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Sustainability of Rapid Response Reef Risk Financing in the MAR Region

Prepared by Willis Towers Watson and MAR Fund

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Willis Towers Watson

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Section 1: Introduction

Marine natural infrastructure, and coral reefs in particular, provide coastal protection from storm impacts by reducing wave height, absorbing wave energy, and reducing storm surge. Reefs are also key recreational assets and support important fish species, which together provide critical underpinning to economic activity across the globe, with coastal and island communities particularly dependent. However, these vital natural assets are at risk to the effects of climate change, including increasingly frequent and severe extreme weather events as well as both short- (e.g. ENSO[1]) and longer-term ocean temperature variability and related biological and chemical changes. Recognising and understanding these risks is a crucial first step to effective management of this public (natural) infrastructure. Crucially, natural infrastructure – just like grey infrastructure – requires both project finance and risk finance, investment and protection.

Therefore, the Mesoamerican Reef Fund (MAR Fund) and Willis Towers Watson (WTW) are collaborating to develop a practical solution to address a portion of this climate risk to the Mesoamerican Reef (MAR): the deployment of parametric insurance tools, which will provide predictable and timely funds to support emergency response activities to help restore and conserve this critical public natural infrastructure. The proposed product will address hurricane[2] risk, funding clean-up and early restoration efforts as well as potentially providing short-term financing to mitigate related economic shocks to individuals, communities, and governments.

The Partners: MAR Fund and Willis Towers Watson

MAR Fund

MAR Fund is a regional environmental fund whose primary goal is to protect the MAR Ecoregion shared by Belize, Guatemala, Honduras, and Mexico (hereafter referred to as the 'MAR countries'). Its mission is to drive regional funding and partnerships for the conservation, restoration, and sustainable use of the MAR.

It was established by four pre-existing environmental funds, one from each country in the region:

- Protected Areas Conservation Trust (Belize);
- Fundación para la Conservación de los Recursos Naturales y Ambiente en Guatemala;
- Fundación Biosfera (Honduras); and
- Fondo Mexicano para la Conservación de la Naturaleza.

[1] El Niño Southern Oscillation.
[2] In the Tropical Atlantic Basin, a cyclonic system with a peak wind speed at or above 64 knots is formally called a Hurricane, with that having a peak wind speed at or above 34 knots but below 64 knots called a Tropical Storm, both being Tropical Cyclones. The word 'hurricane' is also in common usage for high-intensity tropical cyclones and it is in that context that it is used in this report.

The founding members have provided their technical, administrative and financial capabilities to make the MAR Fund operational. The founding funds comprise the MAR Fund's Board of Directors, in addition to a representative of the regional Central American Commission on Environment and Development (CCAD), notable conservation experts from each participating country, and international collaborators and donors.

Willis Towers Watson

Willis Towers Watson (WTW), through its Global Ecosystem Resilience Facility (GERF), focuses on the growing application of insurance and insurance related capabilities to support investment in, and resilience of, marine and terrestrial ecosystems, protecting exposed communities and assets and fulfilling public policy objectives and regulatory requirements. Programmes include the specific protection of natural assets such as coral reefs, mangroves and rain forest, and the provision and delivery of mainstream agriculture and aquaculture risk management programmes and investments that enable the maintenance of natural ecosystems.

The Reef Rescue Initiative

The MAR Fund is carrying out the Reef Rescue Initiative (RRI). Thanks to the generous support of the German Government through KfW, a specific sub-account of €7 Million has been established within the MAR Fund endowment for the Initiative. The RRI aims to support the long-term ecologic and economic viability of the MAR and the environmental services it provides by helping to develop the human capacity, regulatory environment, local economic incentives and financial sustainability required to carry out sound, effective, and timely science-based coral reef conservation and restoration. The RRI is carried out by the MAR Fund and CCAD, with the participation of the four MAR countries.

The RRI strategies include the sustainable long-term funding for continuous and emergency restoration through the establishment of an Emergency Fund and a parametric insurance coverage for reefs to provide rapid financing for urgent response for reefs damaged by hurricanes. The parametric insurance model is being designed for key reef sites in the MAR Region.

Pilot Sites

The proposed pilot sites encompass the following reef areas:

- **Mexico**: the Banco Chinchorro and Arrecifes de Xcalak Marine Protected Areas;
- **Belize**: the Turneffe Atol and Hol Chan Marine Reserves;
- **Guatemala**: the Motaguilla reef site (10,000 hectares within the Punta de Manabique Wildlife Refuge); and
- **Honduras**: the Bay Islands Marine National Park and the Cayos Cochinos National Marine Park.

These sites are depicted in Figures 1.1 and 1.2.

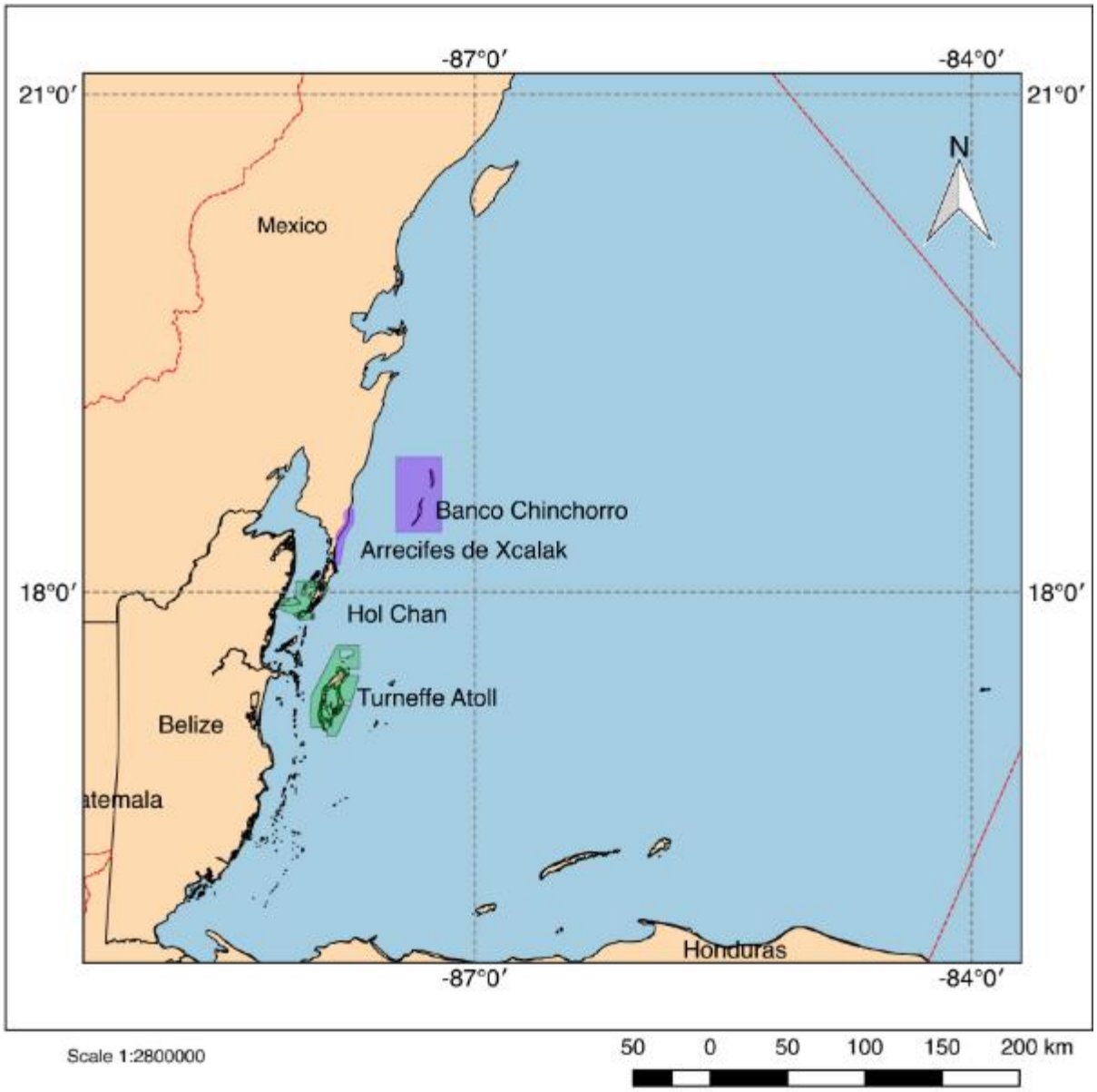

Figure 1.1 Reef sites in Mexico (purple) and Belize (green).

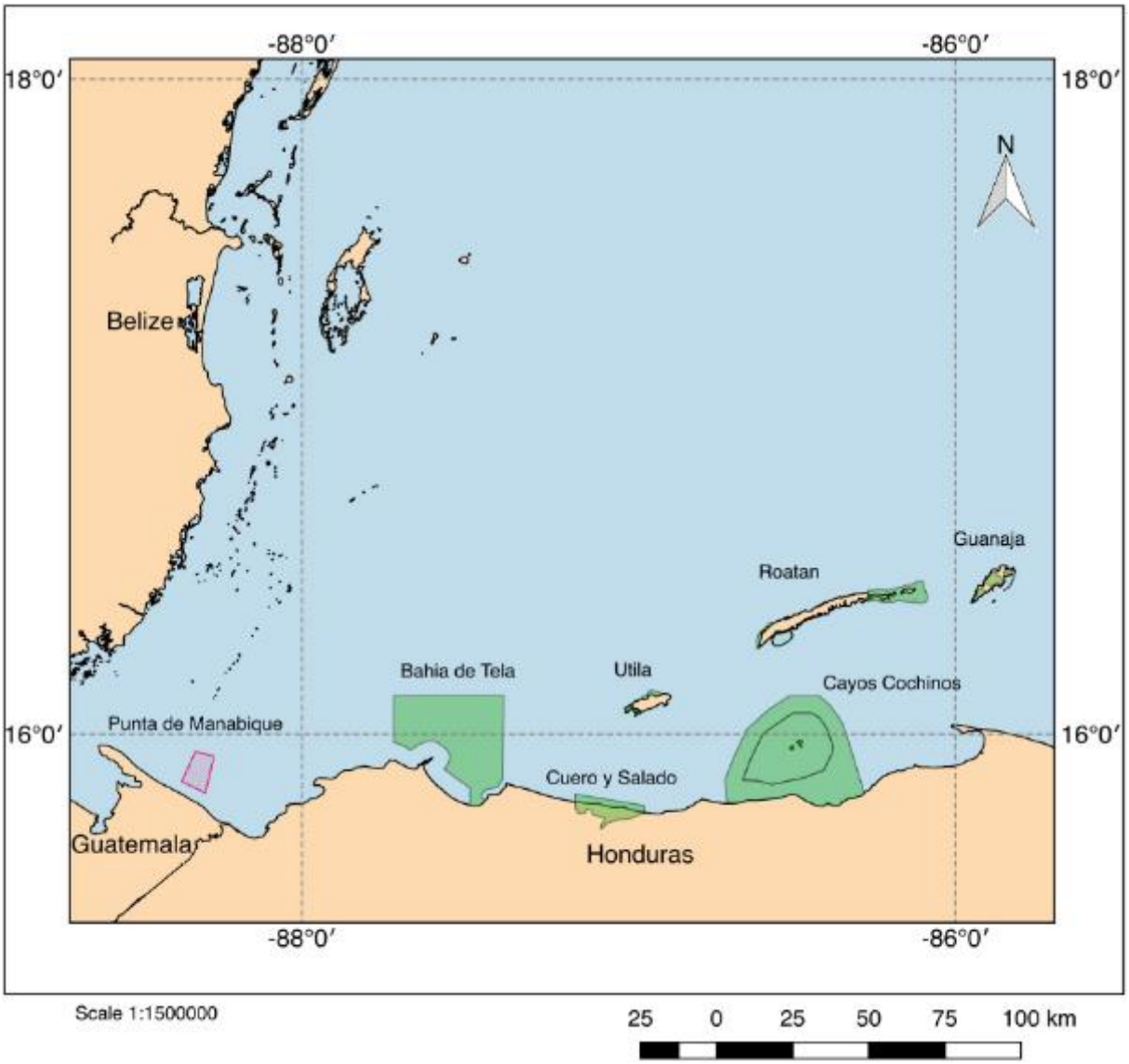

Figure 1.2 Reef sites in Guatemala (pink) and Honduras (green).

Reef Risk Financing

Marine ecosystems 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.

Just like roads and bridges, natural assets are at risk, and therefore, it is imperative that 'blue' assets like coral reefs are embedded in countries' broader planning and risk management strategies, supported by financial planning (including risk financing). However, there is far less engineering and risk information pertaining to coral reefs than there is about grey infrastructure, which has been a barrier to insuring them like traditional assets. Parametric insurance offers a break-through in the potential to proactively manage risk to ecosystems, as the data requirements are significantly less. Therefore, we propose to build on and strengthen an initial parametric reef insurance model developed by The Nature Conservancy (TNC) in Quintana Roo[3] to develop and pilot the implementation of risk transfer for selected sites on the Mesoamerican Reef.

Identifying the Need: the Reef Risk Landscape

The Mesoamerican Reef, along with all of the warm-water coral reef systems of the world, is in existential crisis. The reefs of the MAR have faced, and survived, the impacts of tropical cyclones for eons, but as the effects of anthropogenic climate change, as well as overfishing and pollution, exert rapidly increasing pressure on the reef ecosystems, the risk of a hurricane impact leading to coral mortality has grown exponentially. At the same time, the science of reef repair and recovery, and locking in reef resilience through active intervention (through, for example, planting coral species resilient to rising ocean temperatures and acidity), has developed rapidly, and provides an opportunity to actively reduce, dramatically, the negative impacts of hurricanes on coral reefs. This, in turn, greatly increases the ability of the reef to withstand the anthropogenic threats, alongside complementary conservation actions such as are planned under the Reef Rescue Initiative.

Hurricanes generate heavy seas that directly damage coral reef ecosystems, causing impacts such as breakage of coral colony tips and branches, sand burial, and dislodgement of large colonies. Such impacts in turn affect the ecosystem services the reefs provide. Coastal communities are disproportionally affected by degradation or damage to the reef. In addition to the threat hurricanes pose to lives and property (which is lessened by the very presence of the barrier reef), coastal communities rely on the reef for their livelihoods and food security. For many families, economic wellbeing and ecological resilience are deeply intertwined.

Other major threats to the MAR, all man-made, include increase in ocean temperature, ocean acidification, rising sea level and disease (all directly or indirectly linked to anthropogenic greenhouse gas emissions and the resultant changing climate), and other direct human impacts including the

[3] An approach which originated at the MAR Fund working with a current member of the WTW GERF project team.

negative ecological effects of poor fishing practices, and poor land-use practices (including, for example, pollution from agricultural runoff).

While there are many risks to reef health in the MAR region in need of addressing through management strategies and finance, when it comes to insurance as a risk financing tool, there are more and less appropriate use cases. Crucially, **insurable risks** are risks that are neither 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 many risks to reefs (as 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. For example, the amount of fertiliser that is used on crops and 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.

While we recognise that direct human activities, such as overfishing, agricultural runoff, and tourism, have a very significant impact on reef health, an insurance solution must focus on the part of the risk that is caused by external events (e.g. natural processes). Figure 1.3 shows selected risks to ocean health and reflects whether they are insurable or uninsurable / more difficult to insure due to moral hazard.

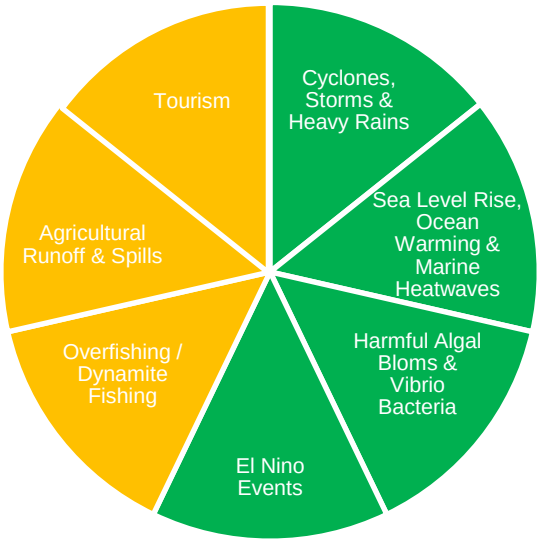

Figure 1.3 Individual risks to reefs, split broadly into insurable (green) and uninsurable / more difficult to insure (orange).

The proposed reef insurance programme for the MAR focuses on hurricane risk for several reasons:

- **Clear need**: the hurricane risk to the MAR is particularly significant, and acts to exacerbate all other risks;[4]
- **Strong use-case**: emergency response and early recovery action to address reef damage is highly cost-effective, but rapid finance is required to unlock the full benefits; and
- **Technical capability:** hurricane risk is well understood by the insurance industry, which means insurance will be more competitively priced and should therefore provide excellent value for money as the financing source.

Therefore, this insurance element aims to support – and protect – the broader aims of the RRI through developing and implementing a parametric insurance solution covering multiple segments of the reef where it has particularly high value. The insurance policy will be designed to trigger when extreme waves and storm surge generated by a hurricane have severely impacted the reef, providing a quick pay-out to fund pre-planned reef clean-up and begin restoration work.

Why Insurance for Reefs?

The case to support the investment in developing such an insurance programme is as follows:

- Reefs are at risk to hurricanes, which generate heavy seas that directly damage coral reef ecosystems through processes such as breakage of coral colony tips and branches, sand burial, and dislodgement of large colonies, which in turn affects the ecosystem services they provide;
- Evaluation of damages, debris clean-up, and salvaging and reattaching dislodged corals following a damaging event has been shown to have positive impacts on coral survival and recovery, and therefore reef health. A simple cost benefit analysis[5] shows, with a recovery time that is twice as fast, a potential benefit to cost ratio of close to 10:1;
- Reefs (alongside other blue and green assets) are almost always neglected in post-disaster planning and financing, meaning emergency response, clean-up, and restoration is often not implemented, allowing broken corals to die and significantly extending the time it takes for reefs to recover (if, indeed, reefs do recover; some do not);
- Healthy reefs are critical natural infrastructure assets, protecting vulnerable communities from storm damage and providing essential ecosystem services that underpin the livelihoods of these coastal communities, supporting both subsistence and formal economic activities, especially contributing directly to fisheries productivity and tourism revenues; and

[4] An academic study supporting the 50 Reefs Initiative (Beyer, H. L., *et al*., 2018. Long-term risk-sensitive planning for conserving coral reefs under rapid climate change. Conservation Letters 11:e12587. doi: 10.1111/conl.12587) identified the reefs that have the best chance of surviving the warmer world we face and therefore should be the primary focus of conservation action; the MAR was not included due to its exposure to hurricanes, an overarching risk which it was assumed, in the study, could not be mitigated.

[5] Details of the cost-benefit analysis are included in the Supplementary Report 'Cost-Benefit Analysis Summary and Sensitivity Analysis.'

- Pre-arranged reef risk financing can significantly contribute to the increased resilience of vulnerable coastal populations 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 reef response and clean-up, speeding the recovery of reefs; and
  - Ultimately, **restoring valuable ecosystem services** provided by this natural infrastructure, thus generating economic value by reducing the cost of impairment of such services.

Therefore, in order to develop key aspects of the project proposal to be submitted to InsuResilience Solutions Fund, in particular the identification of long-term funding streams for insurance premiums, we have conducting a preparatory study, the results of which are presented here. The following report details an analysis of the potential sources of funding for the sustainability of such an insurance instrument and an outline of suitable mechanism(s) for collection and aggregation of premiums, holding of an insurance contract, and management of pay-outs.

Section 2: Risk Ownership and Responsibility

The governments of the MAR countries have sovereign authority over the MAR and are ultimately responsible for the management and maintenance of the reef as an infrastructure asset. However, green infrastructure does not show up on public asset registers or balance sheets. This results in a relatively vague understanding of risk ownership when it comes to the MAR, since risks to the reef primarily end up as undeclared and unquantified contingent liabilities to the public sector, which, when left unaddressed, are often passed on to vulnerable communities who are heavily dependent on healthy ecosystems and businesses that rely on the MAR as a value adding asset.

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 in all four countries that restricts spending of funds derived from damages to reefs for restoration is 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.

There is, however, a key formal structure in place established with the purpose of contributing to the conservation and management of the MAR – the MAR Fund. The MAR Fund actively supports everyday maintenance of the economic and biodiversity value of the MAR and the critical services it provides, as a regional financing mechanism for largescale conservation. The MAR Fund is a private environmental fund with a Board of Directors comprised of international collaborators, experts from each participating country, CCAD, and the founding funds from each of the MAR Countries. It is, therefore, an institution with the mandate and structure to implement programmes and activities to build the MAR's resilience to extreme events. For example, the MAR Fund works with each of the MAR country governments, which also participate in the CCAD - Mexico being an observer to CCAD - to proactively mitigate climate risk to the region, as part of the Reef Rescue Initiative.

Therefore, although when it comes to the risks to the Mesoamerican Reef, risk ownership (and responsibility for emergency response) is currently spread around the public and private sectors in an implicit and informal way, the MAR Fund offers a governance and administrative mechanism that can contribute to the response to reef risk, in agreement with the national governments.

With the MAR Fund as the platform for establishing risk ownership and responsibility, two key questions arise:

1. Who will contribute funds to cover the hurricane risk to the MAR; and

2. How can the MAR Fund and MAR countries unlock risk financing?

Sections 3 and 4 explore these questions by outlining potential sources of funding, discussing beneficiary groups' willingness to pay insurance premiums, and highlighting mechanisms, which the MAR Fund and MAR country governments could employ to raise risk capital to cover the hurricane risk to the MAR.

Section 3: Potential Sources of Funding

Natural catastrophe risk (in this case, hurricane risk) is shared across a complex and diverse set of stakeholders. Because the impacts of these extreme events are potentially so severe, and because natural catastrophe events do not respect borders, property titles, or land rights, risk is spread throughout communities, affecting households, businesses, and governments. Since we are discussing the risk to a single infrastructure asset, the MAR, risk ownership is more easily analysed and defined than for a portfolio of assets; however, it is slightly more complicated than for, say, a certain bridge or a stretch of road, simply because it is not the kind of asset that appears on balance sheets (yet). Risk ownership for natural assets may, therefore, seem more complicated than risk ownership of grey infrastructure assets; however, two things are clear:

1. **The MAR is a valuable natural capital asset** - it provides considerable economic value to a wide range of stakeholders, including local communities, businesses, and governments; and

2. **Damage to the MAR financially affects dependent beneficiaries** - damage to the reef affects its ability to provide the ecosystem services on which beneficiaries rely (i.e. risk reduction, fisheries productivity, and recreation), causing financial impacts in the form of growing contingent liabilities from increased climate risk, and materialising as shocks to revenue.

The proposed insurance programme offers a single framework and financing mechanism to pre-finance the hurricane risk to the MAR, which is shared by a diverse set of dependent beneficiaries of reef ecosystem services, also referred to as 'reef users.' One of the key benefits of the design of the financing mechanism, therefore, goes beyond just an insurance transaction in that it facilitates increased risk understanding and the clarification of risk ownership between the reef users, in addition to offering an efficient way to finance that risk. This section focuses on the identification of those reef users; i.e. the dependent beneficiaries.

Identification of Key Reef Users

The benefits of a healthy reef fall into three main categories, each recognising the value of the reef sites as critical natural infrastructure:

- **Risk reduction**: avoided losses and greater physical resilience to storm impacts. The MAR protects communities from storm impacts by absorbing wave energy, thereby reducing coastal erosion and reducing storm wave damage and inundation;

- **Fisheries productivity**: coral reefs support 25% of all marine species,[6] including as the life-long habitat for crustaceans, molluscs, sea cucumbers, and reef fish[7] and spawning and nursery

[6] WWF; https://wwf.panda.org/our_work/oceans/coasts/coral_reefs/
[7] UNEP-WCMC, 2006. In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs. https://www.preventionweb.net/files/2685_2006025.pdf

habitats for pelagic fish[8]. These services provide a key source of nutrition, as well as economic activity;[9,10] and

- **Recreation**: key recreational assets for local communities and tourists alike.

As well as providing services for the public good, each of these categories underpin both formal and informal economic activity in important sectors to the benefit of coastal communities, businesses, and governments.

The proposed insurance programme focuses on providing rapid response in the aftermath of damaging storm events, treating the MAR as 'natural infrastructure,' which requires the same kind of post-event response as grey infrastructure would. Therefore, the insurance programme benefits the users of this natural infrastructure in the same way that insurance of grey public infrastructure benefits users (communities, businesses, and governments). Along the same lines, then, beneficiaries of the insurance programme will be largely the same as the beneficiaries of the ecosystem services of the reef.

Therefore, there are four key 'reef user groups':

- Local populations;
- The tourism sector of the MAR countries;
- The fishing sector of the MAR countries; and
- The governments (national and local) of the MAR countries.

Local Populations

Local populations are major beneficiaries of the MAR, receiving services such as risk reduction, fisheries productivity for subsistence and commercial fishing, recreation, and employment. Reefs play a significant role in wave attenuation and offer protection against erosion, protecting onshore infrastructure and property. Emergent reefs, such as the MAR, can mitigate over 75% of wave

[8] NOAA; https://oceanservice.noaa.gov/facts/coral_economy.html, https://www.westcoast.fisheries.noaa.gov/habitat/fish_habitat/rocky_reef_habitat_types.html

[9] Various studies have found that fish abundance, and perhaps species richness, decline substantially as coral reefs degrade, a pattern increasingly well documented in a variety of regions, including the Pacific (Sano, 2000; Booth & Beretta, 2002; Jones et al., 2004; Feary et al., 2007; Holbrook et al., 2008; Wilson et al., 2010a; b), the Atlantic/Caribbean (Acosta-Gonzalez et al., 2013), the Indian Ocean (Garpe et al., 2006; Graham et al., 2006), and globally (Wilson et al., 2006; Pratchett et al., 2008; 2011). Source: Bortone, S.A., 2014. Interrelationships between corals and fisheries. CRC Press.

[10] It is highly likely that the decline of coral reefs will lead to loss of fishery productivity in tropical coastal waters (Bellwood et al., 2004; Cinner et al. 2012). Source: Sale, P.F., and M.A. Hixon, 2015. Addressing the global decline in coral reefs and forthcoming impacts on fishery yields.

energy,[11] and estimates suggest that, for example, the MAR off Ambergris Caye (one of the reef sites in Belize) contributes approximately 40% to the stability of the coast.[12]

Each of the MAR countries are densely populated along the coasts, for example, in Belize, approximately 40% of the population lives near the coast.[13] We have identified the following local populations as direct beneficiaries of ecosystem services of the specific pilot reef sites:[14]

- **Mexico**: 1,295 people on the Costa Maya (375 in the small fishing village of Xcalak and 920 in the town of Mahahual);
- **Belize**: 12,067 people on Ambergris Caye and Turneffe Atoll (11,767 in San Pedro and 300 on Turneffe Atoll), as well as 57,310 people in Belize City, which is connected directly to the reef sites via ferry;
- **Guatemala**: 129,666 people in the city of Puerto Barrios and town of Livingston (81,078 people in Puerto Barrios and 48,588 people in Livingston); and
- **Honduras**: 1,835,511 people in the municipalities of La Ceiba, Arizona, El Porvenir, Esparta, Jutiapa, La Masica, San Francisco, Tela, Roatán, José Santos Guardiola, Guanaja, Útila, Balfate, Santa Fé, Trujillo, Sonaguera, Sabá, Tocoa, Puerto Cortés, Omoa, Choloma, and San Pedro Sula (By Department - 432,362 in Atlántida, 62,554 in Islas de la Bahía, 241,651in Colón, and 1,098,944 in Cortés).

Local populations also use the MAR for subsidence fishing and recreation, and it underpins important sectors which provide a source of local employment. Many local populations rely on reef fish for regular meals and food security. Artisanal fishers are known to bring some catch home for their families and themselves to consume.[15] For example, a study conducted in Guatemala calculated the subsistence catch per fisher at 70 kg per fisher per year. This estimate is likely quite conservative, given fishers likely share their catch with their family.[16] Given the high incidence of artisanal fishing activities across the MAR region, the coastal communities in Belize, Guatemala, Honduras, and Mexico are all beneficiaries of the reef's fisheries-related ecosystem services, and the fishing villages are particularly dependent.

Additionally, many locals rely on the MAR for employment opportunities, specifically in commercial fishing and the tourism sector as business owners and employees, e.g. fishing, snorkelling and diving operations, boat tours, hotels, restaurants, etc. For example, in Mexico, 247,765 people were employed in Mexican fisheries in 2001.[17] While only a small portion of that is in inland fisheries, with

[11] Cooper, E., Burke, L., Bood, N., 2009. Coastal Capital: Belize The Economic Contribution of Belize's Coral Reefs and Mangroves. http://pdf.wri.org/coastal_capital_belize_wp.pdf
[12] Ibid.
[13] Belize Integrated Costal Zone Management Plan. https://www.coastalzonebelize.org/wp-content/uploads/2015/08/BELIZE-Integrated-Coastal-Zone-Management-Plan.pdf
[14] Please see the complementary report titled 'Beneficiaries of Rapid Response Reef Risk Financing in the MAR Region' for background information, sources, and additional detail on the profile of the beneficiary population of the reef sites.
[15] Mackenzie, C.L. and Stehlik, L.L., 1996. The Crustacean and Molluscan Fisheries of Honduras. Marine Fisheries Review 58(3).
[16] Funes, M., et al., 2015. Honduras, a fish exporting country: Preliminary reconstructed marine catches in the Caribbean Sea and the Gulf of Fonseca, 1950 – 2010.
[17] FAO; http://www.fao.org/fi/oldsite/FCP/en/MEX/profile.htm

an even smaller portion on the Caribbean coast (3,081 people involved full time in fisheries of Quintana Roo[18]), the reef sites support the fishing communities of Mahahual and Xcalak.

Tourism in Quintana Roo, where the MAR is located on the Mexican coast, employs 169,153 people, more than 20% of the employed population.[19] The number of fishers on the Caribbean coast of Guatemala is estimated at 2,617 ,[20] and 22% of the population of Puerto Barrios and 9% of the employed population of Livingston work in wholesale and retail trade, restaurants, and accommodation.[21] In Belize District (which surrounds the MAR), 19% of employment is in tourism, and there are 2,500 licenced fishers operating in the EEZ.[22] And in Honduras, while only 4% of the employed population in the combined Departments of Atlántida, Islas de la Bahía, Colón, and Cortés work in tourism, tourism accounts for 12% of employment in Islas de la Bahía.[23] Further, it is estimated that in Honduras there are 160 different fishing communities with over 10,000 fishers.[24]

The Tourism Sector

The tourism sector in the MAR countries, and especially those businesses on the Caribbean coast, benefits greatly from the MAR. It is a key recreational asset and attracts visitors from around the world, who then spend on various activities such as diving, snorkelling, sport fishing, hotel accommodation and restaurant dining.

Beneficiaries in the tourism sector of reef sites attracting visitors and providing recreational assets are:

- Dive and marine tour operators (e.g. boat tours offering snorkelling);
- Sport fishing operators;
- Hotels; and
- Restaurants.

[18] FAO, 2011. Coastal fisheries of Latin America and the Caribbean. FAO Fisheries and Aquaculture Technical Paper 544. http://www.fao.org/3/a-i1926e.pdf
[19] National Institute of Statistics and Geography, Mexico and the Government of Quintana Roo, 2017. Anuario estadístico y geográfico de Quintana Roo 2016. http://coespo.qroo.gob.mx/Descargas/doc/Anuario%20Estad%C3%ADstico%20y%20Geogr%C3%A1fico%20de%20Q%20Roo%202016.pdf
[20] FAO; http://www.fao.org/fi/oldsite/FCP/en/gtm/profile.htm
[21] National Statistics Institute of Guatemala, 2003. Censos Nacionales XI de Población y VI de Habitación 2002. https://www.ine.gob.gt/sistema/uploads/2014/02/20/jZgeGe1H9WdUDngYXkWt3GIhUUQCukcg.pdf
[22] United Nations Conference on Trade and Development; https://unctad.org/meetings/en/Contribution/ditc-ted-Belize-28112018-Factsheet-1-fisheries.pdf
[23] National Institute of Honduras, 2013. Censo XVII Censo de Población y VI de Vivienda 2013. http://170.238.108.227/binhnd/RpWebEngine.exe/Portal?BASE=CPVHND2013NAC&lang=ESP
[24] Funes, M., et al. 2015. Honduras, a fish exporting country: Preliminary reconstructed marine catches in the Caribbean Sea and the Gulf of Fonseca, 1950 – 2010.

A recent report that quantifies the economic value of the MAR estimated that it provides almost US$3.5 billion per year to the tourism sector alone.[25] Even if the reef sites in this study only provide 1% of that, they still provide significant value to the tourism sector at close to US$35 million per year.

Further, in their 2017 paper, Spalding et al. present global data on reef value to tourism, which includes Belize, Mexico, and Honduras.[26] Table 3.1 summarises key data available for the MAR countries.[27]

	International and domestic tourism arrivals	Sum of reef-associated tourist arrivals (trip equivalents)	All visitors spending (international and domestic)	Sum of reef-associated visitor expenditure	Reef visitor expenditure as prpn of total tourism	Reef tourism as prpn of GDP
Belize	947,000	208,678	$345,237	$80,611	23%	5.12%
Honduras	1,489,000	347,605	$1,837,054	$446,628	24%	2.41%
Mexico	93,585,000	2,795,921	$102,653,251	$2,999,883	3%	0.25%

Table 3.1 Tourism information, including sub-set that is directly reef dependent[28]. All financial values are in thousands of USD.

Coastal hotels also derive value from the risk reduction benefits of reefs. As discussed, reefs have unique wave attenuation abilities, protecting property and infrastructure (including hotels) from flooding and damage induced by erosion, storm surge and high tide, to a degree.

Table 3.2 provides a summary of the total number of businesses that rely on the reef sites, according to booking sites and social media.

	# of Hotels[29]	# of Dive Shops[30]	# of Cruise Lines[31]
Belize Reef Sites	132	20	18
Guatemala Reef Sites	50	1	7
Honduras Reef Sites	343	51	17
Mexico Reef Sites	114	12	15
Total for Combined Reef Sites	**639**	**57**	

Table 3.2 Number of businesses directly reliant on the reef sites.

[25] UN Environment, ISU, ICRI and Trucost, 2018. The Coral Reef Economy: The business case for investment in the protection, preservation and enhancement of coral reef health.
[26] Unfortunately, Guatemala was not included.
[27] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism. https://www.sciencedirect.com/science/article/pii/S0308597X17300635
[28] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism; https://www.sciencedirect.com/science/article/pii/S0308597X17300635
[29] As listed on Trip Advisor
[30] As listed on Google Maps
[31] As listed on Cruise Critic

The following sections provide a description of each of the reef sites' value to the tourism sector by country.

Belize Reef Sites

Tourism contributes over US$345 million in total expenditure per year in Belize,[32] and on-reef tourism accounts for a significant portion of that; approximately 64% of all 'tourist days' are attributed directly to marine ecosystems,[33] and reef-associated visitor expenditure accounts for over US$80 million. [34] Ambergis Caye and Turneffe Atoll are tourism destinations particularly dependent on the MAR. San Pedro, which has 129 hotels listed on Trip Advisor, for example, has *two* hyperbaric chambers - the only two in Belize[35] - and over 20 dive shops listed on Google Maps. The Turneffe Atoll has three on-island hotels and welcomes over 15,000 divers, anglers, and ecotourists per year (based on 2010 numbers), generating more than US$19 million in direct expenditure.[36]

Additionally, Ocean Ferry Belize operates a ferry route between Belize City and San Pedro, which runs five times a day, indicating that a portion of the tourism expenditure in Belize City is also reef-associated.[37]

The Belize City Port also welcomes a number of cruise lines, which offer excursions and opportunities to experience the reef, a big draw to visitors. The following cruise lines depend on the reef sites for their routes covering Belize CIty:[38]

- Princess Cruises
- MSC Cruises
- Royal Caribbean International
- Fred. Olsen Cruise Lines
- Carnival Cruise Line
- Cruise & Maritime Voyages
- Windstar Cruises
- Costa Cruises
- Silversea Cruises
- Marella Cruises
- Oceania Cruises
- Seabourn Cruise Line

[32] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism; https://www.sciencedirect.com/science/article/pii/S0308597X17300635
[33] Cooper, E., L. Burke, and N. Bood., 2009. Coastal Capital. The Economic Contribution of Belize's Coral Reefs and Mangroves. World Resources Institute, Washington DC.
[34] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism. https://www.sciencedirect.com/science/article/pii/S0308597X17300635
[35] https://ambergriscaye.com/pages/town/hyperbar.html
[36] Turneffe Atoll Trust, The Economic Value of Turneffe Atoll; http://www.turneffeatoll.org/app/webroot/userfiles/66/File/Turneffe%20Atoll%20Valuation.pdf
[37] 1 round trip ticket costs £78.64; https://www.directferries.co.uk/ferries_from_belize_to_ambergris_caye.htm
[38] As listed on Cruise Critic

- Celebrity Cruises
- Ponant Cruises
- Crystal Cruises
- Hapag-Lloyd Cruises
- Viking Ocean Cruises
- SeaDream Yacht Club

Of additional note, the Belize reef sites also support the hotels along the coast by providing them with a source of fresh fish. According to FAO, a large quantity of catch from independent fishers is sold directly to large coastal hotels.[39]

Guatemala Reef Sites

Visitors to Guatemala spent US$1,588 million on tourism and travel in 2018.[40] The reef sites account for key areas of the MAR in Guatemala, covering both Puerto Barrios and Livingston, the two main population centres on the Caribbean coast. There are 15 hotels listed on Trip Advisor in Puerto Barrios and 35 in Livingston. Puerto Barrios is also one of the only places in on the Caribbean coast of Guatemala with dive shops due to its proximity to the MAR.[41]

Additionally, Puerto Barrios welcomes a number of cruise lines to the Amatique Bay: [42]

- Regent Seven Seas Cruises
- Oceania Cruises
- Seabourn Cruise Line
- Ponant Cruises
- Silversea Cruises
- Windstar Cruises
- Marella Cruises

Honduras Reef Sites

Tourism contributes over US$1.8 billion in total expenditure per year in Honduras, and on-reef tourism accounts for nearly a quarter of that, contributing over US$446 million. [43] A key asset that draws people to the beaches and islands of Honduras is the MAR; the Bay Islands (Islas de la Bahía) are world renowned dive and snorkel sites due to this critical natural infrastructure, and the Department has a total of 217 hotels listed on Trip Advisor. It is estimated that 1.6 million tourists visit Roatán every year,[44] supporting around 50 dive shops and 156 restaurants listed on Google Maps. Further,

[39] FAO. http://www.fao.org/fi/oldsite/FCP/en/BLZ/profile.htm
[40] World Travel & Tourism Council, 2019 (2018 figures). https://www.wttc.org/economic-impact/country-analysis/country-reports/
[41] https://travel.padi.com/d/guatemala/
[42] As listed on Cruise Critic
[43] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism. https://www.sciencedirect.com/science/article/pii/S0308597X17300635
[44] https://roatantourismbureau.com

sport fishing operations are also located in the Bay Islands.[45] The MAR in Honduras also generates tourism beyond the islands, as the cities on the mainland such as La Ceiba (with 84 hotels listed on Trip Advisor, where in addition to its own reef site attracting visitors, it is also the main gateway to the Bay Islands via ferry), Sambo Creek (with its own reef site at the Cayos Cochinos, attracting visitors and supporting local businesses, with one dive shop and one tour agency offering trips to Cayos Cochinos listed on Google Maps), and Tela (also next to a reef site attracting visitors to dive and snorkel, supporting 42 hotels listed on Trip Advisor).

Roatán also welcomes a number of cruise lines, which benefit directly from the beautiful reef sites: [46]

- Norwegian Cruise Line
- Carnival Cruise Line
- Celebrity Cruises
- Costa Cruises
- Cruise & Maritime Voyages
- Fred Olsen Cruise Lines
- Holland America Line
- MSC Cruises
- Marella Cruises
- Oceania Cruises
- P&O Cruises
- Princess Cruises
- Regent Seven Seas Cruises
- Royal Caribbean International
- Silversea Cruises
- Viking Ocean Cruises
- Windstar Cruises

Mexico Reef Sites

The economic value of on-reef tourism in Mexico has been calculated at US$1,342.5 million per year,[47] and Quintana Roo is a key tourism state. While the remote sites on the Costa Maya may not contribute a large amount to that total, the reef is critical to the relatively small tourism industry that does generate income and economic growth in the towns of Mahahual and Xcalak. For example, Othón P. Blanco (one of the eleven subdivisions of Quintana Roo, where Mahahual and Xcalak are located) has 114 hotels with a total of 2,815 rooms.[48] Additionally, visitors can pay US$140 for two

[45] Canty, S., et al., 2019. The hidden value of artisanal fisheries in Honduras. Fisheries Management and Ecology, 26(3), 249-259. https://doi.org/10.1111/fme.12346
[46] As listed on Cruise Critic
[47] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism; https://www.sciencedirect.com/science/article/pii/S0308597X17300635
[48] National Institute of Statistics and Geography, Mexico and the Government of Quintana Roo, 2017. Anuario estadístico

dives in Xcalak.[49] There are 12 dive shops listed in Mahahual on Google Maps, all of which depend on the MAR as the main attraction.

Also, crucially, the Costa Maya Cruise Port Terminal opened three kilometres from what was previously the quiet fishing village of Mahahual in 2001, and the tourism industry continues to grow. 54 cruise ships stopped in Mahahual in one busy month (January, 2018), and it is advertised as a 'paradise for divers and snorkelers,' where 'vibrant coral and reef fishes thrive' by cruise operators, who offer excursions such as glass bottom boats, clear-bottomed kayaks, and sailing boat tours with snorkelling as well as 'some of the world's most pristine diving'.[50] The cruise lines that benefit from the Mexican reef sites are: [51]

- Norwegian Cruise Line
- Celebrity Cruises
- MSC Cruises
- Royal Caribbean International
- Regent Seven Seas Cruises
- Oceania Cruises
- Carnival Cruise Line
- Princess Cruises
- Silversea Cruises
- Windstar Cruises
- Marella Cruises
- Disney Cruise Line
- Virgin Voyages
- Crystal Cruises
- Holland America Line

The Fishing Sector

The fishing sector on the Caribbean coast in the MAR countries also benefits substantially from the MAR. Local fishers are not the only reef users, however; in addition to providing the habitat for reef fish, crustaceans, and molluscs, the MAR also provides the spawning and nursing grounds that support pelagic species, benefiting fishers in a much broader area.

Beneficiaries in the fishing sector are mainly artisanal and commercial fishers via income due to reef-dependent fisheries, as well as seafood businesses, including those involved in processing and marketing.

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y geográfico de Quintana Roo 2016. http://coespo.qroo.gob.mx/Descargas/doc/Anuario%20Estad%C3%ADstico%20y%20Geogr%C3%A1fico%20de%20Q%20Roo%202016.pdf

[49] https://travel.padi.com/d/xcalak/

[50] https://www.princess.com/excursion/exlistfordestination.do?portid=MH1&exType=S&t=C

[51] As listed on Cruise Critic

It has been estimated that the MAR generates US$240 million in direct economic value to commercial fishing per year.[52] The reef sites have been chosen in consultation with several stakeholders, including the Departments of Fisheries and protected areas authorities of Mexico, Belize, Guatemala, and Honduras. Several of the selected reef sites include valuable fish recovery sites (aka no-take zones) to underpin sustainable fisheries. Therefore, even given an extremely conservative estimate that these sites account for 5% of the value of the MAR as a whole, they are the source of an estimated US$12 million of value to the fishing sector every year. Further, the ecosystem services these sites provide as fish recovery areas are felt far beyond the populations in the immediate vicinity; coastal communities are particularly dependent, but the entire MAR region benefits. In particular, fisheries productivity of high value species such as shrimp, lobster, and conch is directly dependent on a healthy MAR.[53]

The fisheries of greatest economic value in all four MAR countries are the artisanal fisheries.[54] Figure 3.1 shows the landed value of industrial and artisanal fisheries in each MAR Country from 1950 to 2015.

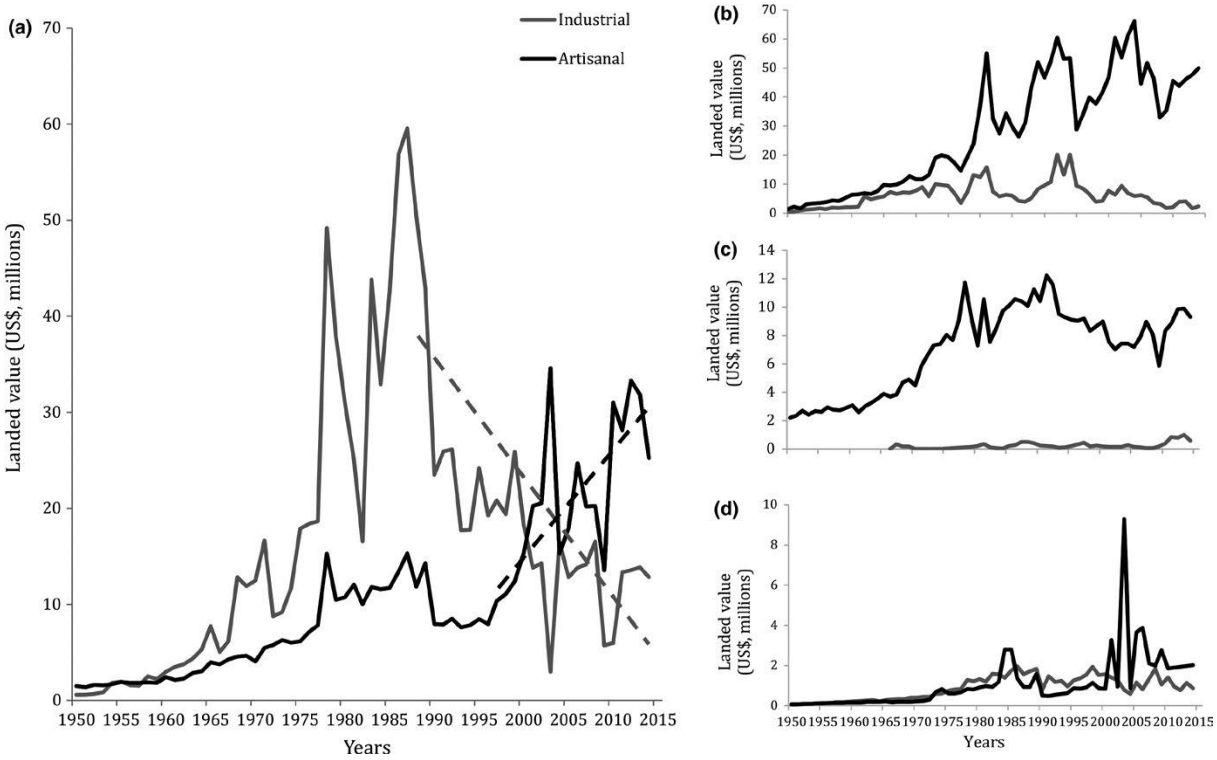

Figure 3.1 MAR ecoregion fishery valuations, based on reconstructed landed data (discards are not included) from the Caribbean Sea fisheries of (a) Honduras, (b) Mexico, (c) Belize

[52] UN Environment, ISU, ICRI and Trucost, 2018. The Coral Reef Economy: The business case for investment in the protection, preservation and enhancement of coral reef health.
[53] UNEP-WCMC, 2006. In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs; https://www.preventionweb.net/files/2685_2006025.pdf
[54] Canty, S., et al., 2019. The hidden value of artisanal fisheries in Honduras. Fisheries Management and Ecology, 26(3), 249-259. https://doi.org/10.1111/fme.12346

and (d) Guatemala (note different *y*-axis scale). Landed catch values are of reconstructed catches, and data for all countries were downloaded from the Sea Around Us online database. The regression trend lines (dashed lines) represent periods of catch decline or increase (identified as a breakpoint by segmented regression analyses) in the Honduran fishery[55].

Belize Reef Sites

In Belize, the gross value of fisheries output in 2004 was US$53.4 million, a significant portion of which was lobster, conch, and shrimp.[56] The fishing for these species (and most of the fishing in Belize as a whole) relies on, and is carried out in, the shallow waters of the lagoon created by the MAR and the three coral atolls (including Turneffe), which also provide ideal breeding and feeding habitats for these, and numerous other, commercially valuable species. Artisanal fishing on the MAR and the three atolls supports 500 boats and more than 1,500 licensed fishermen.[57]

Guatemala Reef Sites

In Guatemala, the estimated value of all fisheries exports (both Pacific and Caribbean) is US$36.3.[58] Industrial fishing is not allowed in the Bay of Amatique (where the reef site is located) and artisanal fisheries flourish on the Caribbean coast, supporting 2,617 fishers. For example, all small scale and artisanal, the shrimp fishery activity is 35 vessels, the lobster fishery is 15 small boats, and the fish fishery (small scale and artisanal) is 1,850 small boats, all supported by the MAR.[59]

Honduras Reef Sites

The fishing sector in Honduras as a whole accounts for an average value of US$385 million per year. Dependent on the reef sites, there are also over 7,000 registered artisanal fishers on the Honduran Caribbean coast. Further, industrial fishing in the Honduran EEZ is restricted to FAO Area 31 (Caribbean) with four fleets licensed to fish Caribbean spiny lobster, queen conch, shrimp, and finfish (i.e. primarily grouper and snapper).[60]

[55] Ibid. Direct quote.
[56] FAO. http://www.fao.org/fi/oldsite/FCP/en/BLZ/profile.htm
[57] United Nations Conference on Trade and Development; https://unctad.org/meetings/en/Contribution/ditc-ted-Belize-28112018-Factsheet-1-fisheries.pdf
[58] FAO; http://www.fao.org/fi/oldsite/FCP/en/gtm/profile.htm
[59] FAO; http://www.fao.org/fi/oldsite/FCP/en/gtm/profile.htm
[60] Canty, S., et al., 2019. The hidden value of artisanal fisheries in Honduras. Fisheries Management and Ecology, 26(3), 249-259. https://doi.org/10.1111/fme.12346

Mexico Reef Sites

While landings from the Caribbean only account for 2% of total national catch in Mexico, a high proportion of that targets high profit yielding species using an artisanal fleet. There are 888 artisanal vessels in Quintana Roo.[61]

The Government

The governments of the MAR countries could be considered the 'reef providers' rather than just 'reef users'. While the other beneficiaries of the ecosystem services of the MAR (i.e. local populations and the tourism and fisheries sectors) *use and consume* the goods and services provided by the reef, the governments are responsible for the management and maintenance of the reef as an infrastructure asset. Therefore, the governments are reef providers to the extent that they manage it, *and* they are reef users to the extent that they use and consume ecosystem services.

While governments are providers to the beneficiaries detailed above (as the reef underpins economic activity as natural, public infrastructure, enabling the tourism and fishing industries), they are also users, since these industries and the associated activities are a source of taxes and levees, and the risk reduction benefits of the reef also apply to grey coastal public infrastructure, reducing public contingent liabilities. Governments, and it may vary from country to country in the MAR, charge marine park user fees, dive levies, fishing licences etc., they hold the risk to public assets and infrastructure, and they are often the insurer of last resort for vulnerable communities in the wake of catastrophe events.

The MAR country governments are 'reef users,' benefiting from the following goods and services:

- **Direct tax revenues**: the MAR countries raise tax revenue through fees / levies on reef-associated activities such as marine park entry, scuba diving, fishing, and cruise line entry to the countries;
    - For example, the Government of Mexico levies a 16% tax on all dive activities,[62] the Turneffe Atoll generated US$3,430,577 in taxes for the Government of Belize in 2010 alone,[63] and MAR country governments (except Guatemala) collect revenue from fishing licences.
- **Indirect tax revenues**: the MAR underpins economic activity in the tourism and fishing sectors, and MAR country governments raise income tax revenue from reef-associated employment;
    - For example, Table 3.3 shows the dependence of employment on tourism in locations adjacent to the reef sites:

[61] FAO, 2011. Coastal fisheries of Latin America and the Caribbean. FAO Fisheries and Aquaculture Technical Paper 544. http://www.fao.org/3/a-i1926e.pdf
[62] https://travel.padi.com/d/mexico/
[63] Turneffe Atoll Trust, The Economic Value of Turneffe Atoll; http://www.turneffeatoll.org/app/webroot/userfiles/66/File/Turneffe%20Atoll%20Valuation.pdf

Country[64]	District / Municipality	Total Employed	Employed in Tourism	% Employment in Tourism
Belize[65]	Belize District	58,015	10,837	**19%**
Guatemala[66]	Total Izabal	86,795	11,805	**14%**
	Puerto Barrios	24,801	5,478	**22%**
	Livingston	12,787	1,178	**9%**
Honduras[67]	Atlántida	123,733	4,920	**4%**
	Islas de la Bahía	20,377	2,496	**12%**
	Colón	85,722	1,839	**2%**
	Cortés	507,080	18,496	**4%**
Mexico[68]	Quintana Roo	762,576	169,153	**22%**

Table 3.3 Employment rate related to tourism dependent on reef sites.

- **Foreign exchange:** fish exports are a source of foreign exchange;
  - For example, shrimp and lobster, both of which rely on the MAR as their key habitat, are important exports for Honduras,[69] and the artisanal fisheries on the Caribbean coast supplies both the national and international markets.[70]
- **Gross domestic product:** contributing to the GDPs of the MAR countries, the MAR underpins fisheries productivity, and therefore the productivity of a key primary sector, fishing, as well as contributing to the tertiary sector through the supply of seafood to restaurants. Tourism is a critical tertiary sector for the MAR countries, and reef-associated tourism contributes significantly;
  - For example, in Belize, the fishing sector is the second largest contributor to GDP amongst primary industries,[71] and tourism is the single most important industry, contributing 21% of GDP.[72]

[64] Guatemala includes wholesale and retail trade in with restaurants and accommodation, leading to an inflated number compared to Belize, Honduras, and Mexico, which only include restaurants and accommodation
[65] Statistical Institute of Belize; http://sib.org.bz/statistics/labour-force/
[66] National Statistics Institute of Guatemala, 2003. Censos Nacionales XI de Población y VI de Habitación 2002. https://www.ine.gob.gt/sistema/uploads/2014/02/20/jZqeGe1H9WdUDngYXkWt3GIhUUQCukcg.pdf
[67] National Institute of Honduras, 2013. Censo XVII Censo de Población y VI de Vivienda 2013. http://170.238.108.227/binhnd/RpWebEngine.exe/Portal?BASE=CPVHND2013NAC&lang=ESP
[68] National Institute of Statistics and Geography, Mexico and the Government of Quintana Roo, 2017. Anuario estadístico y geográfico de Quintana Roo 2016. http://coespo.qroo.gob.mx/Descargas/doc/Anuario%20Estad%C3%ADstico%20y%20Geogr%C3%A1fico%20de%20Q%20Roo%202016.pdf
[69] https://tradingeconomics.com/honduras/exports
[70] Funes, M., et al., 2015. Honduras, a fish exporting country: Preliminary reconstructed marine catches in the Caribbean Sea and the Gulf of Fonseca, 1950 – 2010.
[71] United Nations Conference on Trade and Development. https://unctad.org/meetings/en/Contribution/ditc-ted-Belize-28112018-Factsheet-1-fisheries.pdf

- **Risk reduction**: the MAR provides storm protection to grey public natural infrastructure as well as vulnerable coastal communities, reducing MAR country governments' contingent liabilities.

[72] World Bank; http://documents.worldbank.org/curated/en/870551467995073017/pdf/103941-WP-P152070-PUBLIC-None-Board-version-WB-Belize-CRA-noreport.pdf

Section 4: Financing the Risk

While a number of reef users has been identified, and each of these beneficiary groups faces risk with regard to potential hurricane damage to the MAR and interruption to the ecosystem services it provides, the key to implementing a sustainable mechanism to finance that risk lies in the beneficiary groups' ability to pay to protect those services.

Needs Assessment

First, in gauging beneficiary groups' ability to pay, we must understand the current needs when it comes to immediate, post-catastrophe response funding.

While the MAR Fund's RRI is a great example of a sustainable financing mechanism for reef resilience, it reveals two significant funding gaps:

1. The endowment provides much needed funds for the ongoing operations and regular programmatic activities of the RRI; however, there is a significant funding gap when it comes to addressing shock event risk; and

2. The RRI is currently funded largely through revenues from the endowment granted by the German Government through KfW, on behalf of the beneficiaries of the MAR. Therefore, in order to implement a sustainable financing mechanism for the remaining hurricane risk to the MAR, beneficiary groups will need to recognise their own contingent liabilities related to a damaged reef and be willing and able to take financial ownership of that risk.

Hurricane Risk Funding Gap

The RRI program is funded through revenues generated by an endowment provided by KfW, and one of the key strategies of the RRI is to provide sustainable financing to address the funding gap when it comes to emergency response for natural infrastructure. While the endowment provides much needed funds for the ongoing operations and regular maintenance of programmatic activities of the RRI, there is a notable funding gap when it comes to disaster risk. In particular, given the costs of emergency response to clean up and begin restoration activities for the reef immediately following damaging hurricanes, additional funding is needed.

The current endowment capital of US$9.5 million has generated an average of US$314,197 in annual returns since 2014 (when it was established with an initial capital of US$8.5 million). Of this amount, an average of US$245,000 is approved annually for programmatic activities (the rest goes to financial and operation costs and recapitalisation). While the endowment has allowed the initiative to cover costs for other activities to reduce reef risk, such as feasibility studies to provide information for the design of parametric insurance, selection of the pilot sites in each country, and work in the four

countries to establish the rapid response committees and brigades (among others), the endowment does not generate enough funding to fully finance the risk to the Mesoamerican Reef.

For example, analysis conducted by RRI through a rapid cost assessment[73] indicates that the cost of optimal, immediate post-hurricane response at a single reef site ranges between US$120,663 at the Punta de Manabique site in Guatemala, to US$564,971 in Roatán in Honduras.[74] This means that the cost of immediate response for a single severe hurricane affecting Roatán would far exceed an entire years' returns (or put a 6% dent in the endowment capital), severely threatening the sustainability of the RRI as a whole. Therefore, MAR Fund proposes to 'gear up' its endowment to finance the MAR's catastrophe risk through the purchase of parametric insurance. This coverage will access private risk capital, through payment of premium, to cover the costs of extreme events, providing post-event payments to fund rapid response reef restoration and recovery activities.

The challenge, then, is in funding the insurance premiums on an ongoing basis, guaranteeing access to the capital required to respond effectively to future hurricane events. The cost-benefit analysis included in the introduction to this report, as well as in the Supplementary Report, 'Cost-Benefit Analysis Summary and Sensitivity Analysis,' provides a compelling case for the value of risk financing to provide emergency response for reefs after hurricanes (as the cost-benefit ratio of that early response is estimated at almost 1:10). Below, we review the various beneficiaries of the ecosystem services that are interrupted when reef damage occurs, and should therefore see value in reducing the length of time the services are interrupted, and thus be prepared to contribute to premiums.

We note here that traditionally in the conservation sector, philanthropy plays the dominant role in funding ongoing conservation activities and is also top of the call list when additional funds are needed to respond to a shock event. Such shock response funding is often slow to materialise, or undermines the sustainability of ongoing, long-term conservation efforts if allocated from existing budgets. While philanthropy will still be a key source of conservation finance going forward, *ex ante* financing of hurricane risk to the Mesoamerican Reef requires a broadening of the funding base to include those that benefit from the reef services.

Beneficiary Groups' Ability to Pay

A sustainable financing strategy for insurance premiums will likely combine contributions from a variety of sources. The natural first place to look is towards the reef users who are dependent on its services, and, therefore, at risk.

[73] MAR Fund and Whiterock Natural Capital & Environment, 2019. Required actions, and their cost, for reef restoration and emergency response, after damages caused by hurricanes in selected reef sites of the MAR region. The study includes: 1. A description of the levels of damage, post-storm; 2. A description of the minimum and optimum restoration scenarios after the immediate response for each level of damage; 3. A description of the actions required by level of damage, according to ranges of effort in the designated sites. Because the costs may vary, depending on the distance from a site to the services required for the immediate response and damage repair, it was necessary to evaluate the costs for 7 demonstrative sites in the region.
[74] Further details on response costs are provided in associated reports and in the accompany materials.

Individuals / Households

Local Populations

While local populations are highly dependent, key beneficiaries of the MAR's services as natural infrastructure, they are also certainly the reef users with the least ability to pay. As detailed in the complementary report titled 'Beneficiaries of Rapid Response Reef Risk Financing in the MAR Region' (hereafter referred to as the 'Beneficiaries study'), 63% of the population local to the reef sites live in poverty, including 40% in extreme poverty.

Tourists / Recreational Users

There is another sub-set of individual / household reef users who may have the ability to finance some of the risk to the MAR, namely tourists and recreational users. There has been research into the potential of voluntary contributions to fund conservation, and various studies have indicated tourists are willing to fund the maintenance and protection of natural infrastructure, and the MAR in particular.[75] Additionally, tourists are willing to contribute in the form of fees and taxes levied by the MAR country governments.[76]

The Private Sector

Reef users in the private sector are currently very lucky indeed; as detailed above, they benefit greatly from the ecosystem services of the MAR, and they pay share none, or next to none, of those reef-dependent revenues towards the maintenance, protection, and restoration of the natural infrastructure asset that underpins their business activities.

While tourism and fishing businesses may not currently pay for the protection of the MAR directly, they do contribute through the payment of taxes and fees to the government in the form of fishing licenses, tourism levies (which are mostly actually paid by the tourists / recreational users themselves), marine park user fees (also often passed onto tourists / recreational users), port tolls (also probably passed on), etc. It can also be argued that the more general taxes that these businesses pay *could* go towards financing the risk to the MAR, should the MAR country governments budget accordingly.

In terms of current willingness to pay directly and voluntarily towards reef insurance, it is unlikely that businesses will impact their competitiveness by paying for something that others get for free (the "free rider problem"). Additionally, when risks do not show up as contingent liabilities on balance sheets, as in the case of risk to the MAR, they are not as easily recognised and considered by businesses and investors. Furthermore, while it is in the beneficiary groups' interest to pay to maintain MAR, an asset they depend on, that asset is a public one. However, the studies cited in this and the Beneficiary study that quantify the value of the MAR demonstrate clearly how dependent the businesses in the MAR region are on healthy reefs. Therefore, while it is not individual businesses' *responsibility* to take the bitter pill of financing the hurricane risk to the MAR, it is in their *interest*, if dependent businesses could

[75] Nelson et al., 2019. Nudging tourists to donate for conservation: Experimental evidence on soliciting voluntary contributions for coastal management
[76] Casey, J.F., Schuhmann, P. W., 2018. PACT or no PACT are tourists willing to contribute to the Protected Areas Conservation Trust in order to enhance marine resource conservation in Belize?

come together as a bloc, to do so. Tourism associations and fishing associations are potential avenues for this kind of sector-wide collaboration, and they could engage with the MAR Fund directly.

The private sector contributions to reef conservation that do happen are undertaken as Corporate Social Responsibility (CSR) efforts (particularly amongst the international hotel and cruise operators) and, while these are certainly important to grow, a more robust system for extracting a small toll from all benefiting parties is required. One concept that has been suggested is to require all coastal hotels to assign an appropriate 'seascaping' budget, just as they fund landscaping work, some portion of which would be held for the purposes of funding shock response through insurance.

The Public Sector

The restoration of natural ecosystems that support vulnerable communities is often not a governmental priority in the aftermath of extreme events, as resources are focused mainly on grey infrastructure and property (after live-saving actions are completed). Additionally, existing disaster risk financing mechanisms do not recognise the value of natural assets as public infrastructure also in need of restoration following damaging events. However, the need for natural infrastructure to enter the climate resilience discussion alongside hard infrastructure is increasingly recognised as the value of public assets such as the MAR is quantified and established.

In other instances, such as in Honduras, there is a mechanism to levy fines after ship groundings, but no established pathway to use the funds to actually restore coral reefs. Honduras is now willing to create a sub-account within its national fund for protected areas to channel those funds accordingly.

There are two modalities that the MAR country governments have the ability to finance the risk to the MAR:

1. **Current budget allocation**: the public sector is mandated to maintain and protect public infrastructure, and, therefore, governments have budgets to finance risk to public assets; and

2. **Additional fundraising mechanisms**: governments have the ability to raise additional taxes and levies.

Critically, while the first modality is an internal process regarding public finance and government priorities, the second offers an option for the public sector to compel the private sector to indirectly contribute, which is additional to current taxes and specific to the risk financing of the MAR.

There is already evidence of the MAR country governments' willingness to pay reef insurance premiums; there is a reef insurance coverage currently in place in the state of Quintana Roo. [77] This insurance product covers natural capital – specifically, reef sites on the MAR and beaches – paying out to fund response activities following hurricanes. 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, demonstrating a clear willingness to pay from both the government of Quintana Roo and the

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

tourism industry. While the demand for products like these is not immediately obvious, the ultimate purchase of the reef and beach insurance demonstrates the success following extensive engagement with the government of Quintana Roo and the tourism industry.

The Road to Sustainable Risk Finance

To summarise, there are three main methods the proposed insurance programme and associated activities will employ to encourage public and private sector ability and willingness to finance the risk to the MAR:

1. **Recognition of responsibility:**

   One of the current challenges regarding governments' willingness to pay for reef insurance is that natural infrastructure does not show up on government balance sheets as assets of value. Therefore, the risk to the MAR is currently unrecognised in the financial sense. Similarly, natural infrastructure is not included in risk management strategies or frameworks.

   Therefore, the proposed reef insurance project will provide a platform to work with governments to include reefs and other coastal and marine ecosystems in their climate risk assessments and disaster-risk financial planning. To support the inclusion of green infrastructure in the comprehensive risk management strategies of the MAR countries, the MAR Fund has prepared regional and by-country analysis of the existing regulatory framework and public policy, and existence (or lack) of financing mechanisms for reef restoration. On the basis of this analysis, the MAR Fund has developed general recommendations for improving legislation to enable reef insurance, reef restoration, and emergency response actions at the country and regional level.

   MAR Fund also commissioned a concept paper for the MAR region to assess the viability of including coral reefs into asset valuation and climate related risk assessments, and the economic rationale for using insurance instruments for coral reefs against hurricane damages.[78] Additionally, MAR Fund actively supports the everyday maintenance of the economic and biodiversity value of the MAR and the critical services it provides. MAR Fund works with each of the MAR country governments, which also participate in the Central American Commission on Environment and Development (CCAD) - Mexico being an observer to CCAD - to proactively mitigate climate risk to the region, through the Reef Rescue Initiative.

   In order to provide additional sound and updated information on the value of different environmental services of reefs to the MAR countries, we are in discussions with Inter-American Development Bank for a grant to support their economic valuation. Results will then be used as a key element in work with governments to discuss and promote the development of national disaster-risk planning that may include insurance instruments for reefs.

2. **Proof of concept (willingness to pay):**

[78] Wagner, Alderman and Alderman, 2018. Opportunities for the Mesoamerican Reef countries to include coral reefs into asset valuation and climate related risk assessments, and the economic rationale for using financial instruments to insure coral reefs against hurricanes and damage from ship groundings.

The value of insurance is demonstrated over time, as it does not become apparent until a covered event occurs and a pay-out is made. Therefore, the insurance project budget includes direct financing of insurance premiums to maximise the chances that pay-outs will be made across some of the sites and therefore provide the maximum chance of reef insurance becoming mainstreamed as its value is recognised. Global experience with index insurance has shown that supporting take-up of insurance at launch greatly increases the chances that insurance will become broadly used.

Our expectation is that by the end of the project, governments, along with the private sector and possible contributions from philanthropy, will be able to cover the insurance cost as part of the larger financing for sustainable reef conservation and protection of natural assets.

3. **Identification of budgeting mechanisms (ability to pay):**

Finally, the recognition of responsibility for natural infrastructure and the evidence that insurance is a valuable risk financing tool must then be backed up by finance. As previously mentioned, and further outlined below, governments can either allocate current budgets or implement new taxes or levees to raise additional funds. The private sector can contribute directly through voluntary contributions or indirectly through compulsory fees or taxes levied by the government.

Funds can be raised in various ways, similar to the ways that funds are raised to maintain grey infrastructure. These mechanisms include:

- General budget allocation to responsible ministries (e.g. Ministry of Environment or Fisheries) and / or subcontractors (e.g. MAR Fund). This would function similarly to how budgets are allocated to maintain roads; funds flow from the general accounts of a country to the public works ministry, and then often onwards to subcontractors who carry out maintenance and repairs;

- User fees (similar to a road toll, fees can be applied to marine park entry); and
- Levies on reef-related goods and services such as diving, or even tourism more generally.

Aggregation of Premiums

An additional component of the insurance programme development workplan is to identify mechanisms to enable the aggregation and administration of the risk financing raised. This could be through management agreements with the MAR Fund, who would aggregate premiums for the reef

risk insurance, or the set up of a special purpose trust, which would administer the same funds (for example, the TNC reef and beach insurance is administered in a trust fund).

Strategy for Securing Long-Term Premium Payment Sources

Here, we briefly summarise how we will approach securing long-term funding of premium for reef insurance under the auspices of the proposed project, based on the description of potential funding sources provided above.

- **Individuals**: Individuals are unlikely to be prepared to contribute to premiums unless they have direct exposure of owned, immovable assets to storm surge flooding and wave damage. Given the economic profile of the population benefiting from the services of the MAR in the selected areas, this is a very unlikely situation to occur. The case may be more compelling for a community group where all (or most) individual members have similar exposure, either of fixed assets or livelihood, and could receive similar benefits for sharing the costs. Examples might be an association or credit union of fisherfolk or tourism workers. If connected to existing financial services, such as lending, then the cost might be shared between a borrowing individual and the institution itself (which gets a reduction in credit risk in return). Thus, we propose to engage with existing aggregators to explore this approach, in cooperation with existing micro-finance and micro-insurance initiatives where they are active.

- **Public Sector**: Traditionally, particularly in areas with high poverty rates, public goods and services are assumed by the population to be provided by local, regional and/or national government. Although there is a shift, globally, towards targeted payment for public services (including through public-private partnership structures) rather than payment coming through general taxation (e.g. toll roads, metered water supply), the expectation in all four MAR countries remains that general taxation should support public services (including maintenance of public goods) which benefit most or all of the population.

  While PPP models may be applicable and help to unlock sustainable sources of finance for things such as insurance premiums in specific situations (e.g. reef areas that are highly frequented by those who can afford to pay a use-fee), it is unlikely that such models have broad deployment potential for the selected sites in the MAR, so we propose to concentrate on engaging directly with local, regional and national governments, as appropriate and alongside collaborative partners already active in this area, to demonstrate the need for financing of early response to hurricane damage to reefs (building on the quantification of value provided by the reef and the high benefit to cost ratio of early response actions) and the benefits to using parametric insurance, tied to agreed actions, as the financing tool.

  For this engagement, we will fully leverage existing direct relationships within the various levels of government, including with officials engaged on environmental and climate change issues as well as those working on risk financing within ministries of finance and economy, alongside leveraging the secondary relationships we have via partners such as the World Bank, Inter-American Development Bank, Caribbean Development Bank, COSEFIN, CARICOM, CCRIF-SPC, CDEMA, CEPREDENAC, CCAD, ORRAA, etc. We recognise the challenges associated with unlocking sustainable direct public finance to cover reef insurance premiums, but consider ourselves very well positioned to make the strongest case possible.

- **Private Sector**: We propose to engage with the private sector as a potential source of premium payments through two parallel routes - one indirect, through compelling action via regulation and/or taxation, the other direct, through demonstrating the value proposition for reef insurance either on a stand-alone basis or as part of a broader climate risk management approach. The rationale for directly taxing the private sector to support reef insurance is based on the fact that a certain part of the private sector directly monetises the value of the public goods that the reef represents and therefore has the most resources available to maintain those public goods, as well as the most to lose if they are not maintained.

  The case is most easily made to tax the tourism industry in locations where they derive high value from reefs - and that could be done through specific new taxes or through assigning a portion of existing tax revenue to support reef resilience (including payment of insurance premiums). The case becomes increasingly difficult to make the more disconnected the individual businesses are from the reef that is being made and kept resilient, which presents a challenge for much of the MAR, where there is little or no monetisation of the value of the reef (e.g. where subsistence fishing dominates, or where there is little or no property value gaining protection from the reef).

  Requiring the private sector to spend money on reef resilience, through regulation, is an alternative route to tapping private sector resources for reef maintenance and recovery and is one where there has to date been relatively little innovation. Compelling beachfront hotels to dedicate resources to both ongoing and post-storm reef maintenance is one approach; another might be to compel businesses to have business interruption coverage as well as property coverage, with a small levy on premiums for such coverage going to pay for reef insurance. Making new, cost-effective products available - such as parametric hurricane insurance for business interruption - could help to make such regulation acceptable to the private sector (as it would need to be if it were to be successfully implemented).

  Directly selling reef insurance to private sector actors is certainly worthy of attention, particularly where there is either a strong association of interests already working together to build a better business environment or where there is a dominant private sector player for whom the value proposition of reef insurance is particularly compelling. In both cases, the area of reef in play is likely to be limited, although the nature of parametric reef insurance, and the portable nature of the response mechanism being funded, may enable the benefits of coverage for one specific stretch of reef to be extended to have relevance over a much longer stretch of reef.

  Additionally, there will be a growing interest in the coming years around management of medium to long term climate risk, and, while this is unlikely to materialise in new accounting rules, for example, in the four MAR countries, it has already started to influence multi-national businesses with operations in these countries, as well as investors who would be needed to support new developments. A beachfront resort becomes a stranded asset if there is no beach or if storm surge flooding starts to happen too frequently, both of which are strongly influenced by the health of the reef.

- **Visitors and Global Citizens**: Our final engagement target will be the global public, both as direct beneficiaries of reef services during holidays spent on the beaches and in the tropical waters protected and nourished by the MAR, and as guardians of Planet Earth. While we recognise that individual visitors is a rather large target group, there is a significant body of work on both the willingness of visitors to pay for environmental conservation efforts and effective methods for them

to exercise that willingness. In collaboration with partners already active in this effort, we propose to formulate approaches to test a range of options (additional visitor taxes, carving out of a portion of existing visitor tax revenue, voluntary contributions, etc.) for those sites where international visitors are substantial beneficiaries of the MAR.

But we also propose to explore opportunities to tap into the sense of responsibility for carbon pollution which the generation of Extinction Rebellion has so powerfully brought to the top of the global economic and political agenda. Coral reefs represent the most obviously demonstrated link between anthropogenic carbon pollution and biodiversity loss, putting into sharp focus the degradation and destruction of global public goods by the industrialised nations and their beneficiary populations. While legal attribution and liability will be slow to materialise, the moral obligation is clearly weighing on the next generation of leaders, who are increasingly forthright in their sharing of that obligation with their parents and grandparents.[79] We suspect that the ability to unlock the very modest levels of funding required through both traditional and non-traditional global channels will be greatly enhanced in the coming years, and we will develop a strategy to identify and pursue such opportunities in conjunction with our regional and global partners.

[79] https://www.theguardian.com/environment/2019/oct/09/stanley-johnson-extinction-rebellion-protest-crusties

Section 5: Insurance Contract and Pay-Out Management

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 that is required of a policy holder of parametric insurance is that they 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.

The only requirements to be a beneficiary and, therefore, a policy holder of insurance for natural capital, 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.

Insurance Contract

As discussed in Section 2 and in the complementary Beneficiaries study, the policy holder of the proposed reef insurance product will be the MAR Fund. The MAR Fund is a long-term viable purchaser of insurance, it is an environmental fund with strong governance and administration, and it is the ideal implementation partner for any immediate reef response. The design of the insurance programme will include the specific mechanisms to channel pay-outs to ensure execution of critical actions in a timely fashion. Therefore, smooth implementation of funds / pay-out disbursement requires an understanding of the legal and administrative structure in each country. The legal structure by country is a task already completed by MAR Fund, and MAR Fund is uniquely well positioned to negotiate with national and local authorities to allow local immediate response brigades access to reef sites for response actions following a hurricane. Further, legal counsel has confirmed the MAR Fund's ability to purchase the insurance policy. Also importantly, the MAR Fund is the ideal fund to clarify risk ownership when it comes to green infrastructure. Because of the MAR Fund's relationship with national governments (including collaboration agreements with government entities), its role as a regional long-term financial mechanism, and its experience in funding conservation and restoration initiatives on the Mesoamerican Reef, it can be responsible for the Mesoamerican Reef in the same way that governments are responsible for the management and maintenance of grey infrastructure such as roads and bridges.

Pay-Out Management

The design of the insurance programme will include the specific mechanisms to channel pay-outs to ensure execution of critical actions in a timely fashion. For this, it is vital to understand the legal and administrative structure in each country. The legal structure by country is a task already completed by MAR Fund. Given its prior work, MAR Fund is uniquely well positioned to negotiate with national and local authorities to allow local immediate response brigades access to reef sites for response actions following a hurricane. MAR Fund is in the process of building collaboration agreements with local authorities in each country of the MAR to provide permits to create and train the brigades and for their subsequent operation. Plus, MAR Fund's RRI aims to support the long-term ecologic and economic viability of the Mesoamerican Reef System and the environmental services it provides, by helping develop the human capacity for implementing the restoration services in each country.

Responders

Once a pay-out is triggered and released to the MAR Fund as the policy holder and administrator, funds will then be channelled through an emergency response mechanism established in a contingency planning process (e.g. Emergency Response Brigades and Committees) in each country. Specific institutional arrangements will need to be put in place for specific partners to receive the funds for the emergency response actions in each country, and responsible parties may vary. MAR Fund has already secured a letter of support from the Belize Department of Fisheries regarding the Emergency Response Capacities in particular, and discussions are currently underway with the other MAR countries to obtain the same. Additionally, endorsement letters in support of the reef insurance programme have been obtained from the Governments of Mexico, Belize, and Guatemala, and discussions are currently progressing with the Government of Honduras.[80] The actual response activities will be undertaken by Emergency Response Brigades, all of whom will be trained in emergency response actions and reef restoration, and which will include:

- Expert divers;
- Local tour operators (such as snorkel and dive guides);
- Local fishers; and
- Other local service providers, for example, boat captains.

Insurance pay-outs, when triggered, will cover their stipend / daily fees and their mobilisation costs. The emergency response actions involve clearing the reefs of debris and carrying out immediate restoration by cementing viable pieces of coral that were torn off during the hurricane.

The operation structure for local response actions after a hurricane includes Early Alert and Emergency Response Coordination Committees and Emergency Response Brigades that will be established through the RRI. The Coordination Committees will effectively organise all actors and take

[80] The Letters of Endorsement and Support are provided as part of the materials accompanying this and its associated reports.

the steps required to make sure the response is timely and effective and will include local women and men in each of the MAR countries.

Building Emergency Response Capacities in the MAR Region

MAR Fund has coordinated with TNC to develop and implement a response protocol for storm damage to the MAR, which is outlined in the document, Early Warning and Rapid Response Protocol.[81] The base for this activity is the Emergency Response Protocol that was developed by TNC for the reefs of Quintana Roo. This manual includes guidance regarding the profile of the response brigades and the actions required to secure rapid reef recovery at each of the proposed pilot sites.

The objective of this protocol is to guide the reef managers on the necessary actions to be carried out before, during, and after a tropical cyclone. The protocol includes the structure under which emergency action will be implemented, including the Coordinating Committee, the Response Brigades, and the Operation Teams.

The Emergency Response Brigades will include fishermen and local service providers. Insurance pay-outs, when triggered, will cover their stipend / daily fees and their mobilisation costs. The emergency response actions involve clearing the reefs of debris and carrying out immediate restoration by cementing viable pieces of coral that were torn off during the hurricane. By doing this, the brigades will be restoring the environmental services the reefs provide (e.g. tourism and fisheries). The operation structure for local response actions after a hurricane includes the Response and Early Alert Coordination Committees, that will also be established through the RRI. The Coordination Committees will effectively organise all actors and take the steps required to make sure the response is timely and effective. These committees will be formed of local women and men in each of the MAR countries.

In 2019, MAR Fund and TNC have had meetings with the reef managers and local and national authorities in Belize, Guatemala and Honduras in order to:

- Identify capacities and needs of the countries to adopt and carry out the Emergency Response Protocol;
- Identify the processes required to build and train Rapid Response Brigades; and
- Develop a work plan and timetable to implement the emergency response capacities in the countries.

As a result, the three countries have agreed, in formalising collaboration agreements with MAR Fund, to formally adopt the Early Warning and Rapid Response Protocol, either as an addendum to their Protected Area Management plans, or as a national instrument for climate change preparedness. This includes the agreement to delegate and supervise the protected area managers to organise and maintain the emergency response capacity, take the lead in the process of building and training the

[81] Provided as part of the materials accompanying this and its associated reports.

emergency response brigades, safeguard the equipment, and provide the permits for the brigades to operate.

The national authorities leading the formalisation agreements with MAR Fund are:

- **Belize**: the Fisheries Department;
- **Honduras**: General Direction of Biodiversity (DiBio) and National Institute for Forest Conservation and Development (ICF);
- **Guatemala**: the National Protected Area Council (CONAP); and
- **Mexico**: the Early Warning Response Protocol has already been officially adopted by the National Commission of Natural Protected Areas (CONANP).

In 2019 and 2020, MAR Fund will continue to provide support for the establishment of the brigades and their training, which will benefit the local communities and tourism services providers beyond just the recovery activities funded by insurance pay-outs. In order to implement and strengthen the emergency response capacities in the MAR countries, MAR Fund will also formalise the collaboration agreements with local authorities in each country. Agreements will facilitate the procurement of the necessary permits to create and train the brigades, as well as allowing their subsequent operation.

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