted that for the Jellyfish Lake case, the link between jellyfish mortality and ocean temperature is less direct than for coral bleaching, and noted the role of low rainfall in the jellyfish mortality case.

The following key questions were raised by Dr Golbuu during the meeting, with answers provided by Dr Young provided alongside.

- Dr Golbuu asked why risk transfer was the preferred financing mechanism, rather than a contingency fund. He noted that Koror State (which collects significant revenue from visits to both the main coral reef areas as well as Jellyfish Lake) has an emergency fund already in place. In response, Dr Young highlighted that maintenance of contingency funds at appropriate levels is often very difficult for political reasons and that the use of emergency funds for conservation purposes is likely to be hard to make effective as there will be higher priorities for use of contingency funds— and a need to demonstrate immediate impact of such funds to relieve hardship after a disaster. He also noted that the principles of parametric triggers could be applied to a contingency fund, so long as the discipline locked into an insurance contract could be captured in law or regulation of a contingency fund. This discipline includes primary risk-based funding (annual premium in the insurance case, annual replenishments in the contingency fund case), objective release of funds (through a trigger mechanism leading to a known pay-out amount (or distribution in the contingency fund case), and pre-agreed use of funds for the specific purpose desired.
- Dr Golbuu asked what rapid pay-outs from an insurance mechanism could be used for, in the cases of both the Fiji (cyclone impact) and Palau (coral bleaching impact) case studies, noting that no reef clean-up was necessary after Typhoon Haiyan impacted the east coast of Palau (leading to 60%

reef loss) in 2011 due to the nature of the impact. Dr Young responded that for the cyclone impact, work on reef restoration has progressed significantly in the past decade, so stabilisation of the substrate and some restoration work would likely have been useful to encourage and speed up reef recovery. In the coral bleaching case, the concept was designed to act as a ‘business interruption’ coverage for the national government and for the Koror State government, effectively replacing revenue lost through the inevitable drop-off in reef and lake access passes purchased by visitors.

- Dr Golbuu’s last question was related to sea surface temperature (SST) modelling and other scientific aspects of the index design for the coral bleaching concept. He noted that PICRC is at forefront of investigating heat-resistant corals—which appear to be randomly distributed throughout coral colonies and across species—and was interested in the application of this work both in assessing the likely impact of future extreme SST events and in providing a potential use for pay-outs under the coral bleaching insurance concept (e.g. replanting of heat-resistant corals). He identified key research partners—James Guest (Newcastle University, UK) on restoration and Stephen Palumbi (Stanford University, USA) on thermal resilience. Dr Young responded that he had already made contact with the CRW science team and would follow up with other academics to ensure that the next phase of index design work on the coral bleaching concept takes the latest science fully into account—both in assessing risk and in triggering pay-outs in near real time.

The Nature Conservancy

Stakeholder:	The Nature Conservancy (TNC)
Date:	3 September 2019
Present:	Simon Young Steven Victor (svictor@tnc.org)—Micronesia Director

Given TNC’s involvement in other parts of the POFP project, and ongoing collaboration between WTW and TNC on coral reef insurance in the Americas, this meeting focussed specifically on the Palau case study. Mr Victor indicated that TNC has been interested in working on coral bleaching risk analytics and potential insurance mechanisms but that that interest had not yet converted into any projects or programmes, and was keen for the WTW team to engage with relevant parts of TNC if and when the coral bleaching insurance concept was taken to the next stage.

Mr Victor highlighted that the conservation landscape in Palau is complex, with a lot of actors, and in general attracts good international support in the form of philanthropic funding. However, he did acknowledge the need for introduction of mechanisms to ensure funding stability and sustainability, and to link conservation funding more effectively to the climate change agenda and funding windows, something which climate risk insurance can do.

Palau Conservation Society

Stakeholder:	Palau Conservation Society (PCS)
Date:	3 September 2019
Present:	Simon Young Bola Majekobaje (bola@palauconservation.org)—Executive Director

Lolita Gibbons Decherong—Program Manager

PCS is a local organisation independent of the large international conservation NGOs, supported largely by modest donations from visitors and local businesses. As such it is well aware of the impacts of tourism on reef health—both negative in the form of overuse and positive in the form of revenue (both to the state and national treasuries but also to local businesses). Indeed, Ms Majekobaje noted that their own programmes were impacted when visitors—and their donations to PCS—dried up during the 2016-18 thermal stress event.

While PCS knowledge of innovations in conservation finance—and particularly insurance—was limited, they were keen to learn about applications of insurance, and were very supportive of the overall concepts presented. While their technical contribution to further development of the Palau case study is likely to be limited, PCS will be an important partner within the local community.

Government of Palau, Ministry of Finance

Stakeholder:	Government of Palau
Date:	3 September 2019
Present:	Simon Young Xavier Matsutaro (xavier.matsutaro@gmail.com)—Head of Climate Change Unit, Bureau of Budget and Planning, Ministry of Finance

Dr Young met briefly with Mr Matsutaro, who leads interactions on behalf of the Government of Palau with the international climate change community on issues related to financing, including climate risk finance. He was not familiar with conservation finance generally, other than related to the PAN Fund (see later meeting notes below), but had been involved in discussions with PCRIC over parametric cyclone insurance several years earlier (noting that coverage was not purchased from PCRIC because of the availability of a contingent credit facility from ADB which was more compelling from a political perspective).

Mr Matsutaro was interested to learn of the different applications of parametric insurance presented as concepts under the POFPI project, and agreed to share the concept descriptions document with relevant parts of the government. He noted, as others had, that Koror State would be interested in learning of these concepts; unfortunately his contacts were the same as those who Dr Young had already been in touch with and who were not able to meet with Dr Young. Mr Matsutaro did indicate that he was not aware of any similar initiatives, and that Palau was keen to stay at the forefront of innovative conservation and climate finance.

PAN Fund & Government of Palau

Stakeholders:	Palau Protected Areas Network (PAN) Fund Government of Palau, Ministry of Finance and Ministry of Natural Resources, Environment and Tourism

Date: 3 September 2019

Present:	Simon Young Regis Emesiochel (remesiochel@palaupanfund.org)—General Manager, PAN Fund Charlene Mersai (charmersai@gmail.com)—National Environment Coordinator and Secretariat, National Environmental Protection Council, Ministry of Finance Erbai Matsutaro (erbai.oerc@palaugov.org)—Head, Palau Office of Climate Change, Ministry of Natural Resources, Environment and Tourism

The PAN Fund is recognised internationally as an innovative conservation financing initiative at the sovereign level, enacted through national law and therefore eminently stable and sustainable. It is particularly interesting for the insurance case studies, as enactment of insurance mechanisms requires a legal entity to be the insured party and to pay premiums and receive (and appropriately deploy) pay-outs.

Dr Young ran through the entire POFPI presentation during this meeting, given the broad interest of the counterparts, which left relatively little time for discussion. However, there was significant interest expressed in all of the insurance concepts (and, indeed, the broader POFP project outcomes), and general willingness to support further developments. It was clear that PAN Fund receives a lot of interest from regional as well as international organisations which wish to partner with it, and this limits capacity to engage in early and mid-stage concept development.

Friends of Palau National Marine Sanctuary

Stakeholder:	Friends of Palau National Marine Sanctuary (FPNMS)
Date:	3 September 2019
Present:	Simon Young Jennifer Koskelin-Gibbons (Jennkoskelin@gmail.com) Adora Nobuo (PNMSfriends@gmail.com)

FPNMS is a fisheries-focussed conservation NGO, very interested in revitalising artisanal fisheries cooperatives to help organise around the Palau National Marine Sanctuary (PNMS) efforts—the PNMS comes into effect on 1 January 2020. Existing fishing extension efforts are concentrating on pelagic fisheries—so not directly impacted by reef health in the same way as inshore fisheries. Thus, while there was general interest in the reef-related insurance concepts, neither were directly relevant to FPNMS's core focus.

However, during the broader conversation, Ms Koskelin noted that most fisherfolk use their boat to serve tourism needs as well as fishing—includes fishing tourism as well as boat tours etc. Most don't have any insurance, so Ms Koskelin felt that providing access to insurance, including as a reward for improved compliance (i.e. the Vanuatu concept / case study), would be of high interest. FPNMS flagged in particular the absence of liability insurance within this sector, which is a barrier to access a significant segment of the tourism market, given that tour agents in many countries require tours they are selling to be provided by suppliers which have liability insurance—this is particularly true for Japan and Germany.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