InsuResilience
Solutions Fund

Beneficiaries of Rapid Response Reef Risk Financing in the MAR Region

Prepared by Willis Towers Watson and MAR Fund

21 October 2019

funded by KFW

on behalf of Federal Ministry for Economic Cooperation and Development

managed by Frankfurt School of Finance & Management
German Excellence. Global Relevance.

part of InsuResilience GlobalPartnership

InsuResilience Solutions Fund

Beneficiaries of Rapid Response Reef Risk Financing in the MAR Region

October 2019

Willis Towers Watson

Table of Contents

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.

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 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

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

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 1.1 shows selected risks to ocean health and reflects whether they are insurable or uninsurable / more difficult to insure due to moral hazard.

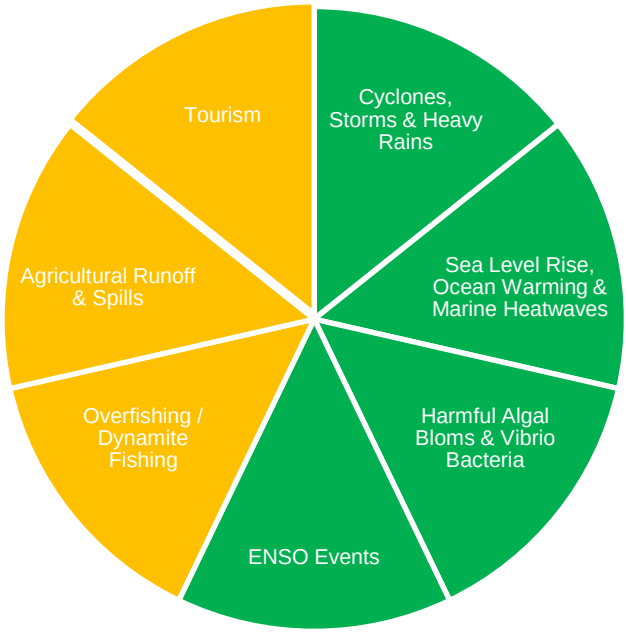


Figure 1.1 Individual risks to reefs, split broadly into potentially insurable (green) and uninsurable / more difficult to insure (orange).

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]

[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.

- **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.[5] A simple cost benefit analysis[6] 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
- 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;

[5] 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. Study conducted by MAR Fund and White Rock consultancy group, as part of the set of three feasibility studies in support of the insurance pilot model for the MAR Region.
[6] Details of the cost-benefit analysis are included in the Supplementary Report 'Cost-Benefit Analysis Summary and Sensitivity Analysis.'

- 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 this insurance product (which will be submitted for funding to the InsuResilience Solutions Fund), in particular the identification and economic profiling of key beneficiaries, we have conducted a preparatory study, the results of which are presented here. The following report details a socioeconomic analysis of the people to be reached by the insurance programme in the MAR Region, providing information of the direct and indirect beneficiaries and the extent to which the insurance programme will benefit the most vulnerable.

A second, sister study to this one, investigating potential sources of sustainable financing for insurance premiums, draws on common background and research, and is cross referenced where appropriate.

Section 2: The Value of Rapid Response and Early Reef Clean-up

The following section details the value of rapid response, including reef clean-up and early restoration activities, to ecosystem and community recovery and long-term resilience. We draw on existing empirical research relating to the quantification of this value, including practical examples and case studies of similar projects around the world.

The restoration of natural ecosystems that support vulnerable communities is rarely 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 (as well as ongoing protection and maintenance). Therefore, exacerbating the hurricane-driven threat to reefs and dependent populations, is the lack of access to immediate funds to implement emergency response actions and reef restoration strategies.

Because there are few examples of immediate response activities focussed specifically on coastal ecosystems in the aftermath of extreme weather events, there is little empirical evidence of the potential value of those immediate activities. However, case studies are starting to emerge to form an evidence base. For example, following the recent, devastating hurricane season of 2017, the U.S. Government, through the Federal Emergency Management Agency (FEMA) and the National Oceanic and Atmospheric Administration (NOAA), conducted rapid response restoration activities and early reef clean-up in Florida, the U.S. Virgin Islands, and Puerto Rico. Additionally, NOAA is the responsible agency for coral restoration from threats beyond storms; they also conduct emergency response and restoration in the aftermath of oil and chemical spills and ship groundings[7]. Figure 2.1 shows the total number of corals NOAA has reattached in the Caribbean (Puerto Rico and the U.S. Virgin Islands) following ship groundings since 2009; almost 20,000 of those were following Hurricanes Irma and Maria in 2017.

This has established rapid response as best practice and identified two critical benefits:

- Rapid response allows for broken corals to be reattached / relocated to significantly boost chances of survival; and
- Rapid response allows for the collection of still-living fragments for coral nursery propagation (and these ‘farmed’ corals can then be transplanted to restore reefs).

Unless corals are relocated to areas where they have adequate exposure to sunlight for photosynthesis or structure to stabilise and continue growing, they will die and neither of these benefits will be achieved.

[7] NOAA; https://blog.response.restoration.noaa.gov/; https://darrp.noaa.gov/

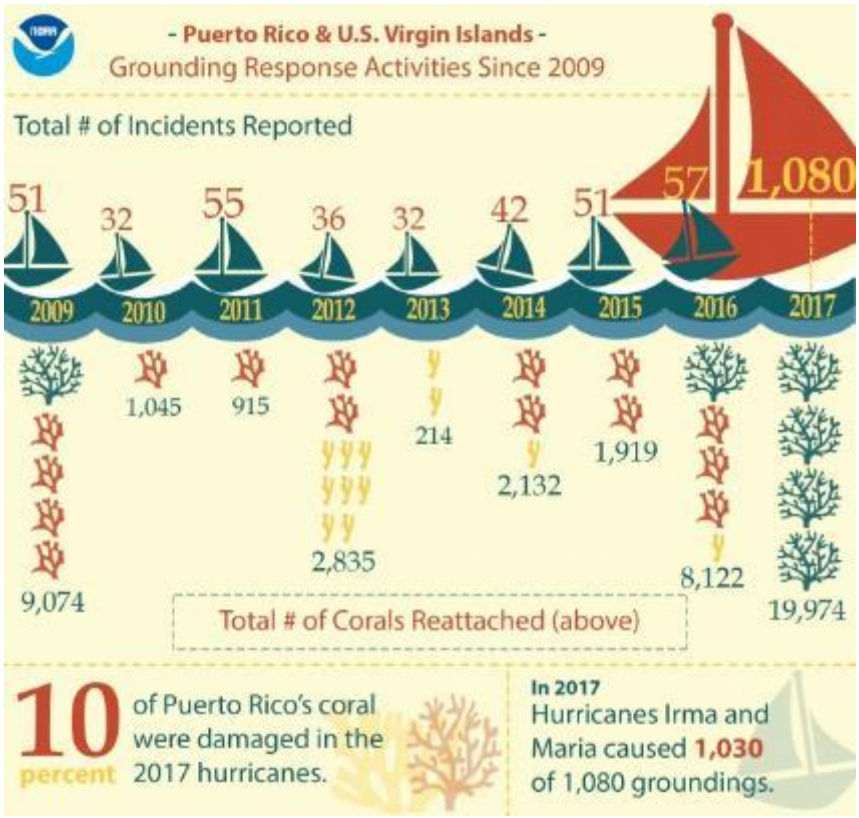


Figure 2.1 Total ship groundings reported, and corals reattached, by NOAA in Puerto Rico and the U.S. Virgin Islands since 2009[8].

Remarkably, according to Sean Griffin, a marine habitat resource specialist and corals expert at NOAA's restoration centre, corals that are rescued and moved to appropriate locations 'have a 90 percent chance of survival as opposed to the 10 percent [they] had before.'[9] Also, according to the previous experience of NOAA scientists and emergency responders, 'It would take decades to regrow the large corals that were impacted, versus minutes to reattach it to the reef.' During the post-hurricane response in Puerto Rico, the team cleaned turf algae and sedimentation from the reef surface and used cement to re-attach corals. Approximately 9,760 broken corals were reattached. Emergency response to rescue and reattach broken corals works.[10]

This assessment is further supported by a review of reef restoration and coral propagation in the Caribbean and Western Atlantic.[11] The authors of that study found, for example, that following a hurricane in the Dominican Republic, 200 elkhorn coral colonies were stabilised in Boca Chica, resulting in 95% survival over the first year and spawning observed three years after transplantation.

In addition to clean-up and the collection and replanting of broken corals, there is significant value in activities such as triage and early damage assessment as well as non-physical interventions, such as additional event-responsive fisheries management / marine special planning. Early damage

[8] NOAA; https://blog.response.restoration.noaa.gov/how-noaa-supports-post-storm-coral-restoration
[9] Ibid
[10] NOAA; https://coastalscience.noaa.gov/project/assessment-of-hurricane-impacts-to-coral-reefs-in-florida-and-puerto-rico/
[11] Young, C.N., Shopmeyer, S.A. and Lirman, D., 2012. A Review of Reef Restoration and Coral Propagation Using the Threatened Genus Acropora in the Caribbean and Western Atlantic. Bulletin of Marine Science, 88, 1075-1098. http://dx.doi.org/10.5343/bms.2011.1143

assessments are critical to informing longer-term restoration plans, and the sooner they can be carried out, the sooner communities can agree and begin to implement shock-responsive restoration activities and policies.

Cost Benefit Analysis

Initial cost-benefit analysis shows that immediate response to reef damage by Tropical Cyclones at selected sites along the MAR results in a cost-benefit ratio of close to 1:10, compared to no intervention, assuming reef recovery time is halved as a result of the early response. We also make assumptions about the pace and degree to which ecosystem services are restored to each of the three main sectors (tourism, fisheries and coastal protection) during the reef recovery window.

A full summary of the cost-benefit calculation, including a sensitivity analysis for key assumptions with the least supporting literature and data available - namely the improvement in reef recovery time and the relative timing of ecosystem service restoration - can be found in the Supplementary Report, 'Cost-Benefit Analysis Summary and Sensitivity Analysis.'

Results

Table 2.1 contains the results of the simple cost-benefit analysis based on the input data and assumptions described above. The benefit to immediate response materialises through the earlier re-instatement of ecosystem services provision – and therefore value - thanks to quicker reef recovery.

Cost of Response	$2,886,542
Benefit of immediate response	$28,040,313
Cost Benefit Ratio of early response	**1 : 9.7**

Table 2.1 Summary of cost-benefit analysis. Values in US$.

Input Data

Ecosystem service values and restoration costs for the MAR were derived from two studies:

- A valuation study prepared by the Prince of Wales' International Sustainability Unit, the United Nations Environment Programme, the International Coral Reef Initiative, and S&P Trucost Limited, an affiliate of S&P Dow Jones Indices LLC;[12] and
- A restoration cost study[13] prepared by Whiterock Natural Capital & Environment, consulting to the Reef Rescue Initiative of the MAR Fund, largely based on the Puerto Morelos Alert and Response Protocol.[14]

[12] 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.

The valuation study estimates the economic value of the entire Mesoamerican reef to tourism, commercial fisheries, and the coastal development sector. Table 2.2 summarises the values in terms of direct economic returns from the entire MAR in 2017.

To the commercial fishing sector	$240 million
To the tourism sector	$3,484 million
To the coastal development sector (protection value)	$975 million

Table 2.2 The direct economic value of the entire MAR in 2017, by sector. Values in US$.

Based on the characteristics of the selected reef sites, in total they have been estimated to account for a proportion of the ecosystem services of the entire MAR as follows:

- Fishing sector - 5% of the total economic returns for the full MAR;
- Tourism sector - 1% of the total returns; and
- Coastal development sector (protection value to terrestrial assets) - 1% of the total returns.

Table 2.3 summarises these ecosystem service values to each key sector.

Sector	Annual value provided by the entire MAR	Monthly value provided by the reef sites
Fishing	$240,000,000	$1,000,000
Tourism	$3,484,000,000	$2,903,333
Coastal Development	$975,000,000	$406,250
Total	**$4,699,000,000**	**$4,309,583**

Table 2.3 Value of the ecosystem services provided by the reef, by sector and geography. Values in US$.

The restoration cost study calculates the cost of restoration for target reef sites; further details can be found in a summary presentation of the report cited above, which is provided as part of the materials accompanying this and its associated reports.[15] The aggregated cost of restoration of all of the

[13] 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.
[14] Zepeda-Centeno C., et al., 2019. Early Warning and Rapid Response Protocol: Actions to mitigate the impact of Tropical Cyclones on Coral Reefs. The Nature Conservancy. http://reefresilience.org/wp-content/uploads/Early-Warning-and-Rapid-Response-Protocol_compressed.pdf
[15] Because the selection of the pilot sites in Mexico was not finalised when this cost analysis had initiated, one of the sites, Xcalak, is not included in the analysis. The full study considered more than the seven pilot sites, collecting a variety of data on the restoration costs for different type of sites (i.e. very near to shore, further off shore, etc.) for demonstration purposes and to

selected reef sites is US$2,886,542, with the costs of immediate, optimal response following a severe hurricane differing for the various sites, ranging between the most inexpensive site, Punta de Manabique in Guatemala, at a cost of US$120,663, to US$564,971 for the most expensive site, Roatán in Honduras. The aggregated cost of restoration of all of the selected reef sites is used to calculate the cost of intervention, as the value of the benefits of the reef is also aggregated across all of the selected sites.

inform the development of a simple tool that calculates the restoration costs for any potential site. That tool calculates the response costs based on the percentage of live coral cover and is also available on request.

Section 3: Socioeconomic Analysis of Reef-Protected Populations

The following section outlines, to the extent possible using available population census and statistical desk research, a socioeconomic analysis of the main populations in the MAR region that are protected from storm hazards by the Mesoamerican Reef and associated ecosystems. We focus in particular on the communities of the selected pilot sites for the development and implementation of the parametric reef insurance.

Pilot Sites

The proposed pilot sites encompass the following reefs:

- **Mexico**: the Banco Chinchorro and Arrecifes de Xcalak Marine Protected Areas;
- **Belize**: the Turneffe Atoll 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 also depicted in Figures 3.1 and 3.2.

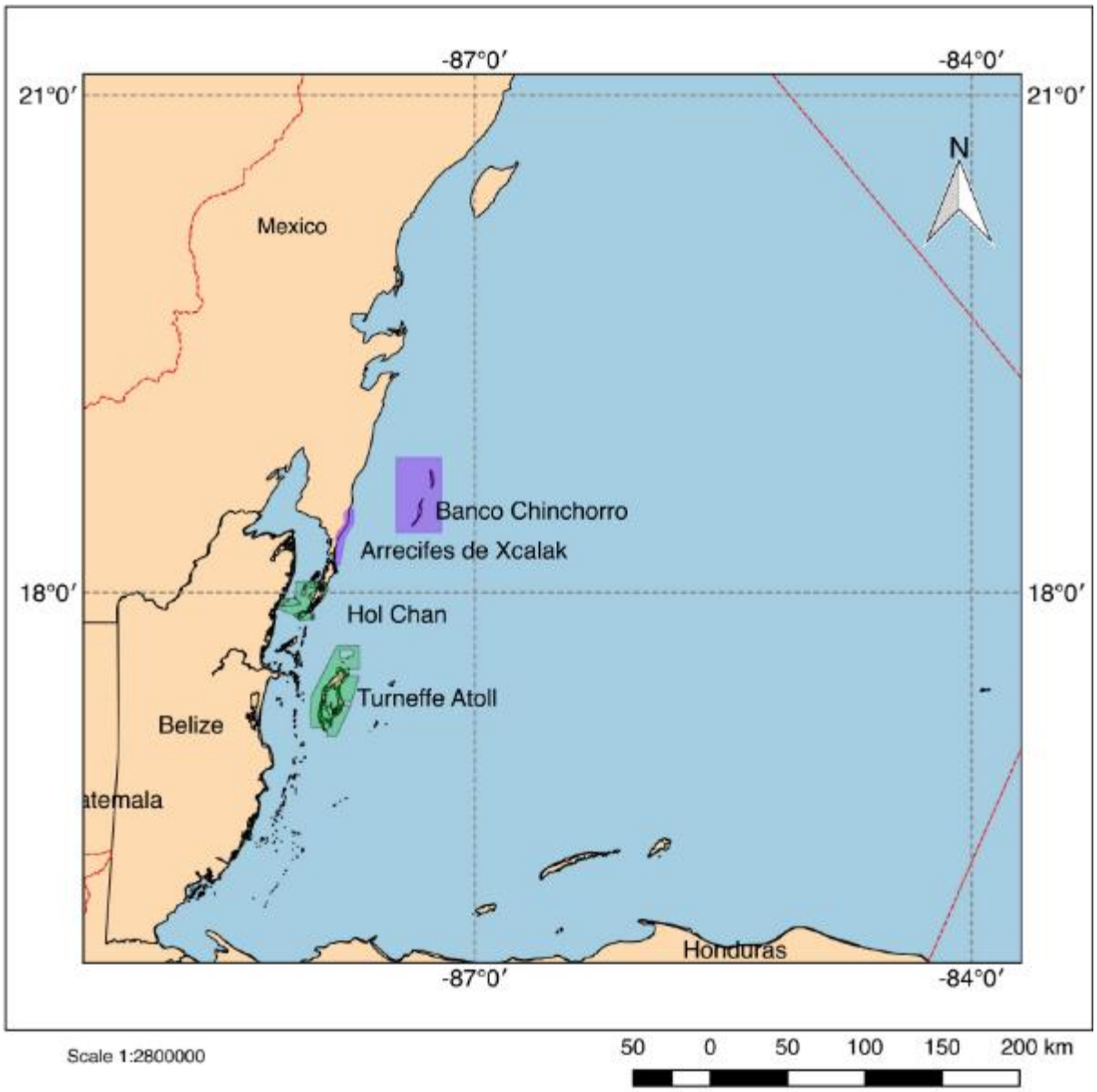


Figure 3.1 Reef sites in Mexico (purple) and Belize (green).

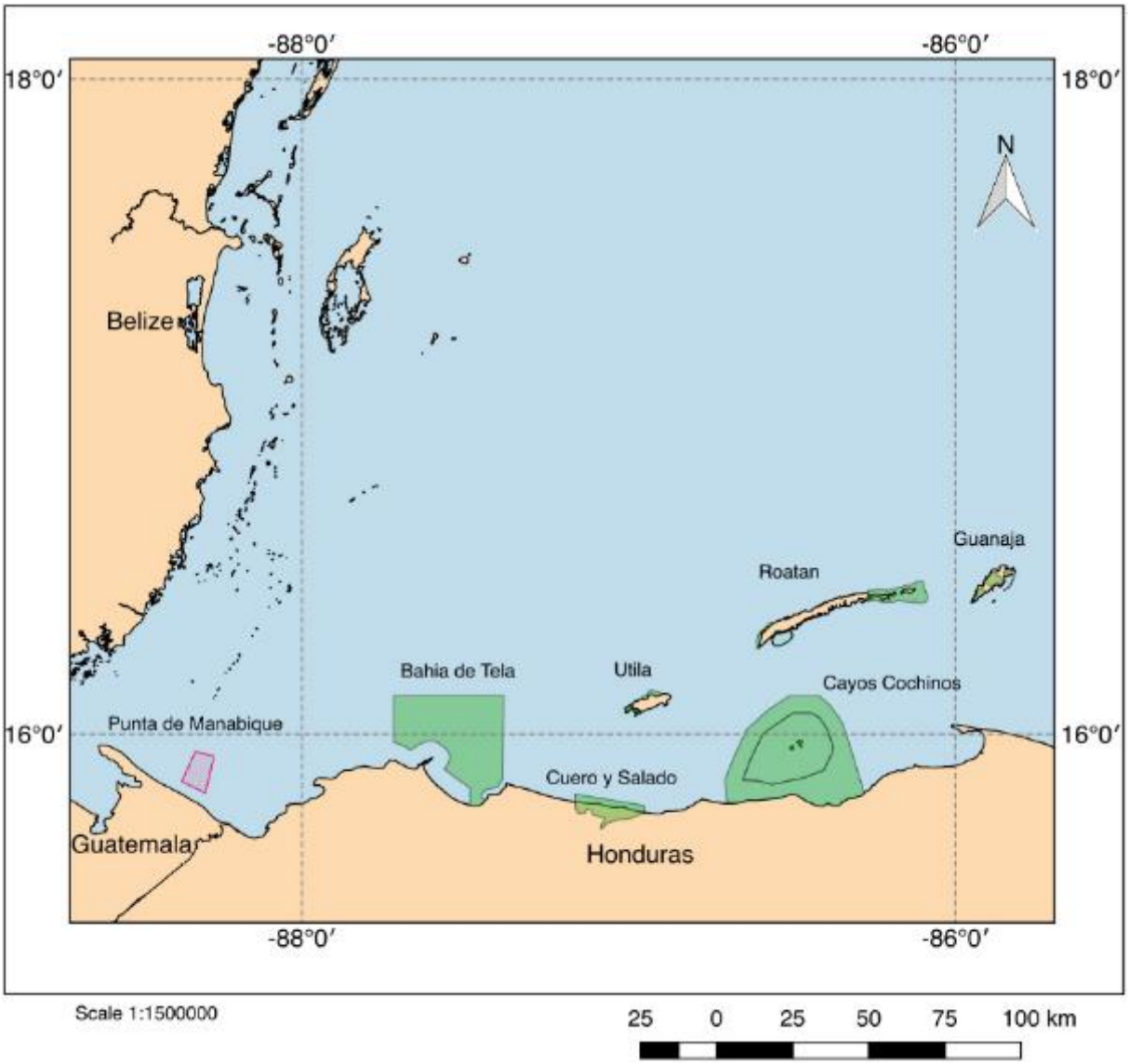


Figure 3.2 Reef sites in Guatemala (pink) and Honduras (green).

Beneficiary Population

Climate-change induced rises in sea level and increased temperature of the sea surface is likely to cause more intense and sustained flooding. Every year, coastal flooding causes a significant amount of economic damage globally. The protective effects of coral reefs contribute to reduced damages from coastal erosion, inundation and storm surges via general wave attenuation, storm surge attenuation and maintaining shoreline elevation[16]. The pilot reef sites selected directly serve the surrounding coastal populations, who are identified in this section.

This section identifies the beneficiary population of the proposed reef insurance programme and the number of people within that population who are poor and vulnerable according to national poverty lines documented and calculated by the MAR country governments. However, in order to evaluate the potential impact of the proposed reef insurance programme for the purposes of applying for InsuResilience funding, it is required to identify a specific sub-set of the beneficiary group: the 'InsuResilience Target Group'. Unfortunately, the national poverty rates as calculated in country poverty assessments and by the statistical departments of the MAR countries do not use the same methodology or income levels as the InsuResilience methodology. Therefore, the Supplementary Report, 'InsuResilience Target Group,' describes the overlap between the poor and vulnerable people identified in this report and the InsuResilience Target Group.

Mexico

Both reef sites in Mexico are located offshore of the coast in the state of Quintana Roo on the eastern side of the Yucatán Peninsula. Quintana Roo has developed rapidly, with the population increasing from less than 100,000 in 1970[17] to close to half a million in 1990[18] and more than 1.5 million in 2015.[19]

While Quintana Roo has relatively lower levels of overall poverty compared to national levels, according to 2018 numbers, 42% of the Quintana Roo population is living in poverty, with 7% falling below the threshold of extreme poverty.[20]

The Banco Chinchorro Atoll reef site is fairly remote (Figure 3.3), and therefore functions more as fisheries and tourism / recreational infrastructure than as storm defence. However, the Xcalak reef, which is near shore (Figure 4), and Chinchorro, do provide direct protection for the residents of the villages of Xcalak and Mahahual on the southern tip of the Costa Maya in the municipality Othon

[16] M.W.Beck, Losada, I.J., Menéndez Fernández, Pelayo, Reguero, B.G., Diaz-Simal, Pedro, Fernández, Felipe, 2018. The global flood protection savings provided by coral reefs. Nature Communications
[17] National Institute of Statistics and Geography, Mexico, 1970. The General Population Census of 1970. https://en.www.inegi.org.mx/programas/ccpv/1970/
[18] National Institute of Statistics and Geography, Mexico, 1990. The General Population Census of 1990. https://en.www.inegi.org.mx/programas/ccpv/1990/
[19] National Institute of Statistics and Geography, Mexico, 2015. The 2015 Intercensal Survey. http://en.www.inegi.org.mx/programas/intercensal/2015/
[20] Poverty is defined as an income less than the value of the wellbeing line (calculated as the income needed to afford basic food and non-food baskets of goods and services) with at least one social deprivation, and extreme poverty indicates three or more social deprivations and an income lower than the minimum welfare line; sources: National Institute of Statistics and Geography- http://en.www.inegi.org.mx/datos; National Council for the Evaluation of Social Development Policy (CONEVAL), 2014, Multidimensional Measurement of poverty in Mexico: an economic wellbeing and social rights approach; https://www.coneval.org.mx/informesPublicaciones/FolletosInstitucionales/Documents/Multidimensional-Measurement-of-poverty-in-Mexico.pdf

P.Blanco.[21] According to the most recent census, Xcalak supports a population of 375, and Mahahual is home to 920 residents, bringing the total number of direct beneficiaries of the risk reduction benefits of the Mexican reef sites to 1,295.

Figure 3.3 The Costa Maya and coastal villages protected by the Banco Chinchorro and Xcalak reef sites[22].

Also to note, both sites are extremely vulnerable to hurricanes. For example, in the early 1900s, Xcalak was a town with a naval base, shipyard, railway, lumber industry, and coconut plantations until 1955 when Hurricane Janet swept through, flattening the town and plantations. The population scattered, and Xcalak remains the small fishing town that was left in Janet's wake. Mahahual has also experienced recent hurricanes, including Hurricane Ernesto in 2012 and Hurricane Dean in 2007. Dean caused significant impacts, destroying homes and damaging the port, making it unsuitable for cruise ships and causing significant losses to the tourism industry of the town.

Since the most recent census in 2010, there has been increasing coastal development along the Costa Maya. For example, the Costa Maya Cruise Port Terminal opened three kilometres from Mahahual in 2001 and the tourism industry continues to grow. However, the size of the industry is still relatively small compared to the northern half of the coast of Quintana Roo, from Cancún to Tulum.

Xcalak is a small fishing village, also known for its diving, where residents live largely 'without electric power or modern indoor plumbing.'[23] Figures 3.4 and 3.5 show some screenshots from Google Maps street view, e.g. the bank and the main road, which is an unpaved stretch running through the town on the coast.

[21] National Institute of Statistics and Geography, Mexico, 2011. Population and Housing Census 2010. http://en.www.inegi.org.mx/default.html
[22] Cinner, J., 2000. Socioeconomic Influences on Coastal Resource Use in in Mahahual, Mexico. https://www.crc.uri.edu/download/CM_MahahualSocioEconomic_thesis.pdf
[23] https://www.nytimes.com/2013/12/29/travel/dodging-a-holiday-in-a-remote-mexican-town.html

Figure 3.4 Photograph of the bank in Xcalak[24].

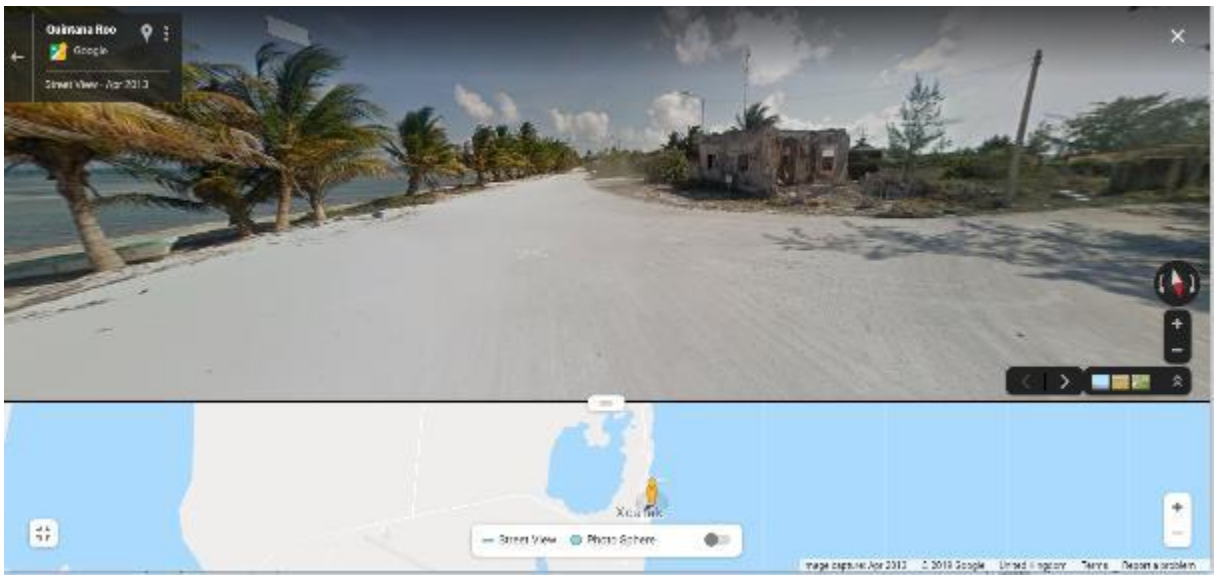


Figure 3.5 Panorama of the main coastal road in Xcalak[25].

[24] Source: Google Maps
[25] Source: Google Maps

Mahahual, on the other hand, is more developed. Next to a regional airport and cruise ship terminal, it is highly dependent on tourism, with 54 cruise ships stopping in January, 2018 alone. Figures 3.6 and 3.7 show the infrastructure of Mahahual.

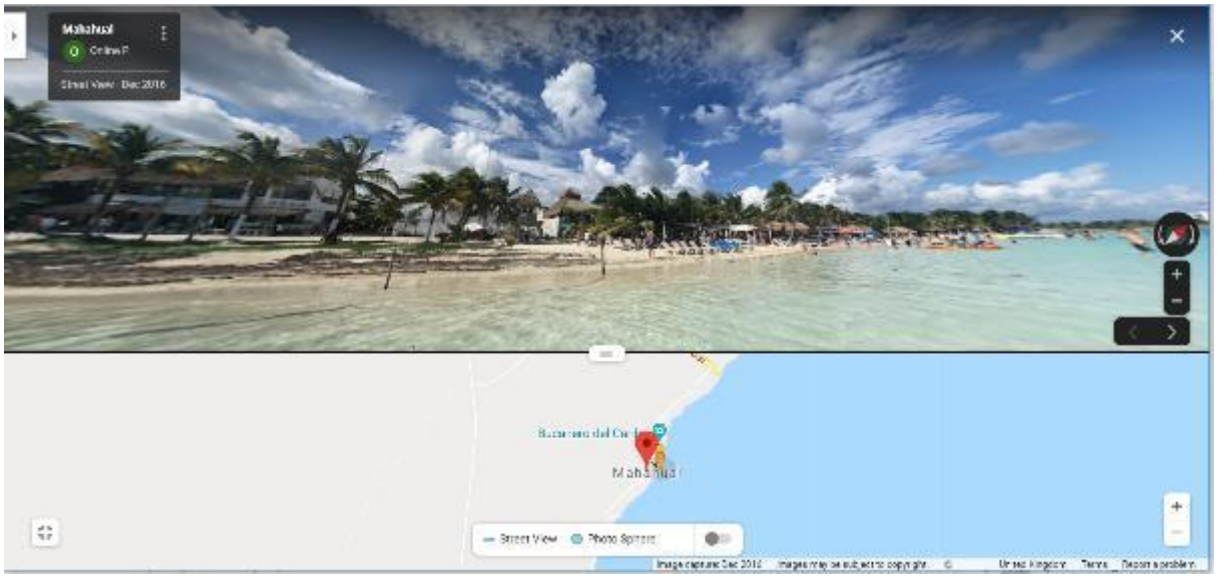


Figure 3.6 Panorama depicting tourism on the coast of Mahahual[26].

Figure 3.7 Panorama depicting hotel and paved road running through the town of Mahahual[27].

[26] Source: Google Maps
[27] Source: Google Maps

Given the above qualitative information, but applying the statistical incidence of poverty in the state of Quintana Roo since higher resolution, quantitative data for the specific populations of the reef sites was not available, the socioeconomic profile of the beneficiary population of the Mexican reef sites is summarised in Table 3.1.[28]

Total beneficiary population	1,295
Beneficiary population in poverty	544
Beneficiary population in extreme poverty	91

Table 3.1 Socioeconomic profile of reef beneficiaries local to the Mexican reef sites.

Belize

Both reef sites in Belize are islands under the administration of the District of Belize (Figure 3.8), although the Hol Chan Marine Reserve is closest to the Corozal district, in the North, and both are located about 20 to 30 miles from Belize City. The district of Belize has a population of 110,644, with 57,310 in Belize City.[29] As detailed below, the total beneficiary population receiving coastal protection from the Belize reef sites is 12,067.

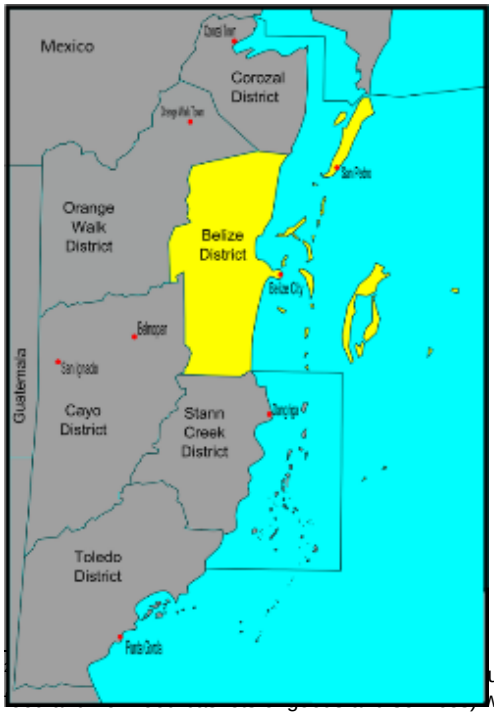


Figure 3.8 The District of Belize, Belize.[30]

ue of the wellbeing line (calculated as the income needed to afford basic with at least one social deprivation, and extreme poverty indicates three or more social deprivations and an income lower than the minimum welfare line; Sources: National Institute of Statistics and Geography- http://en.www.inegi.org.mx/datos; National Council for the Evaluation of Social Development Policy (CONEVAL), 2014, Multidimensional Measurement of poverty in Mexico: an economic wellbeing and social rights approach; https://www.coneval.org.mx/informesPublicaciones/FolletosInstitucionales/Documents/Multidimensional-Measurement-of-poverty-in-Mexico.pdf

[29] The Statistical Institute of Belize, 2013. Belize Population and Housing Census 2010. http://sib.org.bz/wp-content/uploads/2017/05/Census_Report_2010.pdf

[30] Source: https://commons.wikimedia.org/wiki/File:Belize_Map_Belize_District.png

The reef site in the Hol Chan Marine Reserve is located on the coast of San Pedro, a town on the southern tip of the island of Ambergris Caye. This site provides direct coastal protection to the 11,767 residents of San Pedro.[31]

San Pedro is a popular tourism destination (Figure 3.9), known especially for its diving. The 2009 Belize Poverty Assessment noted a constraint to the tourism industry in San Pedro being the poor housing conditions for the migrant workforce, including a housing shortage, slums and barracks-style accommodations, and no wastewater treatment or drainage.[32]

Figure 3.9 San Pedro main street.[33]

The reef site in the Turneffe Atoll is a Marine Reserve, which has a scattering of fishing camps and a few hotels and vacation homes on several cayes. While some of those camps are permanently occupied and some only seasonally, at peak times, the combined inhabitants (including tourists, fishers, and researchers) of Turneffe Atoll is approximately 300 people[34]. Figure 3.10 shows a fishing camp, which benefits from the storm protection services of the reef.

Figure 3.10

2010. http://sib.org.bz/wp-

overty Assessment Final Report.
df

There is limited socioeconomic data available for Belize. For example, welfare indicators are relatively broad-brush and old; the latest poverty assessments are from 2002 and 2009. During the period between these assessments (2002 to 2009), however, the overall poverty rate increased from 34% to 42%, and extreme poverty increased from 11% to 16%.[36] District-level poverty statistics are available, and the 2009 overall poverty rate in Belize District was 29%, with 6% of the district's population in extreme poverty (Figure 3.11).

District		Year	Indigent	Poor	All Poor	Not Poor	Total
Corozal	%	2002	6.2	19.9	**26.1**	**73.9**	100.0
	%	2009	21.4	34.8	**56.2**	**43.8**	100.0
Orange Walk	%	2002	7.1	27.8	**34.9**	**65.1**	100.0
	%	2009	14.6	28.2	**42.8**	**57.2**	100.0
Belize	%	2002	4.9	19.9	**24.8**	**75.2**	100.0
	%	2009	6.1	22.7	**28.8**	**71.2**	100.0
Cayo	%	2002	4.8	22.6	**27.4**	**72.6**	100.0
	%	2009	11.6	29.1	**40.6**	**59.4**	100.0
Stann Creek	%	2002	5.6	29.2	**34.8**	**65.2**	100.0
	%	2009	18.7	25.0	**43.7**	**56.3**	100.0
Toledo	%	2002	56.1	22.9	**79.0**	**21.0**	100.0
	%	2009	49.7	10.7	**60.4**	**39.6**	100.0
Country	%	2002	11.0	23.0	**34.0**	**66.0**	100.0
	%	2009	15.8	25.5	**41.3**	**58.7**	100.0

Figure 3.11 District-level population poverty rates, 2002 and 2009[37].

Also important to note, Belize is highly exposed to the impacts of weather-related events and other natural hazards, and climate change is only going to exacerbate these challenges. The impact of hurricanes and flooding on transportation and energy infrastructure, due to the lack of redundancy in the road network and fragility of the energy network, especially affects the beneficiary island communities, since they are particularly vulnerable to extreme weather events and sea level rise.[38]

[36] Extreme poverty is defined as $ 2.74 per day ($1,000 per year) and moderate poverty by $ 4.65 per day ($1,700 per year); Source: Government of Belize and Caribbean Development Bank, 2010. 2009 Country Poverty Assessment Final Report. http://sib.org.bz/wp-content/uploads/2017/05/Poverty_Assessment_Report_2009.pdf
[37] Government of Belize and Caribbean Development Bank, 2010. 2009 Country Poverty Assessment Final Report. http://sib.org.bz/wp-content/uploads/2017/05/Poverty_Assessment_Report_2009.pdf
[38] World Bank Group, 2016. BELIZE: RIGHT CHOICES BRIGHT FUTURE: Systematic Country Diagnostic. http://documents.worldbank.org/curated/en/870551467995073017/pdf/103941-WP-P152070-PUBLIC-None-Board-version-WB-Belize-CRA-noreport.pdf

Given the above qualitative information, and applying the statistical incidence of poverty in the District of Belize, the socioeconomic profile of the beneficiary population of the Belizean reef sites is summarised in Table 3.2.[39]

Total beneficiary population	12,067
Beneficiary population in poverty	3,499
Beneficiary population in extreme poverty	724

Table 3.2 Socioeconomic profile of reef beneficiaries local to the Belizean reef sites.

Guatemala

The reef site in Guatemala is located off the coast of the department of Izabal, depicted in Figure 3.12, which is the only department where the Guatemalan coast touches the Caribbean Sea. Izabal's projected population for 2011 was 413,399 people, of which 50.7% were women and 26.8% identified themselves as indigenous.[40] Figure 3.13 shows Amatique Bay and municipalities of Puerto Barrios and Livingston, two of the five municipalities of Izabal, both benefiting directly from the risk reduction benefits of the Mesoamerican Reef. As detailed below, the Guatemalan reef sites provide coastal protection for a direct beneficiary population of 129,666.[41]

Figure 3.12

[39] Extreme poverty is defined as $ 2.87 per day ($1,050 per year) and moderate poverty by $ 4.65 per day ($1,700 per year); Source: Government of Belize and Caribbean Development Bank, 2010. 2009 Country Poverty Assessment Final Report. http://sib.org.bz/wp-content/uploads/2017/05/Poverty_Assessment_Report_2009.pdf

[40] National Statistics Institute of Guatemala, 2012. Caracterización Estadística, República de Guatemala. https://www.ine.gob.gt/sistema/uploads/2014/02/26/5eTCcFlHErnaNVeUmm3iabXHaKgXtw0C.pdf

[41] 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

Figure 3.13 Map showing Amatique Bay and the municipalities of Livingston and Puerto Barrios[42].

Puerto Barrios is the capital of Izabal and Guatemala's main port on the Caribbean Sea, and according to the 2002 census numbers, it is home to 81,078 people.

Before the port was built in Puerto Barrios, Livingston was the home to the main Caribbean Sea port. As of the 2002 census, Livingston had a population of 48,588 people, 25,457 of which are indigenous (mostly Mayan and Ladino, and also Garífuna).[43]

There is likely a high level of informal employment and subsistence activities in both Livingston and Puerto Barrios, with an overall informality rate of 71% in Guatemala (although informality varies by location; there is only a 43% informality rate in metropolitan urban areas, while it is 67% in the non-metropolitan urban areas and 83% in rural areas).[44]

According to 2014 statistics from the World Bank (Figure 3.14), the overall poverty rate (using the National Poverty Line) in Guatemala is 59%[45].

[42] Source: Google Maps
[43] 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
[44] National Statistics Institute of Guatemala, online indicators. https://www.ine.gob.gt/index.php/estadisticas/tema-indicadores
[45] World Bank, Poverty & Equity Brief, Guatemala, 2018. https://databank.worldbank.org/data/download/poverty/33EF03BB-9722-4AE2-ABC7-AA2972D68AFE/Archives-2019/Global_POVEQ_GTM.pdf

POVERTY	Number of Poor (million)	Rate (%)	Period
National Poverty Line	9.4	59.3	2014
International Poverty Line 8.3 in Guatemalan quetzal (2014) or US$1.90 (2011 PPP) per day per capita	1.4	8.7	2014
Lower Middle Income Class Poverty Line 13.9 in Guatemalan quetzal (2014) or US$3.20 (2011 PPP) per day per capita	3.9	24.2	2014
Upper Middle Income Class Poverty Line 24 in Guatemalan quetzal (2014) or US$5.50 (2011 PPP) per day per capita	7.8	48.8	2014

Figure 3.14 Poverty statistics, Guatemala.[46]

The most recent complete poverty assessment was carried out in 2002, and a rural poverty assessment was undertaken in 2011.[47] Figure 3.15 shows the incidence of poverty by department in Guatemala. Of Izabal's population, 48% live in poverty, 8% of whom live in extreme poverty. [48]

Furthermore, the National Statistics Institute of Guatemala identifies Izabal as a department with medium human development; by 2011, 78.2% of the population aged 15 or over in Izabal could read and write; however, on average, the population of Izabal only has 5.1 years of schooling.[49]

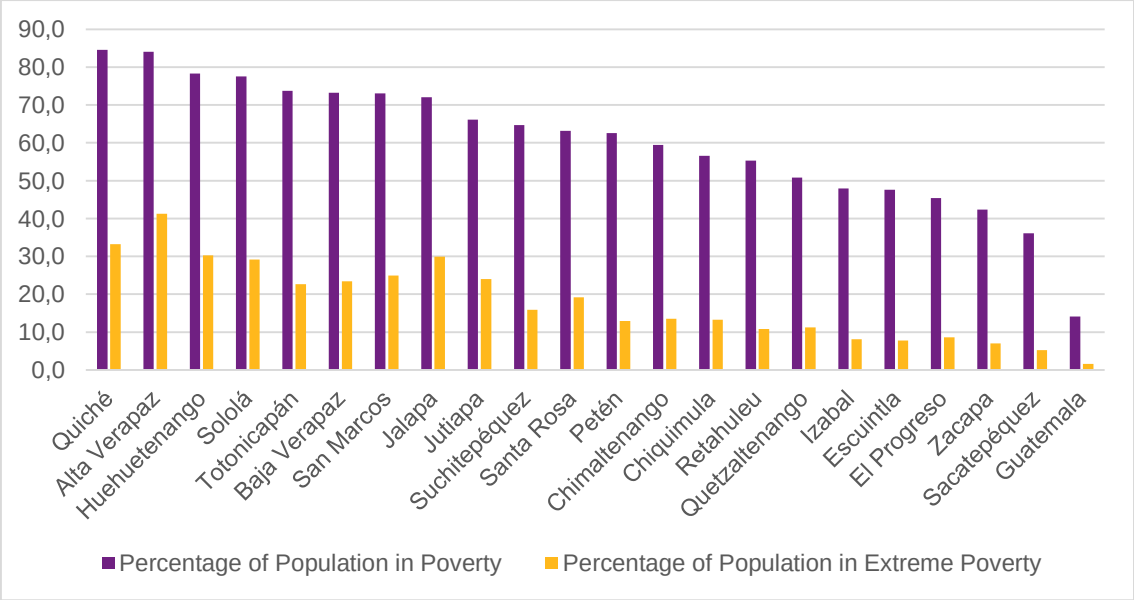


Figure 3.15 Poverty incidence in Guatemala by Department.[50]

[46] Ibid.
[47] National Statistics Institute of Guatemala. Mapas de pobreza. https://www.ine.gob.gt/index.php/estadisticas-continuas/mapas-de-pobreza
[48] Extreme poverty is defined using the cost of acquiring 2,172 minimum calories, and general poverty also includes (beyond the cost of necessary food consumption), a minimum cost in goods and services.
[49] National Statistics Institute of Guatemala. Mapas de pobreza. https://www.ine.gob.gt/index.php/estadisticas-continuas/mapas-de-pobreza
[50] National Statistics Institute of Guatemala, 2011. Mapas de Pobreza Rural en Guatemala. https://www.ine.gob.gt/index.php/estadisticas-continuas/mapas-de-pobreza

There is observable inequality in Izabal, as demonstrated by the different economic profiles of the populations of Puerto Barrios and Livingston. Livingston is a much more impoverished municipality, with 62% of the population below the poverty line and 11% in extreme poverty. Figure 3.16 shows the poverty rate in Izabal by municipality.

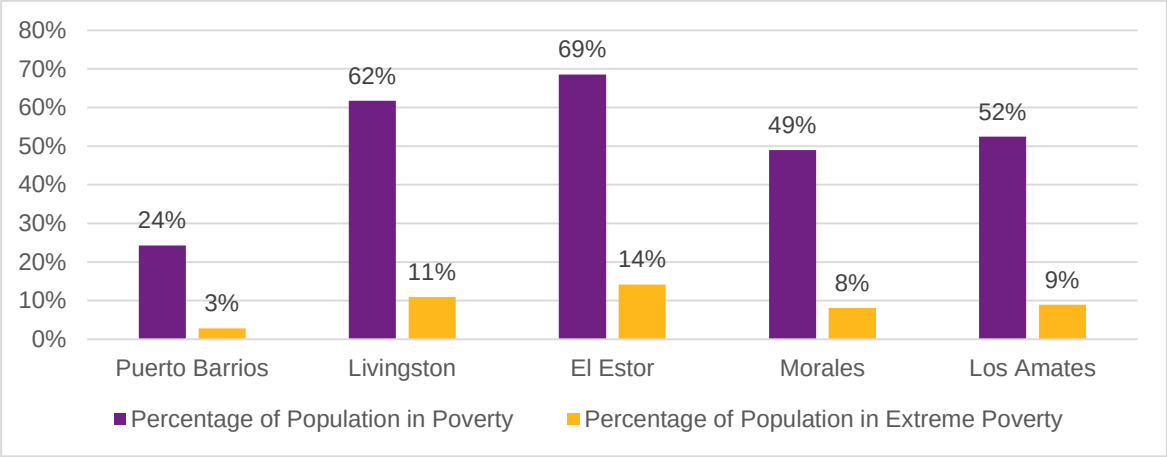


Figure 3.16 Poverty incidence in Izabal by Municipality.[51]

It is worth noting that rural poverty incidence is even higher, and 64% of the population are considered rural.[52] Table 3.3 shows the incidence of **rural** poverty in Izabal as a whole, as well as disaggregated statistics for Puerto Barrios and Livingston. Additionally, an income analysis conducted by local organisations indicated that for 17 communities around the reef site, the daily household income is between EUR 0.89 and EUR 3.57.[53]

Department / Municipality	**Extreme Poverty (% of Rural Population)**	**Poverty (% of Rural Population)**
Izabal	29	69
Puerto Barrios	9	43
Livingston	54	90

Table 3.3 Rural poverty incidence in Izabal.[54]

Given the above qualitative and quantitative information, and applying the statistical incidence of poverty in the municipalities of Puerto Barrios and Livingston to the respective beneficiary populations

[51] National Statistics Institute of Guatemala, 2011. Mapas de Pobreza Rural en Guatemala. https://www.ine.gob.gt/index.php/estadisticas-continuas/mapas-de-pobreza
[52] Caracterización Estadística, República de Guatemala, 2012. https://www.ine.gob.gt/sistema/uploads/2014/02/26/5eTCcFlHErnaNVeUmm3iabXHaKgXtw0C.pdf
[53] Based on MAR Fund collection of information from local organisations
[54] National Statistics Institute of Guatemala, 2011. Mapas de Pobreza Rural en Guatemala. https://www.ine.gob.gt/sistema/uploads/2015/09/28/V3KUhMhfgLJ81djtDdf6H2d7eNm0sWDD.pdf

of those locations, the socioeconomic profile of the beneficiary population of the Guatemalan reef sites is summarised in Table 3.4.[55]

Total beneficiary population	129,666
Beneficiary population in poverty	49,681
Beneficiary population in extreme poverty	7,578

Table 3.4 Socioeconomic profile of reef beneficiaries local to the Guatemalan reef site.

Honduras

The reef sites in Honduras provide protection to a significant population along the coast of 4 of the 18 Departments of Honduras: Cortés, Atlántida, Colón, and Islas de la Bahía. The direct beneficiaries of reef-provided storm risk reduction include the residents of the coastal Municipalities of La Ceiba, Arizona, El Porvenir, Esparta, Jutiapa, La Masica, San Francisco, Tela, Colón, Balfate, Santa Fé, Trujillo, Puerto Cortés, and Omoa, as well as all the residents of the islands of Utila, Roatan, Guanaja, and the Cochinos Cays (Cayo Menor and Cayo Grande), administrated as the Municipalities of Roatán, José Santos Guardiola, Guanaja, and Utila. Additionally, the populations of all of the cities, towns, and villages along the coastal highways CA 13 and RN 133, from Puerto Cortes to Puerto Castilla, including San Pedro Sula (one of the Honduras's main transport hubs) are also direct beneficiaries, since they rely on exposed coastal infrastructure, which is protected by the Mesoamerican Reef. Figure 3.17 shows the geographical area of direct beneficiaries.

Figure 3.17 Exposed coastal area where population benefits directly from reef-provided storm protection.[56]

[55] Extreme poverty is defined using the cost of acquiring 2,172 minimum calories, and general poverty also includes (beyond the cost of necessary food consumption), a minimum cost in goods and services.

Figure 3.18 shows the location of the relevant Departments of Honduras: Cortés, Atlántida, Colón, and Islas de la Bahía. Note in particular that while all residents of Atlántida and Islas de la Bahía, and most of Colón (i.e. the residents of the western municipalities of Balfate, Santa Fe, Trujillo, Sonaguera, Sabá, and Tocoa), are direct beneficiaries, a smaller proportion of Cortés benefits directly (only the coastal half - the municipalities of Puerto Cortés, Omoa, Choloma, and San Pedro Sula).

Figure 3.18 Map of Honduras by Department.[57]

There is a total of 1,835,511 beneficiaries of reef-provided storm protection in Honduras. Table 3.5 summarises the beneficiary population numbers by Department and Municipality.[58]

[56] Source: Google Maps
[57] Source: https://www.mapsofworld.com/honduras/departments-maps.html
[58] 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

Department / Municipality	**Population (2013)**
Total Beneficiaries	**1,835,511**
Atlántida	**432,362**
La Ceiba	197,267
Arizona	23,714
El Porvenir	21,854
Esparta	14,559
Jutiapa	34,224
La Masica	29,427
San Francisco	14,559
Tela	96,758
Islas de la Bahía	**62,554**
Roatán	41,830
José Santos Guardiola	11,333
Guanaja	5,445
Útila	3,946
Colón	**241,651**
Balfate	13,103
Santa Fé	5,428
Trujillo	60,558
Sonaguera	43,152
Sabá	29,561
Tocoa	89,849
Cortés	**1,098,944**
Puerto Cortés	103,033
Omoa	45,179
Choloma	231,668
San Pedro Sula	719,064

Table 3.5 Beneficiary population of the Honduras reef sites by Department and Municipality.[59]

According to official numbers, the World Bank estimates that in 2013, 65% of the population of Honduras lived in poverty, including 43% in extreme poverty[60] (Figure 3.19).

[59] 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

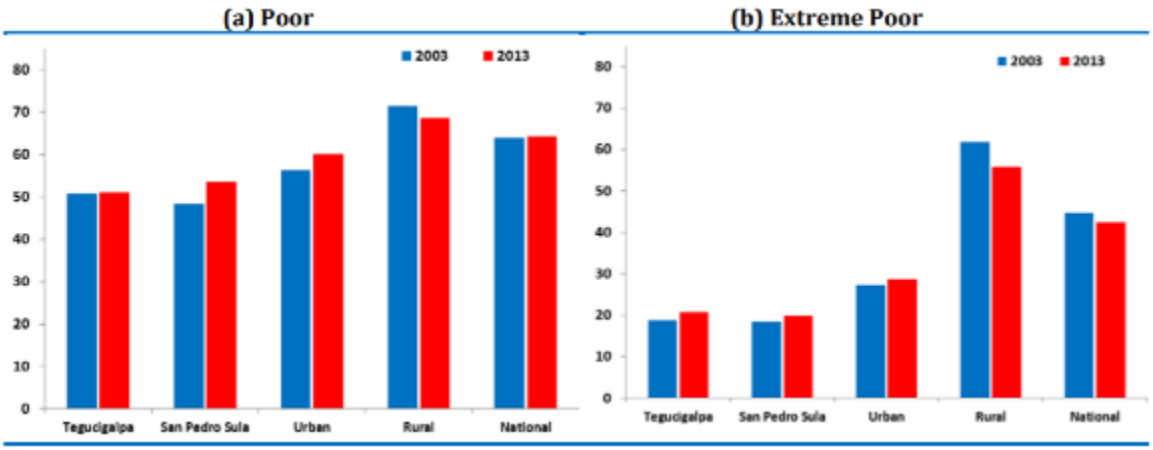
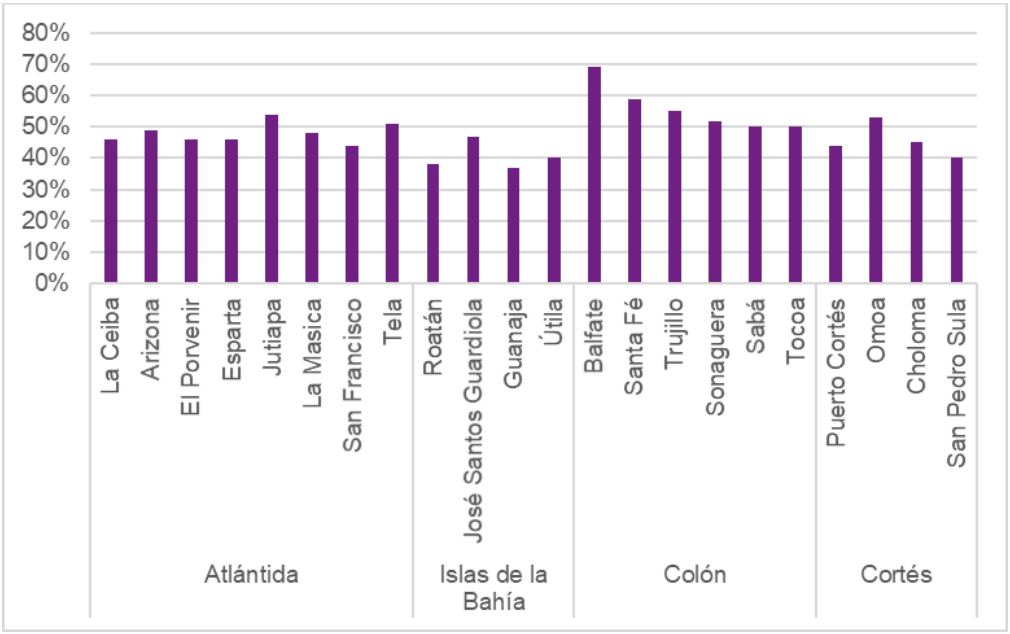


Figure 3.19 National poverty rates by region, in %, for 2003 and 2013.[61]

Poverty information available at the municipal level, based on the Unsatisfied Basic Needs (UBN; Necesidades Básicas Insatisfechas (NBI) in Spanish) index, indicates a poverty incidence of 45% across the entire beneficiary population. The UBN is constructed from 2013 census information, including access to adequate housing conditions, water, electricity, sanitation, and education. Figure 3.20 shows the incidence of poverty at the municipal level for the beneficiary population. The beneficiary municipalities range from 37% incidence of poverty in Guanaja, Islas de la Bahía to 69% in Balfate, Colón.



[60] World Bank, 2015. Honduras Economic DNA. http://documents.worldbank.org/curated/en/150731468189533027/pdf/97361-WP-PUBLIC-Box391473B-Honduras-Economic-DNA-First-Edition-11Jun2015-FINAL-PUBLIC.pdf
[61] Ibid.

Figure 3.20 Poverty incidence in the beneficiary area of Honduras by Municipality.[62]

Given the above qualitative and quantitative information, but applying the statistical incidence of poverty in Honduras as a whole (as this is the highest resolution data available for general poverty and extreme poverty), the socioeconomic profile of the beneficiary population of the Honduran reef sites is summarised in Table 3.6.[63]

Total beneficiary population	1,835,511
Beneficiary population in poverty	1,193,082
Beneficiary population in extreme poverty	789,270

Table 3.6 Socioeconomic profile of reef beneficiaries local to the Honduran reef sites.

Socioeconomic Profile Summary

The socioeconomic profile of the beneficiary populations of the reef sites, by country and in total, is summarised in Table 3.7. Altogether, 63% of the population local to the reef sites live in poverty, including 40% in extreme poverty.

	Beneficiary Population	Beneficiary Population in Poverty	Beneficiary Population in Extreme Poverty
Mexico	1,295	544	91
Belize	12,067	3,499	724
Guatemala	129,666	49,681	7,578
Honduras	1,835,511	1,193,082	789,270
Total	**1,978,539**	**1,246,806**	**797,662**

Table 3.7 Socioeconomic profile of reef beneficiaries local to the pilot reef sites.

[62] National Institute of Statistics Honduras. https://www.ine.gob.hn/V3/baseine/
[63] Extreme poverty is defined as household income per capita that is less than the cost of a locally obtained basic food basket that meets minimum caloric requirements. The overall poverty line is constructed by taking the extreme poverty line and adding a set of basic non-food goods. Source: World Bank, 2015. Honduras Economic DNA. http://documents.worldbank.org/curated/en/150731468189533027/pdf/97361-WP-PUBLIC-Box391473B-Honduras-Economic-DNA-First-Edition-11Jun2015-FINAL-PUBLIC.pdf

InsuResilience Target Group

The InsuResilience Target Group is defined as the 'poor and vulnerable,' based on the MCII framework[64], as follows:

- **Extreme poor**: people earning below PPP$1.90 / day;
- **Poor**: people earning below PPP$3.10 / day and above PPP$1.90 / day; and
- **Vulnerable**: people particularly exposed to extreme weather events earning below PPP$15 / day and above PPP$3.10 / day.

Therefore, because the entire beneficiary population is particularly exposed to extreme weather events (as they are all coastal populations in areas at high risk to hurricanes), the relevant threshold to determine the sub-set who are in the InsuResilience Target Group is PPP$15 per day.

While the national poverty rates as calculated in country poverty assessments and by the statistical departments of the MAR countries, and used in the socioeconomic profiling of the MAR beneficiaries, do not use the same methodology or income levels as the InsuResilience methodology, the World Bank compiles income distribution information at the national scale for each of the MAR countries. Using the most recent national-level data available, Table 3.8 estimates the proportion of the beneficiary population within the InsuResilience Target Group.[65]

Country	Proportion of national population with income below PPP$15/day[66]	Total Beneficiary Population	InsuResilience Target Group	Year[67]
Belize	88.07%	12,067	10,627	1999
Guatemala	88.09%	129,666	114,223	2014
Honduras	88.03%	1,835,511	1,615,800	2017
Mexico	75.84%	1,295	982	2016
Total	**88.03%**	**1,978,539**	**1,741,633**	

Table 3.8 InsuResilience Target Group estimation using the most recent national income distributions for the MAR countries available on the PovcalNet, the online tool for poverty measurement developed by the Development Research Group of the World Bank.[68]

[64] MCII: Climate Risk Insurance for the Poor and Vulnerable. How to effectively implement the pro-poor focus of InsuReslilience. Bonn, 2016.
[65] Further detail on the overlap between the poor and vulnerable people identified in this report and the InsuResilience Target Group is provided in the Supplementary Report, 'InsuResilience Target Group.'
[66] 2011 Consumption PPP.
[67] Most recent year of data availability.
[68] http://iresearch.worldbank.org/PovcalNet/home.aspx

Section 4: Economic Analysis of Additional Reef Ecosystem Service Beneficiaries

In addition to the coastal populations that benefit from direct storm risk reduction due to the protection of the Mesoamerican Reef, many additional stakeholders benefit from the various additional ecosystem services the reef provides. Indeed, those same coastal populations benefit from additional ecosystem services themselves. This section details an economic analysis of those main beneficiaries and their dependence on the ecosystem services the reef provides.

Coastal communities are particularly dependent on reef-related ecosystem services; for example, they rely on healthy reefs to provide fishing grounds for food security. They are often dependent on reef-related tourism (e.g. diving). Even further reaching, reefs are spawning and nursery grounds for important fish populations, and therefore critical fisheries infrastructure, providing livelihoods to many more beneficiaries beyond the immediately surrounding ones. A recent report estimates that the economic value of reefs to tourism, commercial fisheries, and the coastal development sector equals US$6.2 billion per annum in Mesoamerica.[69] For example, in Belize specifically, it has been estimated that coral reef ecosystem services to fishing and tourism in a single year (2007) contributed US$100–130 million to the economy [70], constituting 8-10% of Belize's total GDP that year[71].

Therefore, reefs provide critical infrastructure, stimulating economic activity in at least three dimensions:

- **Contribution to GDP**: reefs underpin the economic activity of two critical sectors if the economies of Belize, Guatemala, Honduras, and Mexico, namely commercial fishing and tourism.
    - **Key beneficiaries**: government (national and local) and business owners (e.g. seafood business owners, hotel owners, tourism operators).
- **Informal livelihoods**: reefs provide local communities with fishing grounds for food security and subsistence activities.
    - **Key beneficiaries**: local communities, especially vulnerable informal sector workers and low-income households.
- **Employment**: Reef-dependent sectors provide a major source of formal employment to coastal communities.
    - **Key beneficiaries**: households and individuals employed in the fishing and tourism sectors.

[69] 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.
[70] 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
[71] GDP in constant 2010 US$. Source: World Bank Data. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?locations=BZ

The following section will focus on all three dimensions in the two main sectors dependent on coral reef-provided ecosystem services: fishing and tourism.

Fishing

Commercial and Artisanal Fishing

It has been estimated that the Mesoamerican reef generates US$240 million in direct economic value to commercial fishing per year.[72] 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 Mesoamerican reef as a whole, they are the source of an estimated US$12 million of value every year. Further, the ecosystem services these sites provide as fish spawning, nursery, and recovery areas are felt far beyond the populations in the immediate vicinity, given the connectivity along the whole region; 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 Mesoamerican Reef. Fisheries provide a major source of foreign exchange, supplying export markets and constituting a significant chunk of primary industry productivity.[73] For example, in Belize, the fishing sector is the second largest contributor to GDP amongst primary industries.[74] Shrimp and lobster are also important exports for Honduras,[75] and the artisanal fisheries on the Caribbean coast supplies both the national and international market.[76]

Coastal communities are particularly dependent on fishing, and the fishing sector provides a source of employment. For example, in Puerto Barrios, out of 24,801 actively employed people over the age of 7, the sector with the largest share of employment is agriculture, hunting, forestry and fishing, which employed 6,795 people according to the 2002 census. The sector is equally important in Livingston, where agriculture, hunting, forestry and fishing is the sector with the largest share of employment, employing more than 8,000 people.[77] The number of fishers on the Caribbean coast of Guatemala is estimated at 2,617. Industrial fishing is not allowed in the Bay of Amatique, and artisanal fisheries flourish on the Caribbean coast. For example, all small scale and artisanal, the shrimp fishery activity is approximately 83 vessels, the lobster fishery is 15 small boats, and the fish fishery (small scale and artisanal) is 1,850 small boats.[78]

[72] 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
[73] 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
[74] United Nations Conference on Trade and Development. https://unctad.org/meetings/en/Contribution/ditc-ted-Belize-28112018-Factsheet-1-fisheries.pdf
[75] https://tradingeconomics.com/honduras/exports
[76] 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
[77] 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
[78] FAO; http://www.fao.org/fi/oldsite/FCP/en/gtm/profile.htm

In Belize, artisanal fishing on the reef and the three atolls is carried out by 500 boats, with 2,500 fishers licenced to operate in the EEZ as a whole.[79] The Belize Fisheries Department estimates close to 13,000 Belizeans are direct beneficiaries of the industry, and up to 1,000 Belizean workers may be employed indirectly (e.g. in the processing, marketing, and services industries). The Turneffe Atoll site is a particularly important fishing grounds, as up to 140 fishers travel from northern Belize to fish here.

In Honduras, 975,933 people are employed in the agriculture, forestry, and fishing sector, making up 38% of total employment. The proportion is even higher in some of the coastal Departments, with 50% of employment in Colón (and 29% in Atlántida, 8% in Islas de la Bahía, and 11% in Cortés) in the agriculture, forestry, and fishing sector.[80] Of this, it is estimated that there are 160 different fishing communities with over 10,000 fishers.[81]

In Mexico, 247,765 people were employed in Mexican fisheries in 2001.[82] While only a small portion of that is in inshore fisheries, with an even smaller portion on the Caribbean coast, the reef sites support the fishing communities of Mahahual and Xcalak. Additionally, fishers from further afield fish in Xcalak and Chinchorro, including Limones and Noh Bek (which are inland, 50-60 miles to the north-west of Xcalak) and Chetumal (which is on the western side of Chetumal Bay, approximately 200 km from Xcalak by road).[83]

Subsistence Fishing

Beyond employment in commercial fishing, coastal communities benefit from the coastal fisheries supported by the Mesoamerican Reef as a source of food security. So, for example, while the reef sites provide comparatively little to commercial Mexican fisheries as a whole (which are largely in the Pacific), they provide critical ecosystem services as fishing grounds for the communities that depend on them, in Mahahual and especially Xcalak.

Artisanal fishers are known to bring some catch home for their families and themselves to consume.[84] 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.[85] 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 (including those communities receiving direct coastal protection from the reef).

[79] United Nations Conference on Trade and Development; https://unctad.org/meetings/en/Contribution/ditc-ted-Belize-28112018-Factsheet-1-fisheries.pdf
[80] 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
[81] 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
[82] FAO; http://www.fao.org/fi/oldsite/FCP/en/MEX/profile.htm
[83] Information from fishing cooperatives, Sociedad Cooperativa de Producción Pesquera Andrés Quintana Roo S.C. de R.L., Sociedad Cooperativa de Producción Pesquera "Langosteros del Caribe" S.C. de R.L., and Sociedad Cooperativa de Producción Pesquera Banco Chinchorro S.C. de R.L.
[84] Mackenzie, C.L. and Stehlik, L.L., 1996. The Crustacean and Molluscan Fisheries of Honduras. Marine Fisheries Review 58(3)
[85] 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

Key Beneficiaries

In summary, key beneficiaries of ecosystem services from the reef sites related to fishing are:

- Seafood businesses;
- Local communities, via fishing on and near reefs;
- Individuals employed by the commercial fishing sector- via income due to reef-dependent fisheries; and
- Government- via taxes / levies collected, but also because fishing supplies export markets and contributes a supply of foreign exchange.

Tourism

Individual reefs provide the infrastructure that underpins in-water reef related tourism, the economic flows from which are directly linked to reef ecosystem services. These activities include scuba diving, snorkelling, and boat tours, as well as certain types of sport fishing (e.g. at the Turneffe Atoll, known for its saltwater fly fishing[86]).

The recent report that quantifies the economic value of the Mesoamerican Reef estimated that it provided almost US$3.5 billion per year to the tourism sector alone.[87] Even if the reef sites in this study only provide 1% of that, that still equates to 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.[88] Globally, they found that approximately 30% of the world's reefs contribute tourism sector value, totalling almost US$36 billion, which is over 9% of all coastal tourism value in the world's coral reef countries. Table 4.1 summarises key data available for the MAR countries.[89]

[86] https://ambergriscaye.com/pages/town/park-turneffe_atoll.html
[87] 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.
[88] Unfortunately, Guatemala was not included.
[89] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism. https://www.sciencedirect.com/science/article/pii/S0308597X17300635

	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 proportion 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 4.1 Tourism information, including sub-set that is directly reef dependent.[90] All financial values are in thousands of US$.

As a key sector in the economies of all four MAR countries, tourism employs a significant portion of the population. Key tourism employment numbers for the Districts / Departments / States of the reef sites are summarised in Table 4.2.

Country[91]	District / Municipality	Total Employed	Employed in Tourism	% Employment in Tourism
Belize[92]	Belize District	58,015	10,837	**19%**
Guatemala[93]	Total Izabal	86,795	11,805	**14%**
	Puerto Barrios	24,801	5,478	**22%**
	Livingston	12,787	1,178	**9%**
Honduras[94]	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[95]	Quintana Roo	762,576	169,153	**22%**

Table 4.2 Employment rate related to tourism dependent on reef sites.

[90] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism; https://www.sciencedirect.com/science/article/pii/S0308597X17300635
[91] 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.
[92] Statistical Institute of Belize; http://sib.org.bz/statistics/labour-force/
[93] 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
[94] 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
[95] 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

Tourism is the single most important industry in Belize, contributing roughly 28% of employment and 21% of GDP,[96] and on-reef tourism accounts for a significant portion of that; approximately 64% of all 'tourist days,' and US$150-196 million in associated tourist spending per year, is attributed to marine ecosystems.[97] Ambergis Caye and Turneffe Atoll are tourism destinations particularly dependent on reefs. San Pedro, which has 129 hotels listed on Trip Advisor, for example, has *two* hyperbaric chambers - the only two in Belize[98] and over 20 dive shops listed on Google Maps. The Turneffe Atoll welcomes over 15,000 divers, anglers, and ecotourists per year (based on 2010 numbers), generating more than US$19 million in direct expenditure and almost US$3.5 million in taxes. [99]

The economic value of on-reef tourism in Mexico has been calculated at US$1,342.5 million per year,[100] and Quintana Roo is a key tourism state. In Quintana Roo as a whole,169,153 people work in tourism, more than 20% of the employed population.[101] 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 for the populations, businesses, and governments of Mahahual and Xcalak. For example, Othón P. Blanco has 114 hotels (including cabanas and villas) with a total of 2,815 rooms. Additionally, visitors can pay US$140 for two dives in Xcalak, and a 16% tax is levied on all diving operations in Mexico.[102] There are 12 dive shops listed in Mahahual on Google Maps, all of which depend on the Mesoamerican Reef as the main attraction.

Tourism accounts for 7.4% of Guatemala's GDP, with visitors spending US$1,588 million.[103] The reef sites account for key areas of the Mesoamerican Reef in Guatemala, covering both Puerto Barrios and Livingston, the two main population centres on the Caribbean coast. Out of 24,801 actively employed people over the age of 7, wholesale and retail trade, restaurants and hotels is the second largest employment sector, with 5,478 workers.[104] Livingston also has a relatively developed tourism industry, with 35 hotels listed on Trip Advisor[105] and, according to the 2002 census, more than 1,000 out of the 12,787 employed people in Livingston work in wholesale and retail trade, restaurants and hotels. Puerto Barrios is one of the only places on the Caribbean coast of Guatemala with dive shops due to its proximity to the Mesoamerican Reef.[106]

---

[96] World Bank; http://documents.worldbank.org/curated/en/870551467995073017/pdf/103941-WP-P152070-PUBLIC-None-Board-version-WB-Belize-CRA-noreport.pdf
[97] 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
[98] https://ambergriscaye.com/pages/town/hyperbar.html
[99] Turneffe Atoll Trust, The Economic Value of Turneffe Atoll; http://www.turneffeatoll.org/app/webroot/userfiles/66/File/Turneffe%20Atoll%20Valuation.pdf
[100] Spalding, M. et al., 2017. Mapping the global value and distribution of coral reef tourism; https://www.sciencedirect.com/science/article/pii/S0308597X17300635
[101] 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
[102] https://travel.padi.com/d/xcalak/
[103] World Travel & Tourism Council, 2019 (2018 figures). https://www.wttc.org/economic-impact/country-analysis/country-reports/
[104] 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
[105] https://www.tripadvisor.co.uk/Tourism-g292010-Livingston_Rio_Dulce_Izabal_Department-Vacations.html
[106] https://travel.padi.com/d/guatemala/

The contribution of travel and tourism to the Honduran GDP is 14.6%.[107] A key asset that draws people to the beaches and islands of Honduras is the Mesoamerican Reef; the 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 Roatan every year,[108] supporting around 50 dive shops and 156 restaurants listed on Google Maps. The Mesoamerican Reef in Honduras also generates tourism beyond the islands, including via the cities on the mainland such as La Ceiba (with its own reef site attracting visitors, it is also the main gateway to the Bay Islands, as the Islas de la Bahía are known in English, via ferry), Sambo Creek (with its own reef site at Cayos Cochinos, attracting visitors and supporting local businesses[109]), and Tela (also next to a reef site attracting visitors to dive and snorkel).

Key Beneficiaries

In summary, key beneficiaries of ecosystem services from the reef sites in the tourism industry are:

- Hotels and restaurants, via reef sites attracting visitors;
- Dive and marine tour operators (including, e.g. boat tours offering snorkelling), via reef sites attracting visitors and underpinning value proposition / providing recreational assets;
- Sport fishing operators, via reef sites attracting fish and visitors;
- Individuals employed by the above businesses, via income due to reef-related industry; and
- Government, via taxes / levies collected.

[107] World Travel & Tourism Council, 2019 (2018 figures); https://www.wttc.org/economic-impact/country-analysis/country-reports/
[108] https://roatantourismbureau.com
[109] There is one dive shop and one tour agency offering trips to Cayos Cochinos listed on Google Maps.

Section 5: Insurance Programme Beneficiary Profiles

The following section draws on the socioeconomic analysis of reef-protected populations and economic analysis of reef ecosystem service-dependent sectors and beneficiaries presented above to identify the overall profile of the various beneficiaries of the proposed insurance programme. While this report presents a summary, additional information on the beneficiaries and their potential role in the proposed insurance programme can be found in a complementary report titled 'Sustainability of Rapid Response Reef Risk Financing in the MAR Region.'

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;
- **Fisheries productivity**: coral reefs support 25% of all marine species,[110] including as the life-long habitat for crustaceans, molluscs, sea cucumbers, and reef fish[111] and spawning and nursery habitats for pelagic fish[112]; 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 reef insurance programme aims to fund rapid response to restore reefs damaged by hurricanes, rather than reimburse individual loss. An important aspect of reef insurance is that a prompt pay-out for rapid response can finance both the protection and growth of a living reef as well as mitigate the interruption of livelihoods of those dependent on reef services. To state this somewhat differently, it addresses the damage to assets from a storm, the economic loss from a suspension of the normal flow of services from the reef, and the related social costs of loss of livelihoods among a vulnerable population.

Direct beneficiaries of such insurance are the fishing and tourism sectors. Individuals *might* seek to purchase hurricane risk insurance that gives a direct cash pay-out for lost earnings. Global experience, however, indicates that it is unlikely that many individuals, particularly low-income workers, would pursue this option. Nor would a direct cash pay-out to individuals likely have long-term benefits for reef health, and therefore, reef-related ecosystem services. Thus, the proposed insurance programme is envisioned to provide a pay-out for reef restoration rather than individual losses, therefore not providing a direct pay-out, but rather indirect benefits to workers and individuals from the

[110] WWF; https://wwf.panda.org/our_work/oceans/coasts/coral_reefs/
[111] 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
[112] NOAA; https://oceanservice.noaa.gov/facts/coral_economy.html, https://www.westcoast.fisheries.noaa.gov/habitat/fish_habitat/rocky_reef_habitat_types.html

demand for their services during a restoration effort and, perhaps more importantly, from long-term ecosystem service provision reinstated more quickly via reef restoration.

Therefore, the proposed insurance programme focuses on providing rapid response in the aftermath of damaging storm events, treating the Mesoamerican Reef as 'natural infrastructure,' which requires the same kind of post-event response as grey infrastructure would. 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, beneficiaries of the insurance programme will be largely the same as the beneficiaries of the ecosystem services of the reef.

However, the pay-out from the insurance can generate further economic beneficiaries if implemented to do so. For example, in the same way that insurance pay-outs for infrastructure coverage directly benefit municipal, provincial, or national governments (depending on the policy holder and infrastructure owners) *and* responders (since the coverage pays for their work), the direct beneficiaries of reef insurance will be the policy holder and whoever implements reef clean-up and restoration.

Direct Beneficiaries

The direct beneficiaries of insurance pay-outs can be classified in two roles:

- **Policy holder**; and
- **Emergency responders**.

A restoration cost study[113] prepared by Whiterock Natural Capital & Environment, in consultation with and commissioned by the MAR Fund, calculates the cost of restoration for target reef sites. The aggregated cost of restoration of all of the selected reef sites is US$2,886,542; the costs of immediate, optimal response following a severe hurricane indicate a range of requirements for different reef sites between the most inexpensive site, Punta de Manabique in Guatemala, at US$120,663, to US$564,971 for the most expensive site, Roatán in Honduras. Further details can be found in a summary presentation of the report cited above, which is provided as part of the materials accompanying this and its associated reports.

Policy Holder

The policy holder of the proposed reef insurance product will be the MAR Fund, which is a regional environmental fund established to drive partnerships and funding for the sustainable use of the Mesoamerican reef. The MAR Fund is a private fund with a Board of Directors comprised of international collaborators, experts from each participating country, the Central American Commission on Environment and Development (CCAD), and the founding funds from each of the MAR Countries. The MAR Fund is the regional financing mechanism for largescale maintenance, conservation, and restoration of the critical green infrastructure that is the Mesoamerican Reef. It is, therefore, an

[113] 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.

institution with the structure to implement programmes and activities to build the Mesoamerican Reef's resilience to extreme events.

As such, MAR Fund is implementing the Reef Rescue Initiative (RRI), which has the objective of increasing the resilience of the Mesoamerican Reef, augmenting its ability to recover from extreme events and slow-onset climate threats alike, protecting the environmental and cultural services the MAR provides to coastal communities through capacity building, regulations, economic incentives, and financial sustainability required for the effective and timely restoration of coral reefs. The RRI offers a positive contribution to the resilience of communities affected by climate risk, just as the timely restoration of grey infrastructure does, and it targets vulnerable populations in particular, since they are the most dependent on healthy ecosystems.

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 and endorsements 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.

The RRI programme is funded through revenues generated by an endowment provided by KfW. 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 above costs of emergency response to clean up and start restoring the reef immediately following damaging hurricanes, additional capital 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 the 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, or, indeed, even to pay insurance premiums to provide access to additional risk capital. Therefore, an integral part of the RRI program has been to work in collaboration with WTW, The Nature Conservancy (TNC), and other partners in the region to design and implement a parametric insurance programme for reefs in at least 7 sites of the MAR Region. This innovative financial mechanism will leverage private capital to cover the costs of extreme events, providing post-event payments to fund rapid response reef restoration and recovery activities.

Legal and Regulatory Environment

There are three main legal and regulatory themes that must be addressed for the implementation of the proposed reef insurance programme:

- Is the institutional set-up of the MAR Fund such that it can act as an insurance policy holder?

- Legal counsel has confirmed that the institutional set-up of MAR Fund is such that it can act as insurance policy holder.

- Is the insurance regulatory environment of the MAR Countries suitable for parametric insurance (of offshore natural assets)?
  - The MAR Countries have approved parametric insurance at the sovereign and micro level.
    - The Government of Mexico has parametric insurance policies in place at the sovereign and micro level.
    - The CCRIF SPC Central American extension has interacted with and received regulatory approval for selling parametric insurance in Belize, Guatemala, and Honduras.
      - The Government of Belize has purchased a CCRIF SPC parametric policy and approved the distribution of the Livelihood Protection Policy (LPP)[114], which is a parametric microinsurance policy developed in collaboration with CCRIF SPC, even though it is not currently in place.
      - Guatemala and Honduras have both approved parametric insurance at the sovereign level, although they haven't yet purchased policies from CCRIF SPC.
    - Parametric microinsurance is offered in Guatemala through MiCRO.[115]

Further, 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. 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.

Endorsement letters in support of the reef insurance programme have already been obtained from the Governments of Mexico, Belize, and Guatemala, and discussions are currently progressing with the Government of Honduras. The Fisheries Department of Belize has also signed an additional letter in support of the Emergency Response Capacities in particular, and discussions are currently underway with the other MAR countries to obtain the same.[116] MAR Fund is also 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.

[114] https://www.ccrif.org/projects/crai/livelihood-protection-policy-lpp
[115] https://www.microrisk.org/central-america/first-index-insurance-product-running-guatemala/
[116] The Letters of Endorsement and Support are provided in the additional materials accompanying this report.

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 be put in place for specific partners to receive the funds for the emergency response actions in each country, and responsible parties may vary. 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 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.

Indirect Beneficiaries

The indirect beneficiaries, on the other hand, have a much broader profile and include all stakeholders dependent on the ecosystem services, which are protected through the reef insurance. More information on the indirect beneficiaries is included in a complementary report, which outlines key reef users and potential sources of sustainable premium finance, titled ‘Sustainability of Rapid Response Reef Risk Financing in the MAR Region.’

In summary, and referencing the key beneficiaries identified above, these indirect beneficiaries include:

- 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

We have identified a total of **1,978,539 people** local to the reef sites as indirect beneficiaries of the insurance programme. This includes **1,259,365 beneficiaries who live in poverty, with 800,458 of those living in extreme poverty.** The breakdown by country is:[117]

- **Mexico**: 1,295 people (375 in the small fishing village of Xcalak and 920 in the town of Mahahual);
  - 544 people in poverty, with 91 in extreme poverty.
- **Belize**: 12,067 people (11,767 in San Pedro and 300 on Turneffe Atoll);
  - 3,499 people in poverty, with 724 in extreme poverty.
- **Guatemala**: 129,666 people (81,078 people in Puerto Barrios and 48,588 people in Livingston);
  - 62,240 people in poverty, with 10,373 in extreme poverty.
- **Honduras**: 1,835,511 people (By Department- 432,362 in Atlántida, 62,554 in Islas de la Bahía, 241,651in Colón, and 1,098,944 in Cortés);
  - 1,193,082 people in poverty, with 789,270 in extreme poverty.

The overall profile of these local populations vary (as detailed above); however, it is important to note that the most vulnerable are also the most dependent on the sustainability of the ecosystem goods and services provided by the reef, as they are the least diversified economically (i.e. heavily reliant on tourism and fishing) and often most dependent on subsistence fishing underpinned by a healthy reef. It is not possible to separate economic wellbeing from ecological resilience for these communities, which depend on the reef for income and daily sustenance.

In terms of the socioeconomic profile of the indirect beneficiaries of the insurance profile, 63% of the total population local to the reef sites live in poverty, including 40% in extreme poverty. Table 5.1 summarises the poverty rates of local populations at the reef sites by country, using the most high-resolution socioeconomic data available.

[117] Summary of above sources and analysis

Country of Reef Sites	% Population in Poverty	% Population in Extreme Poverty
Mexico (data for the State of Quintana Roo)	42%	7%
Belize (data for the District of Belize)	29%	6%
Guatemala (data for the Municipalities of Puerto Barrios and Livingston)	38%	6%
Honduras (data for Honduras)	65%	43%

Table 5.1 Poverty rates of the beneficiary populations local to the reef sites.

The Tourism Sector

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

Indirect beneficiaries in the tourism sector are:

- Hotel and restaurant owners, via reef sites attracting visitors;
- Dive operators, via reef sites attracting visitors and underpinning value proposition / providing recreational assets;
- Marine tour operators (e.g. boat tours offering snorkelling), via reef sites attracting visitors and providing recreational assets;
- Sport fish operators, via reef sites attracting fish and visitors; and
- Individuals employed by the above businesses, via income due to reef-related industry.

The Fishing Sector

The fishing sector in the MAR Countries, and especially those businesses and individuals employed on the Caribbean coast, also benefits substantially from the Mesoamerican Reef. Local fishers are not the only indirect beneficiaries, however; in addition to providing the habitat for reef fish, crustaceans, and molluscs, they are also the spawning and nursing grounds that support pelagic species, benefiting artisanal and commercial fishers in a much broader area.

Indirect beneficiaries in the fishing sector are:

- Local communities, via subsistence fishing on and near reefs;
- Seafood businesses; and
- Individuals employed by the commercial and artisanal fishing sector, via income due to reef-dependent fisheries.

The Governments

Governments themselves are indirect beneficiaries of the insurance programme. Considering the Mesoamerican Reef is a public good, it is also a significant natural capital asset, i.e. natural infrastructure. It underpins economic activity as natural, public infrastructure, enabling the tourism and fishing industries, and is also a source of taxes and levies (e.g. marine park user fees, dive levies, fishing licences etc.). The insurance programme also aims to maintain the risk reduction capacity of the Mesoamerican Reef, and since governments i) hold risk to public assets and infrastructure, and ii) are often the insurer of last resort for vulnerable communities, this reduces the government's own contingent liability.

More detail on the indirect beneficiaries of the insurance programme can be found in the complementary study titled 'Sustainability of Rapid Response Reef Risk Financing in the MAR Region.'

This study has been supported by the InsuResilience Solutions Fund.

www.insuresilience-solutions-fund.org

funded by

KFW

on behalf of

Federal Ministry
for Economic Cooperation
and Development

managed by

Frankfurt School
of Finance & Management
German Excellence. Global Relevance.

part of

InsuResilience
GlobalPartnership