ClimateWise

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Nature-related financial opportunity use case

The role of mangroves, coral reefs and seagrasses in supporting and protecting near-shore fisheries in Bolinao, the Philippines

HOWDEN

The University of Cambridge Institute for Sustainability Leadership

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Howden

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Embedded within our client offering lies the Climate Risk and Resilience (CRR) team: a global, multidisciplinary group of experts committed to embedding climate and resilience across our specialties and regions. Our mission is to de-risk climate challenges by unlocking investment to accelerate the transition and protect businesses, nature and livelihoods.

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Preface

Members of ClimateWise are working with the Cambridge Institute for Sustainability Leadership (CISL) and academic partners from the University of Cambridge to determine a common language and framework for financial institutions to identify and assess nature-related financial risks and opportunities so that these can be measured and managed.

Building on CISL's Nature-related financial risks workstream, including Why Nature Matters: Nature-related risks and opportunities for insurance underwriting and Roadmap: Identification and integration of nature-related risks and impacts in underwriting and insurance brokerage, the next phase of work involved the development of use cases with insurance companies that demonstrate how nature-related opportunities can manifest in their portfolios. The opportunity use cases were developed using the LEAP approach from The Taskforce on Nature-related Financial Disclosures (TNFD) framework as a grounding model.

This paper is one of a series of use cases, each assessing a specific type of nature-related financial opportunity. The insurance companies led the opportunity assessment process and subsequent write-ups in close collaboration with the CISL team, who offered guidance, input and support.

The purpose of these use cases is to enable and galvanise further assessments of nature-related opportunities across the insurance industry. In detailing opportunity assessment process, this document aims to provide examples for the wider financial sector. Insurance firms are vulnerable to nature-related financial risks; and the financial materiality of nature loss evidenced constitutes an urgent call to action.

Insurance companies have started to engage internally on nature loss and catalysing external conversations with clients and investee companies, these use cases are an example of this. Through these conversations, collaborative strategies to mitigate nature loss and support a transition to a nature-positive economy can emerge. Aligned with The Kunming-Montreal Global Biodiversity Framework (GBF), which requires that we fully need the financial system to allow nature to start recovering by 2030,1 providing examples of bringing nature into mainstream financial decision-making will pave the way for other financial firms to follow suit.

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Executive Summary

The Philippines is highly exposed to climate-related risks such as typhoons and storm surges. These risks threaten lives, livelihoods, and ecosystems, and increasing losses from insured assets also present an insurability problem. Howden operates within the Philippines, serving corporate and public sector clients from its Manila office by providing insurance broking and risk advisory services to many actors in the fishing and mariculture industries.

Using the Taskforce on Nature-Related Financial Disclosure's (TNFD) Locate, Evaluate, Assess and Prepare (LEAP) methodology, this use case seeks to establish how insurance can play a role in enabling opportunities within the Nature-based Solutions (NbS) space to help protect vulnerable marine ecosystems and to increase the resiliency of coastal communities.

This use case studies the municipality of Bolinao, Philippines, an area dependent on its biologically diverse marine ecosystem for coastal resiliency and economic benefits. Focussing on mangroves, corals and seagrass beds, this paper identifies insurance solutions that can help build resiliency within marine ecosystems and associated communities. These include cover for Marine Protected Areas (MPAs), insurance against ocean warming events and insurance against ecosystem damage from storms.

This use case suggests that these be implemented in tandem with the designation of new MPAs and are designed to incentivise long term resilience building by offering premium reductions in exchange. Furthermore, the cover could be sustainably financed through the generation of carbon credits.

Designing policies to protect natural assets in emerging and developing markets requires an enhanced duty of care on behalf of the insurance market. This paper seeks to provide guidance on the kinds of considerations that should be made to ensure inclusivity and effectiveness. This includes establishing an understanding of existing governmental and non-governmental disaster risk management and response strategies and organisations operational within the area, as well as understanding site-specific socioeconomic conditions which may influence or be influenced by the introduction of insurance. Within this case study this is illustrated by a prolific capture fishing and mariculture industry that supports livelihoods while having a considerable impact on the health of the marine ecosystem.

To understand the local context in more detail and ensure an effective and equitable application of insurance, this paper suggests that more on-the-ground research and stakeholder engagement is required.

Investing in economical and equitable insurance solutions to support resilience building today has the potential to protect the natural ecosystems and biodiversity underpinning them. It also contributes to the long-term resilience of coastal communities and the viability of insurance within the region.

Introduction

Nature provides a wide range of ecosystem services critical to human well-being. These services include air quality and local climate, water security, food provision, habitat intactness, and hazard regulations.[2] When nature is degraded or lost, these services can be disrupted, leading to risks such as food shortages, water scarcity, and increased vulnerability to natural hazards.

Nature and biodiversity play a crucial role in enhancing resilience to environmental risks, and providing stability and adaptability of ecosystems.[3] According the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), an estimated 1 million species are at risk of extinction, with alarming implications for ecosystems worldwide.[4] Healthy ecosystems can protect and mitigate the impacts of climate change, reduce the severity of events like floods, hurricanes, and droughts, and decrease communities' vulnerability to risks.[5] Furthermore, the degradation of the goods and services nature provides poses a financial risk, as underscored by the findings of the UNEP FI's Principles for Sustainable Insurance Initiative report.[6]

> **Ecosystem Services:**
>
> "Benefits that people obtain from natural capital, such as air and water purification services, crop pollination and the breaking down of waste. Biodiversity underpins the flow of benefits. Ecosystem services are also known as 'nature's contributions to people'."
>
> Source: CISL Handbook for Nature-related Financial Risks

The TNFD defines nature-related opportunities as activities that create positive outcomes for organisations and nature by avoiding or reducing impact on nature or contributing to its restoration.[7] Nature-related opportunities can occur:

i) when organisations mitigate the risk of natural capital and ecosystem services loss; and,

ii) through the strategic transformation of business models, products, services and investments that actively work to halt or reverse the loss of nature, including implementing NbS or support for them through financing or insurance.

Nature-related financial opportunities will vary according to the market, region and industry in which an organisation operates. Some opportunities could include:

- transitioning to more efficient services and processes requiring less natural resources,
- development of less resource-intensive products/services,
- access to biodiversity-related and/or green funds, bonds, or loans,
- resilience through the diversification of biodiversity-related resources, and
- enhanced reputational benefit as a pioneer in reducing nature loss and protecting/restoring nature.

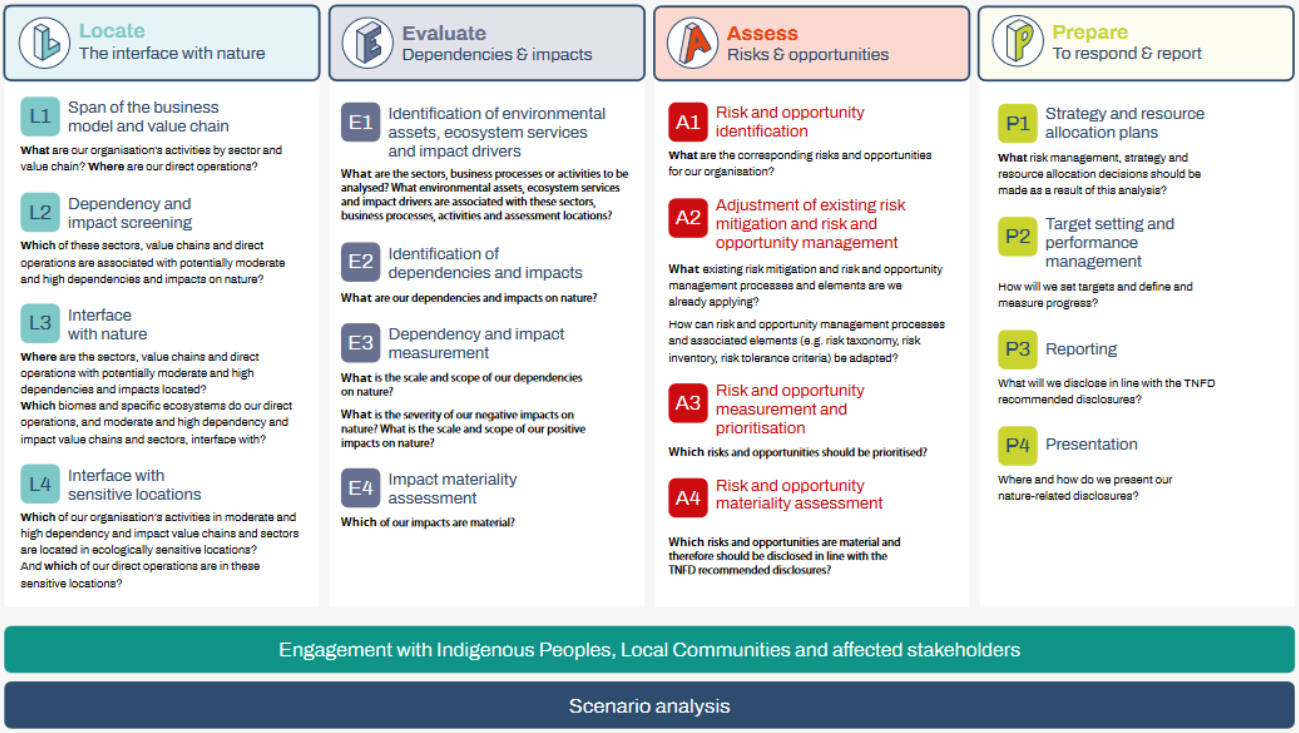
Through its membership of ClimateWise, Howden has explored the potential for the role of mangroves, coral reefs and seagrasses in supporting and protecting near shore fisheries in Bolinao, Philippines, and how insurance could be used to help protect the financial resilience of small-scale fishing communities.

The LEAP Approach

To investigate the financial prospects associated with nature, this case focuses on the utilisation of insurance to safeguard the economic stability of small-scale fishing communities in the Philippines. The approach involves harnessing the protective qualities of mangroves, coral reefs, and seagrasses, which enables greater resilience to the fishing industry in the Philippines.

To develop this opportunity use case, the LEAP (Locate, Evaluate, Assess and Prepare) approach from the TNFD has been used to explore and implement nature-related financial opportunities. See the framework in Figure 1 below:

Figure 1: The TNFD LEAP approach to identifying nature-related financial opportunities[8]



Analysis and Findings

1. Locate your interface with nature

Howden Philippines is based in Manila and works with corporate and government clients operating within the fishing and related industries, often with coastal Natural Catastrophe (NatCat) exposures. Howden partnered with Blue Finance and AXA Climate to design and place insurance coverage for two Marine Protected Areas (MPAs) in Belize and the Philippines, with the aim of bridging the financing gap in marine conservation to promote financially self-sustainable MPAs that positively impact marine biodiversity and local communities.[9] The Philippines is widely considered one of the most climate vulnerable countries in the world, having experienced losses averaging 0.54% of GDP annually between 2000 and 2019.[10] Partly as a result of this, the Philippines has emerged as having one of the most comprehensive approaches to disaster risk management and financing among emerging Asian economies,[11] which includes significant insurance structures and has prompted wider industry interest.

1.1 Case Study Area

The Philippines is in the Coral Triangle, an area that is home to around 76% of all coral species and 37% of the world's coral reef fish.[12] As an archipelago of over 7,000 islands, the Philippines is a hotspot for marine biodiversity, hosting extensive coral reefs, mangroves, and seagrass beds. These ecosystems play a pivotal role in supporting and sustaining the livelihoods of coastal communities and contribute significantly to global fish catch through both commercial and small-scale fisheries. (See appendices 1, 2, & 3 for more information on mangroves, seagrass and coral reefs.) However, the region is highly susceptible to the impacts of storms and monsoons, which pose significant threats to both the biodiversity of the marine ecosystem and the fishing communities that depend on it. Given the vastness of the marine ecosystem and its crucial role in supporting livelihoods, the Philippines emerges as a natural focus with its extensive marine biodiversity and the dependency of coastal communities on these ecosystems.

The coastal municipality of Bolinao sits on the northwestern part of Pangasinan, bounded by the South Sea and the Lingayen Gulf (Figure 2). It is a microcosm of the biodiversity of the Philippines and the wider Coral Triangle. The municipality is composed of 30 *barangays* (the native Filipino term for village, district or ward denoting an administrative or political municipal subdivision), of which 23 are situated along its rich coastal expanse; an indication of the close relationship between the marine environment and the 84,000 people who live there. Mainland Bolinao and surrounding areas, including Santiago Island and Santiago Lagoon, boast diverse coastal waters and channels characterised by extensive coral reef flats, seagrass beds and protected mangrove areas along the Balingasay River estuary and the South Sea coast. This convergence of natural features underscores the critical role Bolinao plays in both local and global marine ecosystems.

Figure 2: The Municipality of Bolinao[13]

Key Takeaway

Coral reefs, mangroves and seagrass beds protect coastlines from storm surges and sea-level rise, reducing the impacts of such risks and averting damage of more than USD 1.6 billion throughout the Philippines. [14] The Philippines is abundant in these ecosystems while being subject to an average of 20 cyclones per a year; providing the opportunity to develop tailored nature-based insurance products to promote coastal resilience. Howden selected the Philippines for this use case, leveraging its presence in the country and understanding of the local area. The choice of Bolinao as the project site was deliberate, considering its abundance of all three ecosystems and the availability of data on these ecosystems.

2. Evaluate dependencies and impacts on nature

The lives and livelihoods of coastal communities in the Philippines often depend on the ecosystem services provided by coastal and marine ecosystems. The primary services delivered by these ecosystems include their contribution to the health as well as productivity of fisheries, upon which a large proportion of the population relies for income and sustenance, and through their contribution to the protection of the coast from natural hazards, including typhoons. The dependence of coastal communities on marine ecosystems makes them particularly vulnerable to human and climate-related impacts that may inhibit the provision of ecosystem services. This section explores the current provision of services by the marine ecosystem around Bolinao and the potential for climate-related damages.

2.1 Marine ecosystem dependencies and impacts

Approximately 25% of the ocean's fish rely on the health of coral reefs for their survival.[15] Coral reefs, spanning 27,000 sq. km in the Philippines, are crucial for the survival of 25% of the ocean's fish, supporting over 4,000 species. Bolinao, within the Gulf of Lingayen's Fisheries Management Area (FMA) 6 (see appendix 4), boasts a 200 sq. km fringing reef vital to national fisheries, sustaining diverse marine resources for traditional and modern activities, and providing income for 40% of coastal households. [16]

The negative impacts of the fishing industry on nature are multifaceted and can have far-reaching consequences for marine ecosystems and the communities reliant upon them. Overfishing, one of the most significant issues, leads to the depletion of fish populations, disrupting the delicate balance within marine ecosystems. This depletion affects the targeted fish species and alters the abundance and distribution of other marine organisms, leading to cascading effects throughout the ecosystem.

Moreover, destructive fishing practices exacerbate these impacts by causing widespread habitat degradation. Techniques such as bottom trawling can damage sensitive habitats like coral reefs and seafloor habitats, which serve as nurseries, breeding grounds, and essential refuges for numerous marine species. The destruction of these habitats not only directly impacts biodiversity but also undermines the resilience of marine ecosystems to environmental stressors such as climate change.

Furthermore, bycatch – the incidental capture of non-target species – is another significant negative impact of the fishing industry. This includes the unintentional capture of endangered species, juveniles, and non-commercial species, contributing to biodiversity loss and disrupting ecosystem dynamics. Additionally, discarded fishing gear continues to trap and kill marine life long after it has been abandoned, further contributing to the degradation of marine ecosystems.

These negative impacts are material due to their severity and scale, posing significant challenges to the long-term health and sustainability of marine ecosystems and the livelihoods of coastal communities. Maintaining healthy coastal ecosystems, including seagrasses and mangroves, enhances fisheries' economic value and acts as natural protection, reducing annual property damages by up to 30% and saving approximately USD 1.6 billion in avoided losses from extreme weather events. [17] (See Appendix 5 for more information on coastal protection.)

2.2 Impacts of natural hazards on coastal communities and marine ecosystems

Bolinao, experiencing a tropical climate and situated in the Pacific Northwest Basin, contends with approximately 20 tropical cyclones annually, making it highly susceptible to extreme weather events that

stress the marine ecosystem.[18] Adverse weather poses substantial financial risks for municipal fishers, whose incomes often fall below the poverty threshold, with recent storms highlighting direct consequences on their lives and livelihoods. Despite diversification into tourism and public services, bad weather can impact supplementary income sources. Even aquaculture operators face risks in treacherous conditions, leading to potentially life-threatening situations and damage to fish cages and nets, which impacts a higher upfront cost to build and repair than other fishing equipment.[19] Beyond immediate financial repercussions, these extreme weather events cause long-term challenges. They damage mangroves, coral reefs, and seagrass beds, disrupting ecosystem structures and biodiversity. It can take decades to recover the biodiversity in these Bolinao's ecosystems, which have already been negatively impacted.[20] The intrinsic link between Bolinao's economic security and the health of its marine ecosystem underscores the urgency of conservation efforts to mitigate the impact of severe weather events. Providing support during dangerous conditions is crucial for reducing risks to fishers' lives and sustaining the long-term viability of the fishing industry in the region. (See Appendix 6 for more information.)

Climate change in the Philippines has led to rising water temperatures, decreased oxygen levels, and increased ocean acidity, resulting in sea level rise, intensified typhoons, and ecosystem degradation.[21] These changes directly threaten Bolinao's population, causing property damage and disrupting fishing and aquaculture. Natural assets like coral reefs, mangroves, and seagrass beds become more vulnerable, exacerbating challenges for local communities. Rising temperatures and changing rainfall patterns may hinder coral growth and elevate pollution risks. While there is limited evidence of increased cyclone frequency, intensification during El Niño years is noted, with projections indicating heightened rainfall. The interplay of tropical cyclones with rising sea levels and extreme rainfall is expected to increase flooding risks, contributing to a 50% projected increase in response costs.[22] Satellite observations reveal significant sea level rise, impacting the Philippines. Critical ocean conditions, including temperature, oxygen concentration, and acidity, are at risk, posing challenges to marine ecosystems. Ocean acidification may harm corals, plankton, and crustaceans, with projections indicating a 4.2% decrease in ocean oxygen and a 0.25 pH unit decrease by 2100, potentially causing destructive impacts on Philippine marine ecosystems.[23] (See Appendix 7 for more information.)

2.3 Climate change and insurability

Losses from extreme weather events are expected to increase, with escalating losses attributed to these events considered material due to their profound ramifications. This is partly because of increasing property values and the extent to which property is built within hazard zones. An increase in the frequency and severity of climate hazards due to climate change will have a material impact. These events result in physical damage to infrastructure and pose significant threats to human lives, livelihoods, and the environment. The increasing frequency and severity of climate-related hazards exacerbate vulnerabilities, particularly among the fishing communities, leading to disproportionate impacts on their well-being and economic stability. To ensure the availability of insurance products in the face of increasing losses, risk-based premiums are likely to increase over time. This could lead to the lowest income and potentially most vulnerable individuals being priced out of the insurance market, limiting the size of risk pools, and potentially leading to further increases in premiums for remaining insured.

Additionally, the potential rise in insurance premiums and the risk of individuals being priced out of coverage underscore the materiality of these impacts, as they directly affect access to financial protection against future losses. Losses may eventually become so high and frequent that the financial viability of

insurance as a risk transfer mechanism is undermined, and it ceases to be available. Therefore, addressing these material impacts requires urgent and concerted efforts to enhance resilience, implement adaptation measures, and promote equitable access to risk management strategies, including within vulnerable fishing communities. Adaptation measures, such as the restoration of green infrastructure, are crucial to managing increasing climate and non-climate-related physical risks and ensuring the affordability and availability of insurance where it is needed most.

Key Takeaway

Bolinao, with its diverse marine ecosystem centred on the Bolinao reef flat, is a vital hub for fishing, aquaculture, and related industries, supporting 40% of coastal households and a crucial commercial fishing sector dependent on a healthy coastal ecosystem.

Bolinao's tropical climate poses significant weather-related challenges. It affects marine ecosystems and endangers fishers, both municipal and in aquaculture, with recent deadly storms causing direct and indirect consequences.

Climate change and increasing urban exposure to the coast may affect the affordability and availability of insurance in coastal communities. Nature-based adaptation measures such as mangrove and reef restoration can help manage a widening insurance protection gap.

3. Assess risks and opportunities

The success of different insurance strategies in the Philippines requires collaboration with local communities, government agencies, and environmental organisations. Assessments could consider the unique socio-economic factors, cultural practices, and existing governance structures to ensure the relevance and effectiveness of proposed insurance solutions.

3.1 Socioeconomic context

The socioeconomic context significantly influences vulnerability to risks and access to opportunities. Bolinao, comprising 2.65% of Pangasinan province's population, relies heavily on fisheries, with a population centred on coastal areas. Between 2015 and 2020, Bolinao saw a 2.31% population increase, with an annualised population growth rate of 0.48%, lower than the Philippines' overall rate of 1.53%[24] which could be linked to the saturation of the primary industry, fishing. The average size of households decreased from 5.3 inhabitants per household in 1990 to 4.6 in 2015. [25] Despite a slower population growth rate than the Philippines, Bolinao faces challenges due to a high dependency ratio on working age individuals and a young population. This demographic imbalance increases vulnerability to immediate coastal hazards and the risk of long-term economic stability, particularly in the fishing industry. The implementation of insurance in Bolinao faces obstacles due to financial insecurity, which can impact individuals' ability to make premium payments. Furthermore, the concentration of populations in coastal zones increases risk accumulation, potentially driving up premiums for individual households. One solution is to finance premiums through local or municipal bodies which could provide more stability. This approach could help smooth incomes after natural catastrophes and reduce reliance on destructive fishing practices. Additionally, providing cover for marine ecosystems could leverage the growing coastal population to increase funds for premium financing while addressing natural catastrophe risks. Insuring fishers and aquacultures directly, without sufficient local governance and assurances, could inadvertently promote harmful practices. Therefore, as part of a more comprehensive capacity-building and education programme, insurance could be used as an incentivising mechanism to encourage diversification of income sources into other industries, such as seaweed farming, by targeting coverage in this industry. (See Appendix 8 for more information.)

3.2 Fishing policies and practices

Nearly half (48.98%) of Bolinao's municipal waters are allocated for use by small-scale fishers with vessels below three gross tonnes in size. In contrast, larger commercial fishing vessels are forced to fish beyond 15km of the shoreline, deeper in the Lingayen Gulf and the South Sea.[26] A small portion of the municipal waters (0.84%), typically in the channels to the east of mainland Bolinao, is used for aquaculture and mariculture activities, involving shoreline aquaculture ponds, fish nets and fish cages for milkfish oysters, seaweeds and sea urchins.

3.2.1 Capture fishing

In the Philippines, capture fishing is conducted by commercial and small-scale (municipal) fishers, with commercial and municipal fisheries accounting for 22% and 36% of total production value, respectively.[27] Over one million fishers are engaged in capture fishing, but the industry directly supports at least one million others through employment in vending, processing, and gleaning activities.[28] Municipal fishers

supply the market with an annual value of USD 1.1 million[29] and contribute to the livelihoods of around 6.5 million people.[30]

Despite its economic importance, the resilience of this sector is challenged by various factors, including the rise in coastal population and prevalent overfishing.[31] This has led to the gradual degradation of marine ecosystems and increased vulnerability for small-scale fishers.[32] While conventional fishing methods are generally not directly harmful, historical illegal practices such as poison and blast fishing have severely impacted marine ecosystems, often employed due to their cost-effectiveness or when conventional methods fail. To mitigate these challenges, maintaining sufficient fish stocks to support conventional fishing methods is crucial to ensure financial security for municipal fishers and prevent further degradation of marine ecosystems. (See Appendix 9 for more information.)

3.2.2 Aquaculture

Aquaculture practices, initially leading to the destruction of mangroves before regulation was introduced, have since evolved to become a significant contributor to the Philippines' fish catch, accounting for 42% of its value nationally.[33] While properly managed aquaculture can offer economic and environmental benefits, such as yield security and reduced bycatch, overcrowded and poorly managed facilities can result in environmental damage. Despite efforts like municipal licensing and reductions in cage numbers, eutrophication around aquacultures in Bolinao persists, causing mass fish kills and biodiversity loss.[34] This environmental degradation undermines the effectiveness of insurance solutions aimed at protecting marine ecosystems, as insured assets face significant damages beyond the insured risks. However, insurance can still play a role in breaking the cycle of financial insecurity and destructive fishing practices by improving fishers' financial resilience, incentivising diversification of income sources like seaweed farming, and promoting capacity building and education. (See Appendix 10 for more information.)

3.3 Gender analysis

The Philippines ranks 16th in the 2023 Global Gender Gap report, reflecting national efforts for gender equality, supported by legislation like the Magna Carta of Women.[35]

In coastal fishing communities in the Philippines, there is a division of roles based on different social characteristics, including age, gender, and social status. Cultural norms and traditions pose challenges for women in the predominantly male-centric fisheries sector. According to the Philippine Department of Labor and Employment, 90% of those employed in the fisheries are men.[36] This statistic relies on a limited definition of fisheries, which includes only fishing by boat.[37] Women hold a significant value in fishing activities, particularly in gleaning, which involves collecting benthic macroinvertebrates (they include worms, crustaceans, and immature forms of aquatic insects such as stonefly and mayfly nymphs), in intertidal zones, as well as nearshore fishing, including spearfishing in rivers and reef fishing, using various tools such as scoop-nets, traps, and fish baskets. Gleaning statistics, crucial for understanding women's contributions, often go unrecorded in fisheries data, making it invisible to researchers and policymakers. Additionally, the lack of data collection by the Food and Agriculture Organisation (FAO) in the secondary sector and small-scale fisheries further obscures the significant participation of women in these areas.[38]

In Bolinao, the community-based coastal resource management (CBCRM) programme, implemented in 1993, aimed to empower rural coastal communities with a focus on gender sensitivity.[39] The programme documented the active involvement and leadership roles of women in decision-making at barangay and

municipal levels. Family support was crucial for women to sustain leadership positions, highlighting women's agency and active participation in Bolinao's community dynamics.[40]

The lack of reliable data on the role of women in fishing activities can make it difficult to determine their specific hazard exposures and vulnerabilities and to provide appropriate insurance coverage.

Key Takeaways

In the context of high fisheries dependence, insurance could play an important role in building financial resilience to extreme weather. This could contribute to ecosystem health by helping break the cycle of poverty, the use of destructive fishing practices, and overfishing.

Any solution focused only on natural catastrophe impacts without considering anthropogenic impacts on the ecosystem would ignore important causes of ecosystem degradation. The provision of insurance could avoid undermining the health of the ecosystem by providing support to fishers exhibiting good fishing practices or looking to diversify incomes, such as seaweed farming.

The opportunity to access more disaster risk financing with better terms could act as an incentive to invest in the better management of marine capture and mariculture activities.

4. Prepare to respond and report

The Philippines can strengthen its resilience to the challenges posed by extreme weather events. Preparing to respond and report involves developing comprehensive disaster risk reduction plans, including early warning systems and evacuation protocols, in collaboration with local authorities. A proactive approach streamlines post-event recovery and establishes a foundation for continuous monitoring and adaptive strategies to protect the invaluable marine ecosystems supporting the country's near-shore fisheries. By integrating insurance mechanisms and promoting sustainable fishing practices, robust approaches seek to enhance the resilience of coastal communities, protect natural assets, and mitigate the adverse impacts of extreme weather events.

4.1 Disaster response strategies

When developing an insurance product that addresses disaster risk response and reduction, it is imperative to conduct a background review of current disaster response strategies.

4.1.1 Disaster risk management and financing in Bolinao

In Bolinao, the Local Disaster Risk Reduction and Management Fund (LDRRMF), which is funded by the local government, allocates 30% of funds to a Quick Response Fund (QRF). This dedicated fund is pivotal in supporting relief and recovery activities during emergencies, ensuring swift normalisation of living conditions in disaster-stricken communities. Additionally, unutilised funds are directed to a special trust fund, exclusively supporting disaster risk reduction and management activities of the Local Disaster Risk Reduction and Management Councils (LDRRMCs). Bolinao's commitment to decentralisation aligns with the national directive, emphasising the significance of local government budgets in disaster management.

Bolinao's proactive approach includes innovative measures such as encouraging risk pooling among local governments and promoting the use of insurance for short- and medium-term fiscal protection against catastrophic risks.[41] The localised nature of the funds is a key feature, facilitating a smoother distribution process to beneficiaries and fostering community engagement for the study and development of efficient, tailored disaster risk reduction and management products. The local character of these funds reflects Bolinao's willingness to embrace various initiatives for community protection, creating a foundation for effective disaster response strategies.[42]

4.1.2 Anticipatory action

The Philippines has an established agency for disseminating vital information prior to a natural hazard event, particularly for weather-related events, named the Philippines Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA). The Philippines population relies on the agency for timely weather advisories and hazard monitoring, which has been mandated to develop hazard mitigation programmes for coastal areas since the Calamity Hazard Mitigation Programme Act in 2010.[43]

In 2019, in a significant stride towards advancing forecasting capabilities, the Department of Science and Technology (DOST-PAGASA) introduced an innovative Storm Surge Forecast and Warning system, enhancing public understanding through visualised impact-relevant data. These services are divided into two segments: Storm Surge Watch, indicating a moderate to high risk within the next 48 hours, and Storm Surge Warning, indicating a high risk within the next 24 hours, specifically targeting low-lying coastal communities. This anticipatory approach aims to enhance public understanding and preparedness and

improve disaster risk response, focusing on proactive measures.[44] Before an insurance product could be placed, a thorough investigation involving active engagement with the local government and various barangay communities was needed to understand the existing system's effectiveness and ability to respond to disasters in Bolinao.

Case Study: B-Ready Philippines

The Philippines is where the B-ready concept was created. B-Ready uses parametric forecasting with community inputs to provide humanitarian assistance to individuals, communities, and businesses prior to a disaster. This anticipatory approach combined impact-based disaster forecasting, pre-emptive action and community design. In collaboration with Visa, Oxfam developed a cash-transfer programme through a mobile-based payment system to create a digitised humanitarian payment to help vulnerable communities. This initiative was based on a growing acknowledgement that cash transfer is an efficient strategy for delivering aid because it allows recipients to decide and acquire what they need, which simultaneously jumpstarts the economy.

4.1.3 Historic cost for the natural ecosystem

In disaster response planning, the Philippines demonstrates an increasing commitment to preventive measures, allocating funds for disaster-related initiatives in advance. The importance of natural assets in resilience plans is becoming more widely recognised and understood, with the Philippines promoting schemes that enhance resilience through the conservation and restoration of these assets. Following the 2013 Typhoon Haiyan, known in the Philippines as Super Typhoon Yolanda, the United Nations Strategic Response Plan (SRP) aimed to provide direct assistance to three million people in affected areas, requiring USD 791 million.[45] The plan complemented the Philippine government's Yolanda Recovery and Rehabilitation Plan (YRRP), focusing on humanitarian needs and aiding communities in transitioning to early recovery. [46] Although the plan did not provide information on funding to be allocated specifically to ecosystem restoration, it did acknowledge the commitment to livelihood restoration for affected communities and assisting small and medium enterprises in the fishing industries impacted by the typhoon.

Under the Philippines Local Disaster Risk Reduction and Management Fund (LDRRMF), local governments are directed to set aside 5% of their budgets in a 'local calamity fund'.[47] As of March 2022, the LDRRMF mandates that 30% of funds, amounting to more than USD 5 million, are to be allocated to Quick Response Funds (QRF), and 70% of funds, totalling more than USD 12.5million, are to be allocated to Mitigation funds that support pre-disaster preparedness and risk reduction activities such as mangrove planting and public service training. In 2022, USD 90,000 was deployed through the mitigation portion of the LDRRMF to fund mangrove planting activities[48] which shows that there is local recognition of the pivotal role of ecosystems as a natural buffer to extreme weather and as a provider of livelihoods.

4.2 Market assessment

4.2.1 Philippines insurance market

This section of the report examines the dynamic insurance landscape in the Philippines, as highlighted by the 2023 finding for the Insurance Commission. With low insurance penetration at 1.75%, there's potential for improvement through increased investment in digitisation and financial literacy services.[49] In 2023, the Philippines government announced an indemnity insurance plan to provide financial protection

for critical assets such as schools, hospitals, roads and bridges.[50] Moreover, there has been recent legislative changes, including the passage of a House bill, broadening the scope of crop insurance services to include livestock, fisheries and aquaculture, agroforestry projects, and forest plantations.[51] Below are some of the key insurers shaping the evolving insurance landscape in the Philippines:

Philippines Catastrophe Insurance Facility (PCIF): In 2021, the Philippine Insurance Commission (PIC) issued Circular Letter No 2021-27, issuing the strict implementation of sustainable catastrophe premium rates and establishment of the Philippines Catastrophe Insurance Facility (PCIF). Prior to the establishment of the PCIF, domestic insurance companies that cover catastrophe insurance had to reinsure their risk overseas. The PCIF will allow the Philippine insurance industry to take on more risk because the country's resources will be pooled to keep the funds within the country.[52]

Philippine Crop Insurance Corporation (PCIC): As part of the Department of Agriculture, PCIC is a government owned and controlled cooperation mandated to provide insurance protection to farmers against losses arising from natural calamities, plant disease and pest infestations.[53]

CARD Pioneer microinsurance (CPMI): Formed in 2013, CARD is the Philippines' largest micro-finance institution. Created to address the calamity, agriculture, income loss, and other non-life insurance needs of the underserved market, CPMI aims to provide microinsurance access to most Filipinos and fill the protection gap.[54]

Asian Development Bank (ADB): The ADB actively supports the government of the Philippines in addressing poverty, inequality, climate change, enhancing resilience and sustainability, making cities more liveable, improving governance and institutional capacity, and encouraging gender equality.[55] In 2023, the ADB approved USD 2.1 billion to construct a climate-resilient bridge connecting Bataan and Cavite across Manila Bay, aiming to ease congestion in Metro Manila, improve transportation, and boost economic productivity in Luzon. The project is helping lower annual greenhouse gas emissions in the country. In 2021, ADB issued its first ever blue bond to finance ocean-related projects in Asia and the Pacific. This initiative aligns with ADB's Action Plan for Healthy Oceans and Sustainable Blue Economies, which is committed to investing and providing technical assistance of at least USD 5 billion by 2024 to catalyse sustainable investments in the region.[56]

Case Study: Rare and Ocean Risk and Resilience Action Alliance (ORRA) Strengthening the Financial Resilience of Small-Scale Fisheries

ORRA supported the expansion of Rare's pilot project aimed at providing small-scale fisheries in the Philippines, Indonesia, and Honduras access to insurance products, enhancing livelihood protection and building resilience in coastal communities against climate-related events. The pilot phase in the Philippines successfully enrolled over 4,000 members in basic livelihood insurance, providing insurance literacy training to over 2,750 participants, with over half being women working in fisheries. In the second phase, Rare expanded the training and product offerings to 50 new savings clubs in the Philippines. In the third phase (2024-2025), Rare aims to expand its microinsurance programme to 6,500 new policyholders across the Philippines.[57]

4.3 Key stakeholders

Active engagement from various stakeholders would be required for the development of insurance products. The Philippines is home to numerous risk pooling and financing projects, undertaken by or in partnership with relevant governmental and non-governmental organisations. Broadly, there is an appetite for, and the necessary governance structures to support the appropriate implementation of insurance.

4.3.1 Government

Agricultural Credit Policy Council (ACPC): ACPC was created in 1986 by Executive Order 113 to assist the Department of Agriculture (DA) in synchronising all credit policies and programmes supporting the latter's priority programmes. Prior to approval, it was tasked to review and evaluate the economic soundness of all ongoing and proposed agricultural credit programmes, whether for domestic or foreign funding.[58]

Bureau of Fisheries and Aquatic Resources – Regional Fisheries Office V (BFAR – RFO V): BFAR, under the Department of Agriculture, is the government agency responsible for the development, improvement, management and conservation of the country's fisheries and aquatic resources. It was reconstituted as a line bureau by virtue of Republic Act No. 8550 (Philippine Fisheries Code of 1998).[59]

Fisheries and Aquatic Resources Management Councils (FARMC): FARMCs in every city, municipality and barangay neighbouring municipal waters, bays, lakes, rivers, and dams were created by law to encourage participation by small fisherfolk and small-scale fisheries owner associations in plans and actual project implementation affecting their industry. Standard protocol in government is that projects that assist the small fisherfolk be coursed through member associations of the FARMCs.

Bolinao Provincial Mangrove Information Center and Nursery (BPMICN): The provincial government set up the BPMICM as part of a coastal defence campaign.[60] Lodged under the Provincial Agriculture Office, it is a joint undertaking with the University of the Philippines-Marine Science Institute (UP-MSI). The nursery produces 100,000 seedlings annually, which are given away for free to the municipal government. The nursery aims to help resilience to threats from overfishing and climate change.[61]

4.3.2 Non-government organisations and research/consultancy institutions

Rare Philippines: Rare is an international conservation and development organisation using behavioural insights to inspire change so people and nature can thrive. Rare has implemented a Fisher Forever programme in the Philippines that works with fishing villages and municipal governments to build and strengthen community-based coastal fisheries management. The programme aims to advance coastal fishing communities' inclusion in financial and market opportunities to increase household resilience.[62]

U.S. Agency for International Development Oceans and Fisheries Partnership (USAID Oceans): A collaboration between USAID Oceans and the Southeast Asian Fisheries Development Center (SEAFDEC), works to strengthen regional cooperation to combat illegal, unreported and unregulated (IUU) fishing, promote sustainable fisheries and conserve marine biodiversity in the Asia-Pacific region.[63]

NGO for Fisheries Reform (NFR): True to its mandate, the NFR, established in 1994, has focused on fisheries policy reform and advocacy at the national and local levels. It has been instrumental in the passage of the Philippine Fisheries Code of 1998 or Republic Act 8550.[64]

Southeast Asian Fisheries Development Center – Aquaculture Department (SEAFDEC–AQD): SEAFDEC–AQD was established in 1973 to conduct research, develop technologies, disseminate information, and train people in the farming of fishes, crustaceans, molluscs, and seaweeds for food, livelihood, equity, and sustainable development. The Philippines, as host, provides AQD with the physical facilities, the funds for operations and the salaries of researchers, scientists, and service personnel.[65]

The Department of Science and Technology (DOST) and the Philippines Council for Agriculture, Aquatic and Natural Resources Research: Together, the two groups developed an initiative that responds to coral degradation by deploying coral transplant technology. The programme works by collecting dislodged live coral fragments or "corals of opportunity" (COPs). It attaches them to coral nursery units (CNUs) for quick recovery and regeneration to increase survival rates upon transplantations in degraded coral reef sites.[66]

The Samahang Maliliit na Mangingisda ng Victory (SMMV), Inc. and the Samahan ng Mangingisda at Magsasaka sa Kalikasan (SAMMAKA), Inc.: are People's Organisations established to help small fisherfolks with the issues they face in the coastal communities of Santiago Island, Bolinao, and Pangasinan.[67]

The Alpha Phi Omega International Service Fraternity & Sorority (APOISFS): A non-profit organisation based in Bolinao, has recently undertaken a mangrove conservation and restoration initiative.[68]

Haribon Foundation: The foundation has been at the forefront of protecting and restoring the country's diverse ecosystems and communities in the Philippines for the last 50 years. Haribon leads sustainable projects that train, nurture, and empower Filipinos to be environmental leaders and guardians for countless generations.[69] Haribon has conducted projects in Bolinao in the past. In 1984, a programme was implemented to convert local fishers from cyanide users to net users.

Key Takeaways

Even given the named insurance market actors in disaster risk reduction and management, the Philippines has one of the lowest insurance uptakes in the world, the highest exposure to typhoons and an intensifying climate change that all impeded the growth of the sector. If an insurance product were to be designed to cover marine ecosystems, it would be imperative to assess the country's receptiveness to such offerings. Introducing a new insurance mechanism requires overcoming regulatory hurdles, building trust among stakeholders, and establishing a robust understanding of the unique risks associated with insuring marine ecosystems. The next stage of the project will require community engagement and stakeholder involvement, which are critical to local support and ensuring the effective implementation of the products.

Following receptiveness, it is essential to evaluate the Philippines' ability to seamlessly integrate these insurance mechanisms into the existing disaster risk management plan. This assessment will involve collaborative efforts with relevant authorities, ensuring that the tailored parametric insurance products contribute synergistically to the overall resilience and sustainability of the marine ecosystems while aligning with the national disaster preparedness and response strategies.

Mapping the Route to Protection: How to Leverage Insurance for Ecosystem Conservation

This section explores innovative insurance strategies aimed at mitigating risks and enhancing resilience to disasters events affecting coastal communities. It examines a diverse range of risk-mitigation measures, emphasising the integration of Nature-based Solutions (NbS) with insurance mechanisms. Real-world case studies and ongoing initiatives within this domain are highlighted to provide practical insights. The section also discusses premium reduction incentives, carbon credit financing, and gender-responsive design, aimed at developing an understanding of fostering sustainable coexistence between coastal communities and their vital ecosystems.

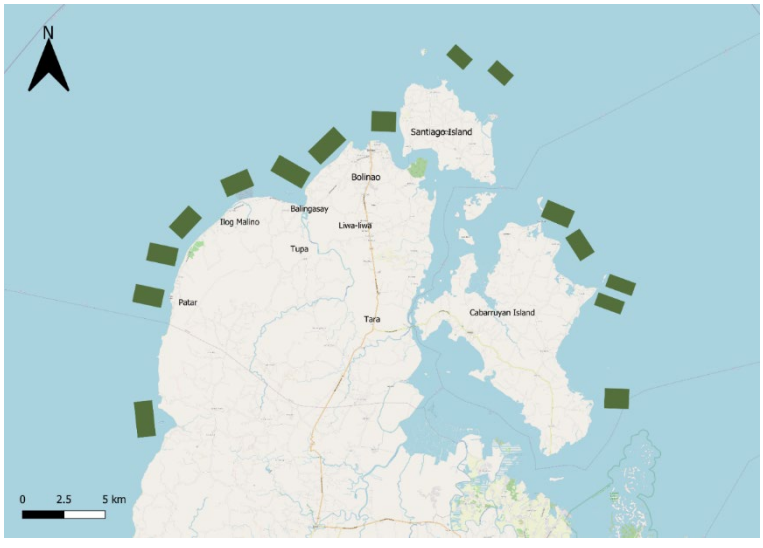
5.1 Implementation of insurance for marine ecosystems

This section explores the implementation of insurance strategies on marine conservation and disaster resilience, specifically that could be applied to coral reefs, mangroves and seagrass.

5.1.1 Insurance for Marine Protected Areas (MPA)

One of the most powerful and effective methods for protecting fisheries and resources is creating MPAs, a clearly defined geographical space managed for long-term conservation. MPAs protect crucial marine species' habitats, preserving areas vital for feeding, wintering, resting, and migration routes, thereby enhancing resilience against major threats like overexploitation, pollution, sedimentation, ocean acidification, and habitat destruction. With marine environments facing increasing deterioration and biodiversity loss, MPA offer numerous benefits. These include coastal protection, species survival and reproduction, fisheries advantages, carbon storage, employment opportunities, commercial benefits, and cultural value.[70] Bolinao has actively engaged in managing MPAs since as early as 1994, with proposed locations requiring verification of exact coordinates and coverage. These MPAs, located in rivers, near coastlines, and islands contribute to various barangays, as depicted in Figure 3.

Figure 3: Marine Protected Areas in the municipal waters of Bolinao and surrounding areas. The map is based on MPA areas illustrated in inferred from Vicente and Cerezo[71], Paz-Alberto and Teñoso[72] and MPA Philippines Blogspot[73]



Case Study: Blue Finance, Howden and AXA Climate, designed insurance coverage for two MPAs in Belize and the Philippines.

In Belize, the insurance product covers the Marine Reserve of the Turneffe Atoll, which encompasses 132,000 hectares of coral reefs. In the Philippines, it covers a network of reserves north of Oriental Mindoro that cover 5,200 hectares of coral reef, upon which 12,000 fishers depend. The first year's premium will be financed by Howden. The insurance cover was designed by AXA Climate to pay-out within a few days of a cyclone coming within a 50km radius of the MPAs. The model was based on meteorological information provided by government agencies. Once compensation is triggered, the social enterprise Blue Finance will engage in activities to support weakened marine ecosystems through funding activities such as cleaning up debris and repairing damaged corals. Blue Finance has allocated funding towards repairing MPA equipment such as guard posts and reimbursing operating losses, covering ecotourism and artisanal aquaculture.

5.1.2 Insurance for ocean warming events/coral bleaching of coral

Average water temperature changes of 1-2 degrees Celsius over several weeks can harm coral reefs. To help coral recover from these impacts, an environmental shift and reduction of reef stressors are necessary. This could be achieved through halting overexploitation or fishing in areas where an extreme weather event has recently caused damage. Insurance payouts for such coverage could be utilised in two ways:

1. **Supporting Reef Recovery Initiatives:** The payout could contribute towards initiatives aiding reef recovery, such as the Coral Reef Restoration Program. In the Philippines, the Department of Science and Technology (DOST) and the Philippines Council for Agriculture, Aquatic and Natural Resources Research and Development of the DOST responded to coral degradation by implementing coral transplant technology. The programme involves collecting dislodged live coral fragments, known as "corals of opportunity" (COPs) and attaching them to coral nursery units (CNUs) for rapid recovery and regeneration. This approach aims to enhance survival rates during transplantations in degraded coral reef sites.[74]
2. **Providing Compensation for Local Communities:** The payout could compensate the local population, mitigating the loss of fishing days and discouraging fishing at the coral reef until recovery occurs. This compensation could be used to alleviate the impact on communities by providing water, food, and alternative sources of protein.

Case Study: AXA Climate designs coral bleaching cover

In 2022, AXA Climate developed an insurance product specifically tailored to cover coral propagation to mitigate damages caused by bleaching events. Valuing coral damage is challenging when designing such insurance, but in this case, the insurable value was evident. The hotel would cover the expenses for replanting young corals as part of the reef conservation project. Premiums for coral bleaching cover tend to be higher due to modelling uncertainties related to the complexity of bleaching events, where different areas may be affected differently, and the lack of available parameters makes monitoring such events challenging.[75] Ultimately, the hotel chose not to buy AXA's policy. The reasons for this are not clear but while this insurance product wasn't implemented, it provides a case study highlighting the complexities and challenges in designing emerging insurance products. This type of insurance product could be replicated and implemented in the Philippines in order to halt and reverse damage caused to coral reefs.

5.1.3 Coral Reef Insurance for storm events

Insurance can help to build the resilience of natural capital and coastal communities to the impacts of typhoons by ensuring that resources are made available for reef restoration and community support.

Case Study: Mesoamerican Reef Fund, WTW and AXA Climate place parametric insurance cover for hurricane risk to coral reef

The Mesoamerican Reef provides USD 4.5 billion in economic benefits to coastal communities in Mexico, Belize, Guatemala, and Honduras. It supports the fishing and tourism industries while offering vital protection against coastal hazards.[76]

An innovative insurance policy serves to protect the reef from hurricanes exacerbated by climate change, which are the leading driver of live coral loss in the area. This policy funds trained community groups for assessing and responding to coral damage after a storm, facilitating prompt restoration efforts. The challenge lies in ensuring timely payouts to obtain a payout rapidly addressed by employing a parametric or index-based mechanism linked to predefined event characteristics. Payouts are made based on predefined event characteristics that act as a proxy for impact. In the case of the MAR policy, an index capturing response costs as a function of modelled cyclone impact across a predefined geography is used to determine the level of payout that has been triggered.

As a result of this predefined structure, when Hurricane Lisa struck the Mesoamerican reef in November 2022, the policy swiftly paid out USD 75,000 through the MAR emergency fund within two weeks of impact.[77] To obtain a payout in a rapid and timely manner would likely be impossible under traditional insurance structures, which rely on lengthy loss assessments. With premium financing support from the Ocean Risk and Resilience Alliance, InsuResilience Solutions Fund and the United Nations Development Programme, the policy has been renewed twice to continue providing protection from the North Atlantic hurricane season.[78]

With its extensive coral reef systems and reliance on fishing and tourism industries, the Philippines shares similarities with the Mesoamerican Reef region in terms of economic dependence on marine resources and vulnerability to climate change-induced hazards. Implementing a similar insurance policy for protecting coral reefs in the Philippines could be a viable strategy to safeguard its marine ecosystems and support coastal communities.

5.1.4 Mangrove insurance covering storm and typhoon events

After a typhoon, mangroves can naturally recover within three to five years. However, full recovery may take up to 20 years. The exact restoration activities will depend on the type and magnitude of the damage caused, as well as the pre-storm state of the forest.[79] An insurance payout can play a crucial role in financing post-event mangrove restoration and repair activities, encompassing hydrologic and topographic rehabilitation, as well as reforestation. The cost of these activities varies based on factors such as material, labour, site accessibility, and distance.

The Philippine government recognises the critical role of mangroves in disaster-prone coastlines, allocating PHP 1 billion (~USD 17.8 million) for the Mangrove and Beach Forest Development Project.[80] This fund provides a cash--for--work cleanup and planting initiatives for typhoon-affected communities. In Bolinao, Hands on Manila, in collaboration with Refinitiv, implemented a Community-Based Forest Management (CBFM) programme, guiding fisherfolks to plant mangroves in their designated area.[81] Members receive payment for each mangrove seedling that is collected, planted, and survives a year; fostering awareness of mangroves' importance.[82]

While current mangrove projects in Bolinao are government-funded and focus on post-typhoon support, insurance could be utilised to cover the costs of restoration, repair and protection. Estimates suggest restoration costs range from USD 3,000 to USD 45,000 per hectare of mangroves.[83] Funding these costs may require a combination of financial mechanisms, such as a self-insuring emergency fund, insurance risk transfer mechanisms, resilience credits, or catastrophe bonds.[84]

Case Study: The Nature Conservancy, University of California and AXA, Reducing Caribbean Risk: Opportunities for Cost-Effective Mangrove Restoration and Insurance

In 2020, AXA collaborated with The Nature Conservancy to release a report featuring a spatially explicit benefit-cost analysis across the Caribbean, pinpointing areas where mangrove restoration may be cost-effective for conservation and restoration.[85] The study found 20 states, territories, and countries in the region that would yield greater overall benefits with investment. In other terms, more than 165 coastal units where the benefit of mangrove restoration, particularly in coastal protection, would exceed the cost of mangrove restoration activities.[86] The final report suggested nine specific locations—three in Mexico, four in Florida, and two in The Bahamas—as potential sites for mangrove insurance pilot projects. These locations were identified based on the presence of large areas of mangroves, high protective value of mangroves, and strong interest from key stakeholders. Further insights suggested that a combined parametric-indemnity insurance product could be created for mangroves, where the parametric proportion of the payout could be received immediately post-storm, with the remainder to be paid out later based on the post-disaster assessed damage.

5.1.5 Seagrass insurance against storms

Seagrass plays a pivotal role in combatting the climate crisis by absorbing significant oceanic carbon each year. It provides critical habitats for endangered species, acting as a nursery and breeding grounds for various fish, and support for smaller marine creatures. However, up to 92% of seagrass habitats have disappeared in the last century due to various factors such as dredging and pollution, representing a real threat to the health of coastal ecosystems.[87]

Case Study: Saving Britain's Seabeds, a Zurich's Initiative for Seagrass Recovery

Zurich Insurance Group has recently embarked on a ground-breaking partnership with the Marine Conservation Society (MCS) to address the critical decline of seagrass habitats around the coasts of Britain through a dedicated seagrass recovery project.

Zurich's customers are now actively contributing to England's largest seagrass recovery operation, with the commitment that for every customer claiming escape of water or flood damage over the next year, Zurich pledges to donate to the Marine Conservation Society's recovery projects, specifically focusing on recovering one sq. meter of seagrass per claim.

Based on past claims data, Zurich anticipates sustaining the recovery of over 10,000 sq. meters of seagrass in the next 12 months, equivalent to 51 tennis courts. Zurich's funding will contribute to restoring seabeds around key locations, including Falmouth, Plymouth, and the Solent. These areas are crucial for carbon sequestration, with the current and future seagrass estimated to absorb around 1,127 tonnes of carbon annually.[88]

Bolinao's seagrass beds covers approximately 3,308 hectares and hosts diverse species. These are also vulnerable to similar pressures such as dredging and pollution, leading to their degradation. Zurich's initiative highlights the potential for innovative partnerships between insurance companies and conservation organisations to address seagrass decline. By engaging in similar collaborations or implementing tailored conservation initiatives, the Philippines can protect its seagrass ecosystems, contribute to climate change mitigation efforts, and provide support to its coastal communities.

5.2 Broadening the design and implementation of insurance products

Insurance can continue to be a strong option for supporting the disaster response. However, there remains an opportunity to broaden the design and implementation of insurance products, especially when aiming to create well-rounded products that consider the cultural contexts and ensure long-term sustainability. This section outlines key milestones in enhancing the effectiveness of insurance products.

5.2.1 Incentivising resilience building through insurance premium reduction

In disaster risk management, risk transfer via insurance and risk reduction via hazard mitigation have traditionally been treated as distinct mechanisms. Despite the proven cost-effectiveness of pre-disaster hazard mitigation, with examples such as the United States, where future disaster cost savings could surpass current mitigation spending 6:1, securing funding for these initiatives remains challenging. This challenge is particularly pronounced in the face of escalating losses from natural catastrophes, contributing to a widening global protection gap, especially for tropical coastal nations. However, an innovative resilience solution that integrates both risk transfer and risk reduction, rather than relying solely on pre-hazard mitigation, offers the potential to align environmental and risk management goals. This integrated model creates opportunities for public and private investment in nature-based projects. By incorporating resilience services into insurance pricing, this approach can yield substantial premium savings, providing a powerful incentive for the conscientious stewardship of Marine Conservation Entities (MCEs) by governments, businesses, and society at large.[89] Within the framework of the combined risk reduction and risk transfer mechanism applied to a reef restoration project, the reduction in premiums acts as a resilience service, incentivising the adoption of nature-based risk reduction measures. In this mechanism, a portion of the risk is shifted from the risk owner to the insurer through conventional

insurance. Simultaneously, a hazard mitigation project, like reef restoration, is implemented to lower the baseline risk of flood losses for the risk owner.

The risk-mitigating impact of the hazard mitigation project is monetised through reduced premiums over the insurance treaty term. These reduced premiums act as a financial incentive for the risk owner to invest, engage in risk reduction measures, and contribute to offsetting the initial investment in the hazard mitigation project.

The hazard mitigation project, such as reef restoration, reduces the baseline risk, leading to a decrease in the Average Annual Loss (AAL) and, consequently, the premium. The difference in insurance costs before and after the project implementation represents the premium savings, making risk reduction measures economically attractive and contributing to covering the initial hazard mitigation investment.[90]

This use case on ecosystem restoration exemplifies how upfront investment in nature-based risk reduction can be offset through savings in insurance premiums, proving economic feasibility with benefits exceeding costs over the project's lifespan. By aligning risk reduction efforts with insurance mechanisms, the concept provides a viable pathway for financing and promoting nature-based projects in regions with limited capacity and funding but pressing needs for effective risk management.

5.2.2 Promoting conservation and restoration with carbon credits

Mangroves and seagrass beds serve as crucial carbon sinks, offering interesting opportunities for long-term financing options, including insurance, to support ecosystem protection projects.

Mangroves are incredibly carbon-dense ecosystems, storing more carbon per unit area than temperate and tropical forests.[91] Most of this carbon is stored in the dead, below-ground roots and soil, making mangroves capable of storing around 1,500 tonnes of CO2 equivalent per hectare. Similarly, by anchoring sediment to the ocean floor with their roots and in their above-ground biomass, seagrasses can sequester around 600 tonnes of CO2 equivalent per hectare.[92] In Bolinao's municipal waters, with 145,500 hectares of mangroves and 3,308 hectares of seagrasses[93], conserving and restoring these ecosystems presents an opportunity to maintain and grow important carbon sinks. The carbon sequestered in these ecosystems is collectively referred to as 'blue carbon'. Similar to how 'green carbon' in terrestrial ecosystems is traded widely on compliance and voluntary carbon markets, blue carbon from marine ecosystems has increasingly become the focus of carbon offset credit schemes. Carbon is securitised and sold to entities looking to reduce their net carbon emissions by contributing to verified carbon projects, either removing or preventing additional carbon release into the atmosphere.

The use of carbon credits as an additional source of financing provides another mechanism within this use case to attract capital to potential projects. Funding marine ecosystem protection, partially supported through the issuance of carbon credits, not only enhances the financial security of fishers by providing a potential secondary income source and improving the health of fisheries but also improves resilience to coastal hazards. This enhanced resilience, stemming from the established coastal protection benefits of the ecosystems, could lead to a reduction in the cost of protection through an insurance mechanism.

One example of a blue carbon initiative is the Cispatá Bay project in Colombia, which protects 11,000 hectares of mangroves by issuing carbon credits that finance 70% of the project costs. The project brings the community many additional biodiversity, social, and cultural benefits. Its success has led to its expansion.[94] However, the blue carbon industry is only in its infancy, and although there have been

developments in internationally recognised methodologies for measuring and monitoring such projects[95], there can be technical difficulties with the estimation of carbon sequestration in mangroves and seagrasses. As of 2022, there were eight validated mangrove blue carbon projects and one validated seagrass blue carbon project.[96] This is only a fraction of the number of green carbon projects. Some estimates suggest that Philippine waters hold around 700 billion tonnes of sequestered carbon.[97] As a signatory of the World Economic Forum's Blue Carbon Action Partnership, the Philippine government has signalled that it intends to contribute to the blue economy by providing NbS to the rest of the world. Any developments in this field should ensure the involvement of local peoples and clearly define the rights of indigenous communities to the ownership of and access to these natural assets. Blue carbon should be used as a sustainable financing tool to benefit local communities rather than serve only as a tool for profit that could further marginalise local communities.

5.2.3 Gender considerations

Disaster Risk finance (DRF), like insurance, frequently fails to cater to and address the specific needs of women and vulnerable groups. However, there is widespread acknowledgement that adapting DRF instruments to target marginalised segments of society could significantly enhance resilience against the impacts of extreme events. To ensure sensitivity to the needs of these populations, several actions should be undertaken when implementing an insurance product.[98]

1. **Building trust within the target population** is essential for the successful development and implementation of effective and targeted DRF instruments. Strategies for building trust may include training staff, the recruitment of experts in gender-related matters or engaging with intermediary groups. Collaborating with advocacy organisations that represent diverse, vulnerable groups, including but not limited to women, LGBTQI, persons with disabilities, the youth and elderly and indigenous people, can be particularly valuable. These organisations bring valuable insights into the unique needs, barriers, and primary risks faced by these populations. As influential advocates, these groups are well-positioned to influence the DRF agenda, encouraging the development of inclusive financial products. Women-led groups are instrumental in educating the government and other stakeholders about the specific needs and priorities of the target populations.[99]

2. **Incorporating participatory and feedback loops** is crucial for ensuring that DRF effectively addresses the needs of vulnerable populations. Continuous dialogue and input from these groups plays a pivotal role in shaping financial provisions, mechanisms, and processes related to disaster risk management so as to meet their requirements. The inclusivity of feedback mechanisms is paramount, especially for women and vulnerable groups, and it necessitates multiple avenues for providing input. For instance, a feedback system reliant on individuals phoning helplines or completing forms may need to be more inclusive for those who cannot access a phone, have low literacy levels, or need more comfort or confidence in using such methods. Similarly, community-based groups and participatory feedback mechanisms might unintentionally exclude individuals facing logistical barriers or influenced by social norms that hinder their participation.[100]

3. **Tailoring payment triggers** to address the needs of women and vulnerable populations. A one-size-fits-all trigger system may leave the most vulnerable at heightened risk. Payment triggers should be designed to consider specific vulnerabilities to address gendered differences in risk and timeframes for action. For example, the insurance instrument could consider the cumulative

impacts of successive events, such as successive typhoon events, which can trap communities in cycles of vulnerability. Analysing past disasters, recovery capacity, and time required for recovery can inform trigger values. An alternative approach is to include a minimum payment for qualifying weather events, ensuring smaller disruptions receive attention. This flexible approach accommodates multiple small events triggering the main payment. Implementing these adjustments ensures DRF instruments are responsive and inclusive.

4. Implementing effective delivery mechanisms and securing funds for the intended beneficiaries is just the beginning; ensuring prompt and efficient fund delivery is equally crucial. To achieve this, the delivery mechanism should leverage existing programmes where funds are regularly transferred or, a system should be established prior to a disaster. These mechanisms must be designed to avoid delays and be cautious of potential politicisation and corruption that may arise in the aftermath of disasters. Clearly defined and pre-agreed processes for approving and releasing funds, spanning various departments down to the local level, are essential to prevent administrative delays. For instance, in the Philippines, despite contingency financing mechanisms for disaster response, delays occurred in releasing emergency funding after Typhoon Haiyan.[101] The chosen delivery system, whether manual or electronic, should be established before a disaster. For example, in Kenya, the Hunger Safety Net Programme (HSNP) proactively identified households, pre-enrolled them, and allocated bank cards and accounts in advance. This established a responsive payment system and also significantly increased financial inclusion to over 90% of the target population.[102]

5.2.4 Establishing insurable interest

NbS such as coral reefs, mangroves, and seagrass provide public goods, ensuring that everyone can enjoy their benefits without exclusions and that the enjoyment of these goods by one person does not diminish their availability for others. For public goods, private companies may lack the financial motivation to protect them as they cannot capture economic benefits. This means there is a lack of incentive to pay the insurance premium. Even if businesses or groups would suffer from financial harm to the ecosystems, they may not want to pay for the insurance cost alone. To address this, there have been examples of coordinating mechanisms and institutions that help to overcome this problem, such as involving the government. However, not all ecosystems can be insured. This approach works best for ecosystems that can be restored, and the restoration is expensive, making an insurance payout necessary. The insurance should also provide value beyond what the affected entity could achieve.[103] For example, the insurance policy might offer additional financial resources beyond what the entity could afford alone to fund restoration efforts. It could also provide expertise, coordination, access to resources. The aim is to ensure that the insurance policy incentivises participation and investment in ecosystem protection and restoration by offering benefits that make it worthwhile for entities to contribute financially, even if they cannot capture all the economic benefits directly.

5.2.5 Financial sustainability

Protecting public marine environments through insurance-based risk transfer can be an extremely impactful solution for restoring ocean ecosystems. However, long-term premium funding strategies are crucial to support the sustainability of such programmes. Financing the ongoing premiums poses a key challenge since only some entities have a large enough insurable interest to take on the full cost, especially in high-risk regions.

Many solutions have been tested to overcome the financing obstacle. For instance, insurance can efficiently pool capital for conservation efforts – such as through a multi-site Marine Protected Area trust fund. The fund's prearranged financing through insurance policies ensures that disaster relief money can be quickly targeted and deployed to heavily impacted zones.

This concept is demonstrated through the successful Coastal Zone Management Trust Fund model in Quintana Roo, Mexico, which provides a valuable real-world precedent. This trust uses a sustainable premium funding approach to secure consistent financing for long-term ecosystem conservation. This avoids the risk of halting critical conservation efforts due to unpredictable donations or insufficient government funding alone. The fund collects money through various fees and taxes – such as a portion of state lodging taxes and fines for environmental violations. A key aspect is its diverse, dedicated revenue streams beyond government funding or donations, providing financial sustainability. The fund administration involves collaboration between MPA managers, government, academic, and civil society groups for governance, ensuring a participatory approach aimed at including local considerations into the governance structure.

The same structure could be replicated in the Philippines, leveraging local knowledge and a network of marine protected areas and organisations involved in marine conservation. For example, Howden has established relations with Coast 4C, launched in 2021, a social enterprise based in Bohol, Philippines, that drives marine protection by implementing inclusive, community-driven value chains for regenerative seaweed and end-of-life fishing nets. The appropriate integration of regenerative seaweed farming into MPAs forms a key component of the value chain model. It allows for larger and more effective community-managed MPAs – branded “ideal Marine Protected Areas” (iMPAs).

Key Takeaways

Insurance can and should be used as a force for good. Insurance is by no means the only solution to ecosystem conservation in the face of climate change, however, insurance is effective in this context, where restoration efforts can help the ecosystem to recover. Insurance is an important tool in risk management. It protects against an ecosystem loss that the government or NGOs could not otherwise fund on their own. In this section, we have provided multiple examples of different nature-based insurance products that could be applied to marine ecosystems. It is essential to highlight that the success of these insurance solutions depends on their tailoring to the unique characteristics of the local environment and the needs of the local community. Recognising the dynamic nature of the ecosystem and community needs, the insurance product should undergo subsequent iterations to fine-tune the evolving requirements of the local communities, thereby maximising their effectiveness in promoting resilience and sustainability.

Conclusion

The Philippines is one of the most vulnerable countries to the impacts of climate change, with typhoons presenting a significant danger to life and livelihoods. The country also has an extensive marine ecosystem with rich biodiversity that provides coastal communities with many co-benefits, including fisheries resources, support of tourism industries, and cultural and coastal protection benefits. These ecosystems are threatened by coastal hazards and anthropogenic impacts, which undermine the resilience of coastal communities to climate change. In providing financing for marine ecosystem protection and reconstruction following damage from climate hazards, insurance can contribute to the resilience of both ecosystems and the populations that benefit from them.

The integration of insurance mechanisms with Nature-based Solutions (NbS) presents a promising avenue for bolstering resilience to climate-related risks and safeguarding coastal ecosystems. By tailoring insurance products to address the specific needs of marine conservation and disaster resilience, initiatives like Marine Protected Areas (MPAs) exemplify effective measures aimed at conserving crucial habitats and enhancing resilience against major threats like overexploitation and habitat destruction. Case studies, such as the collaboration between Blue Finance, Howden, and AXA Climate in Belize and the Philippines, demonstrate the practical application of insurance in supporting ecosystem recovery and community well-being post-disaster events. Furthermore, specific insurance products designed to address warming events, coral bleaching and storm events demonstrate targeted approaches to mitigate risks and support ecosystem recovery. Similarly, the implementation of mangrove and seagrass insurance, as showcased by Zurich's initiative, underscores the importance of private-public collaboration in addressing coastal vulnerabilities and promoting carbon sequestration.

The broader design and implementation of insurance products also comes into focus, with emphasis placed on incentivising resilience building through premium reduction and promoting conservation and restoration with carbon credits. Furthermore, in order to maximise the effectiveness of insurance products for ecosystem conservation, aspects including incorporating gender considerations (building trust, creating dialogues and feedback loops, tailor trigger payments and effective fund delivery mechanisms for the population), establishing insurable interest, and securing financial sustainability, should be taken into account These measures aim to enhance the inclusivity and effectiveness of insurance products, ensuring they cater to the unique needs of coastal communities and ecosystems.

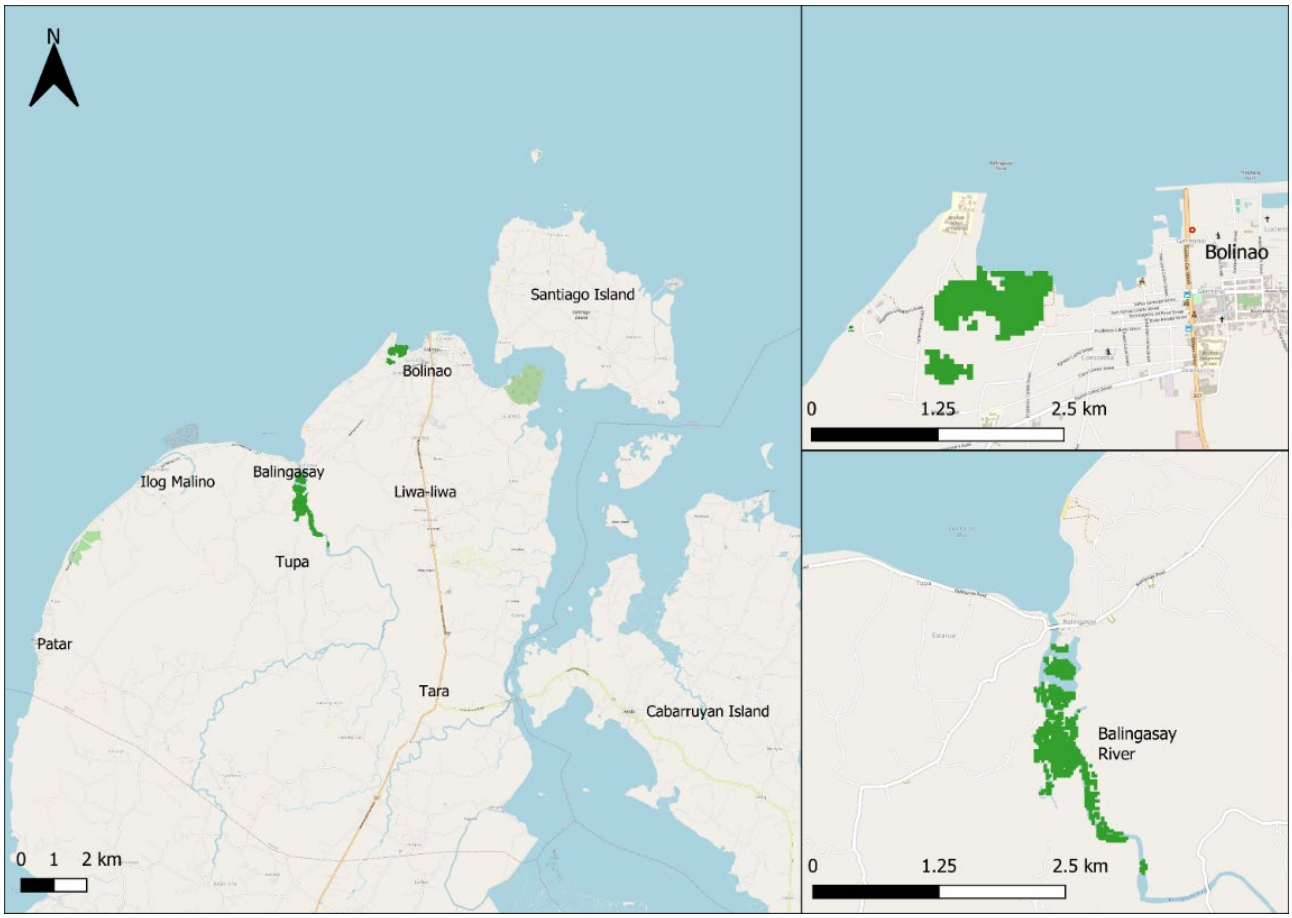
It is in the interest of the insurance industry to support the implementation of NbS to ensure the long-term financial viability of insurance in the face of increasing exposures and climate change. It is of great importance to consider the local context, the possibility of unintended consequences, and presence of NGOs and government actors in the space to ensure that insurance offers additional benefit. While insurance is not a panacea for ecosystem preservation in the face of climate change, it can be a powerful tool to fill a financing need not addressed by other mechanisms.

Appendices

Appendix 1: Mangroves

Mangrove forests thrive in tropical and subtropical coastal regions, particularly in tidal river areas with shallow waters. These unique ecosystems are characterised by their intricate network of dense and tangled prop roots, which allow trees to endure fluctuating tides while slowing the movement of water around them. This, in turn, fosters the accumulation of sediment at the base of the trees, serving as both a vital carbon sink and a natural barrier against coastal erosion. Bolinao, with its municipal waters spanning 145.50 hectares[104] (Figure 4), is home to a diverse array of mangrove species, with one study identifying at least 24 distinct types. Among these, Rhizophora mucronata emerges as the predominant and densest species across a significant portion of the area, underscoring the ecological richness and significance of Bolinao's mangrove ecosystems.[105]

Figure 4: Areas with mangrove cove, sourced from Global Mangrove Watch[106]



Appendix 2: Seagrass

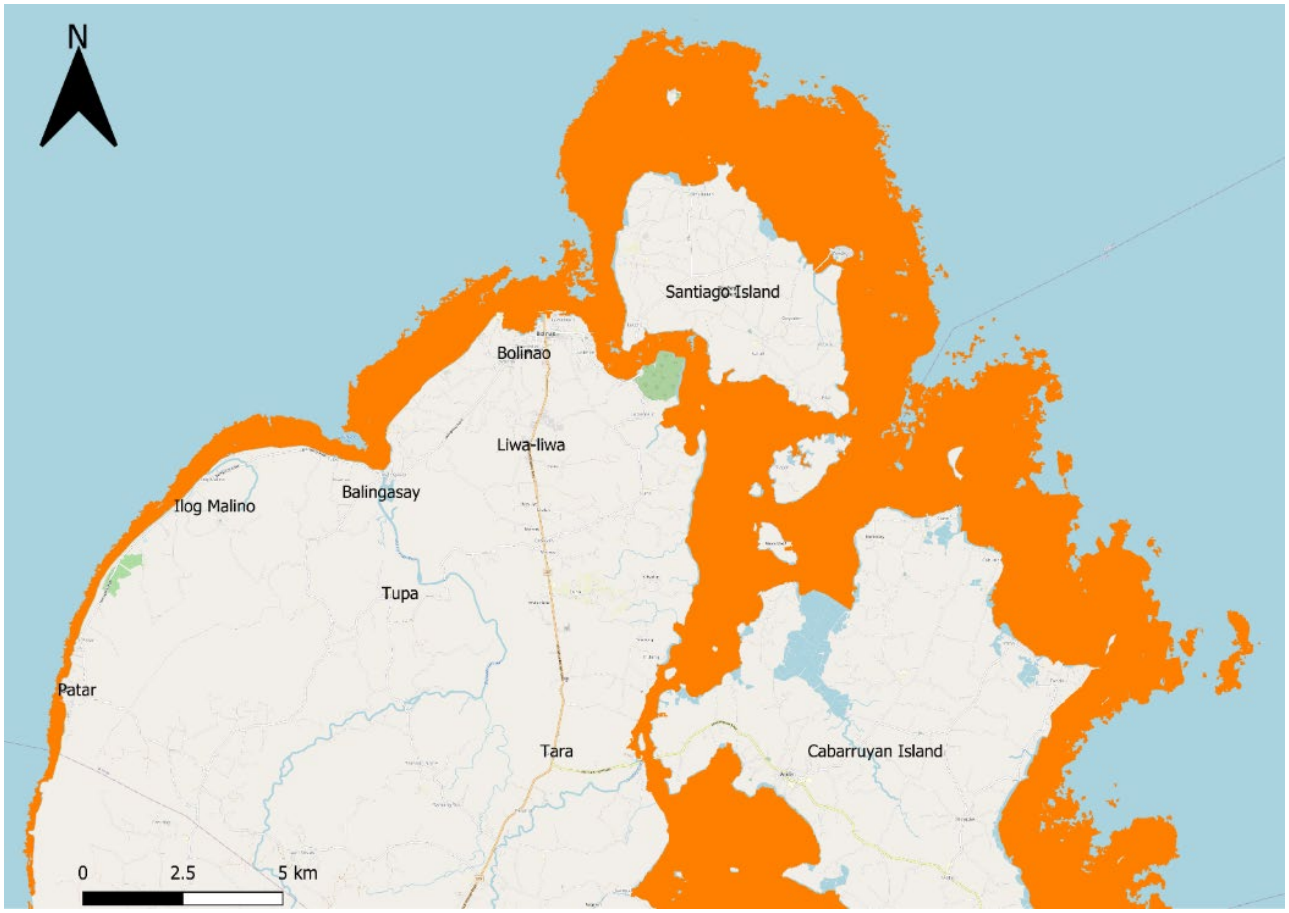
Seagrasses are small flowering plants rooted in saline and brackish waters that often create large, dense underwater meadows, giving the appearance of terrestrial grasses. Bolinao's municipal waters host extensive seagrass beds spanning approximately 3,308 hectares (Figure 5). Comprising seven distinct species, these seagrass meadows are notably characterised by the prevalence of Enhalus acoroides and Thalassia hemprichii emerging as the most prevalent and widespread among the vibrant marine flora in the area.[107]

Figure 5: Areas in Bolinao municipal waters and other surrounding waters with seagrass cover[108]

Appendix 3: Coral Reef

Corals are formed of many small organisms called polyps, which secrete calcium carbonate to form an exoskeleton, giving corals their unique and distinctive appearance. These structures are inhabited by algae, which contribute to the vibrant colours of corals and engage in photosynthesis to provide essential energy to the coral organisms. Thriving in warm, shallow waters, much like seagrasses, corals tend to be found in reef flats where they are protected from the full force of waves. Corals cover an area of about 5,493.7 hectares of the municipal waters of Bolinao (Figure 6)[109], consisting primarily of branching and massive reef-building coral species, including Acroporids, Pocilloporids, and Poritids, and further enhance the ecological tapestry of Bolinao's marine environment.[110]

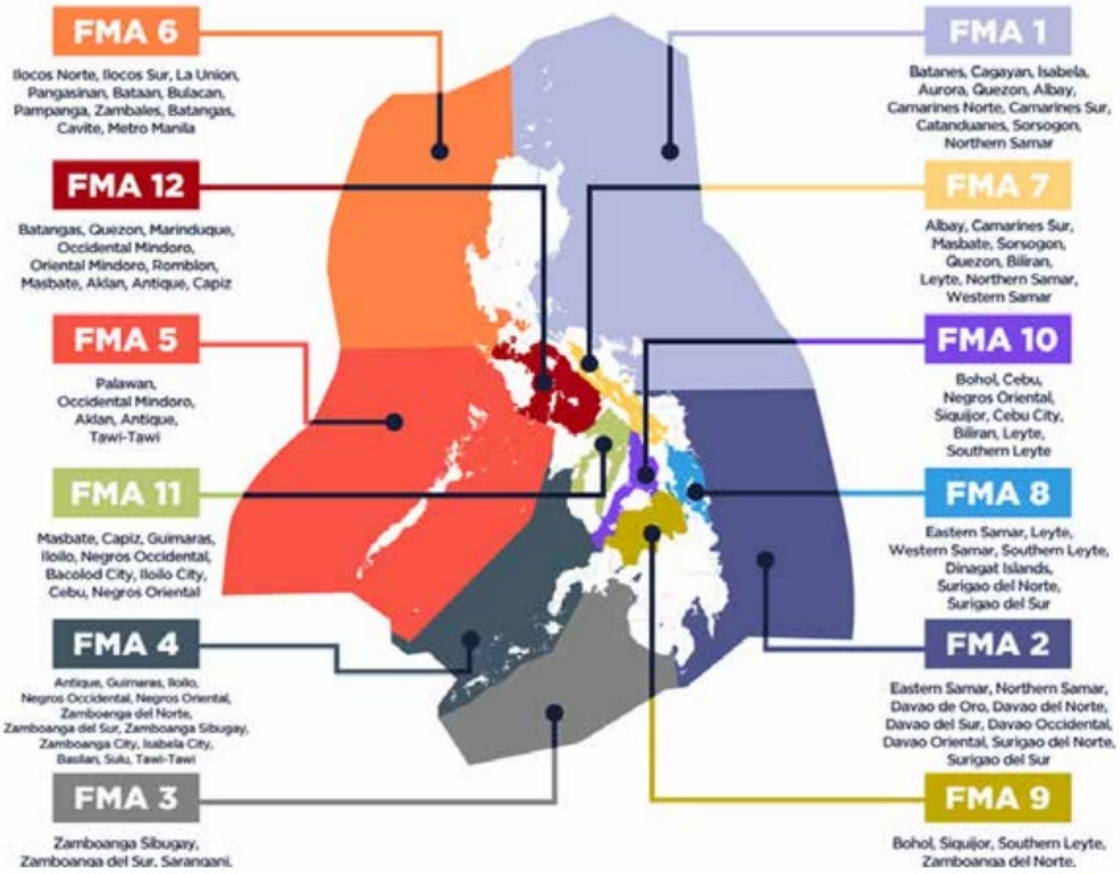
Figure 6: Areas in Bolinao municipal waters and other surrounding waters with coral reef cover[111]



Appendix 4: Fisheries

Approximately 25% of the ocean's fish rely on the health of coral reefs for their survival.[112] Coral reefs, spanning 27,000 sq. km in the Philippines provide vital shelter, feeding grounds, and reproductive areas for over 4,000 species of fish, molluscs, crustaceans, starfish and sponges. This, coupled with seagrasses and mangroves, sustains the marine ecosystem. It is crucial for the livelihoods of at least 2 million Filipinos, significantly 1 million small-scale fishers directly dependent on reef catches. This industry also supports coastal economies and the livelihoods of the 40 million people who live within 30km of reefs.[113] Bolinao, located in the Gulf of Lingayen's Fisheries Management Area (FMA) 6 (Figure 7), hosts the Bolinao reef flat, a key component of the largest fringing reef in the northwestern Philippines, covering 200 sq. km.[114] Bolinao fisheries are also important nationally, exporting fish across the country to Metro Manila and abroad.[115] Bolinao's marine resources are diverse, catering to traditional, small-scale fishers, commercial fisheries and more modern aquaculture and mariculture activities. These activities coexist with related industries such as shell crafts and dried fish making, collectively providing income and sustenance for 40% of coastal households.[116] The commercial fishing sector in Bolinao is heavily dependent on a healthy coastal ecosystem, as it uses 34.85% of municipal waters. The region is one of the country's most productive fisheries.[117] Approximately 95% of all commercially important fish rely on a healthy coastal ecosystem. It has been estimated that a single hectare of seagrass can enhance fisheries by USD 24,000, emphasising the economic value of maintaining a robust coastal environment.[118] Moreover, well-managed coral reefs have been estimated to yield 5 to 10 tons of fish per square kilometre annually, underlining the critical role these ecosystems play in sustaining local and national fish stocks.[119]

Figure 7: Fisheries Management Areas (FMAs) in the Philippines, Bolinao is located in FMA 6[120]

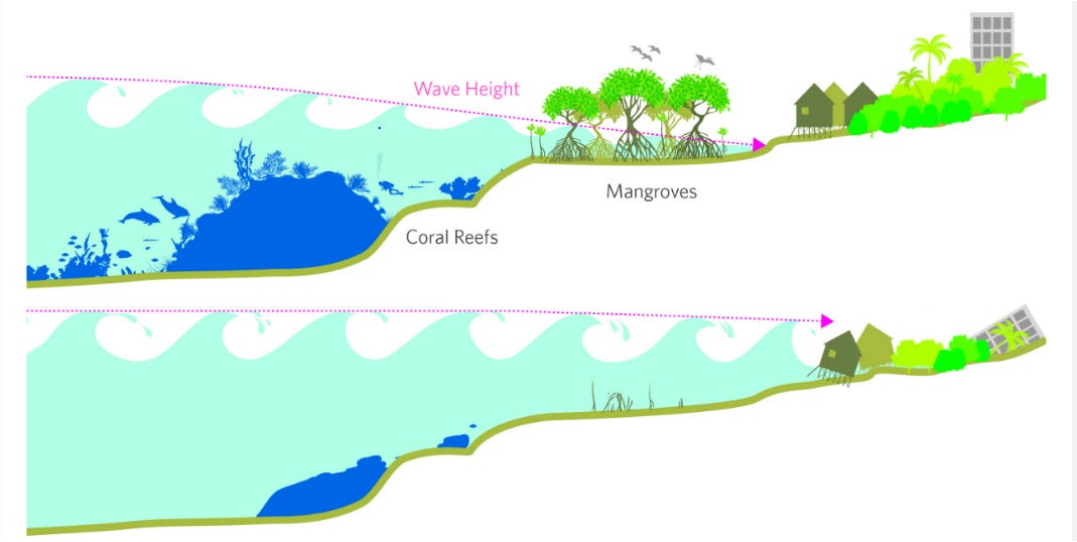


Appendix 5: Coastal protection

Corals, seagrasses and mangroves offer valuable co-benefits in terms of coastal protection. Mangrove roots, with their capacity to trap sediments, enhance soil stability and reduce erosion, while seagrass roots play a vital role in stabilising shallow seabeds by trapping detritus[121] By preventing coastal erosion, these natural assets contribute to the preservation of valuable land and property, ensuring the safety of the local population and their homes (Figure 8).

Furthermore, coral reefs can act as natural breakwaters, dissipating the energy of storm surges, reduce and mitigate the impact on the shoreline. The density of mangroves adds an additional layer of protection by dissipating energy and reducing wave heights[122]. This, coupled with their ability to maintain coastal elevation and prevent erosion by trapping sediment amongst their roots, makes mangroves an important protector against storm surges.[123] Figure 8 illustrates the coastal protection benefits of these natural assets against extreme storm events. It has been found that the Philippines' coastal ecosystems contribute significant protective services to coastal communities, reducing annual property damages from extreme weather by up to 30% and saving approximately USD 1.6 billion in avoided losses.[124]

Figure 8: The role of Coral Reefs and Mangroves in protecting Coastal Environments[125]



Appendix 6: Current impacts of natural hazards on coastal communities and marine ecosystems

The climate of Bolinao is tropical, experiencing a warm, wet, south-westerly typhoon season from July to October and a cooler northeasterly monsoon from November to March. The Philippines is also situated in the Pacific Northwest Basin, one of the world's most active tropical cyclone basins. With an average of 20 tropical cyclones crossing the Philippine Area of Responsibility (PAR) each year, it is amongst the most affected countries globally.[126] Extreme weather events, such as cyclones, hurricanes, typhoons, and changes in sea surface temperature can cause significant stress on Bolinao's marine ecosystem. These challenges intensify with climate change, threatening the resilience of coral reefs and emphasising the need for robust conservation efforts.

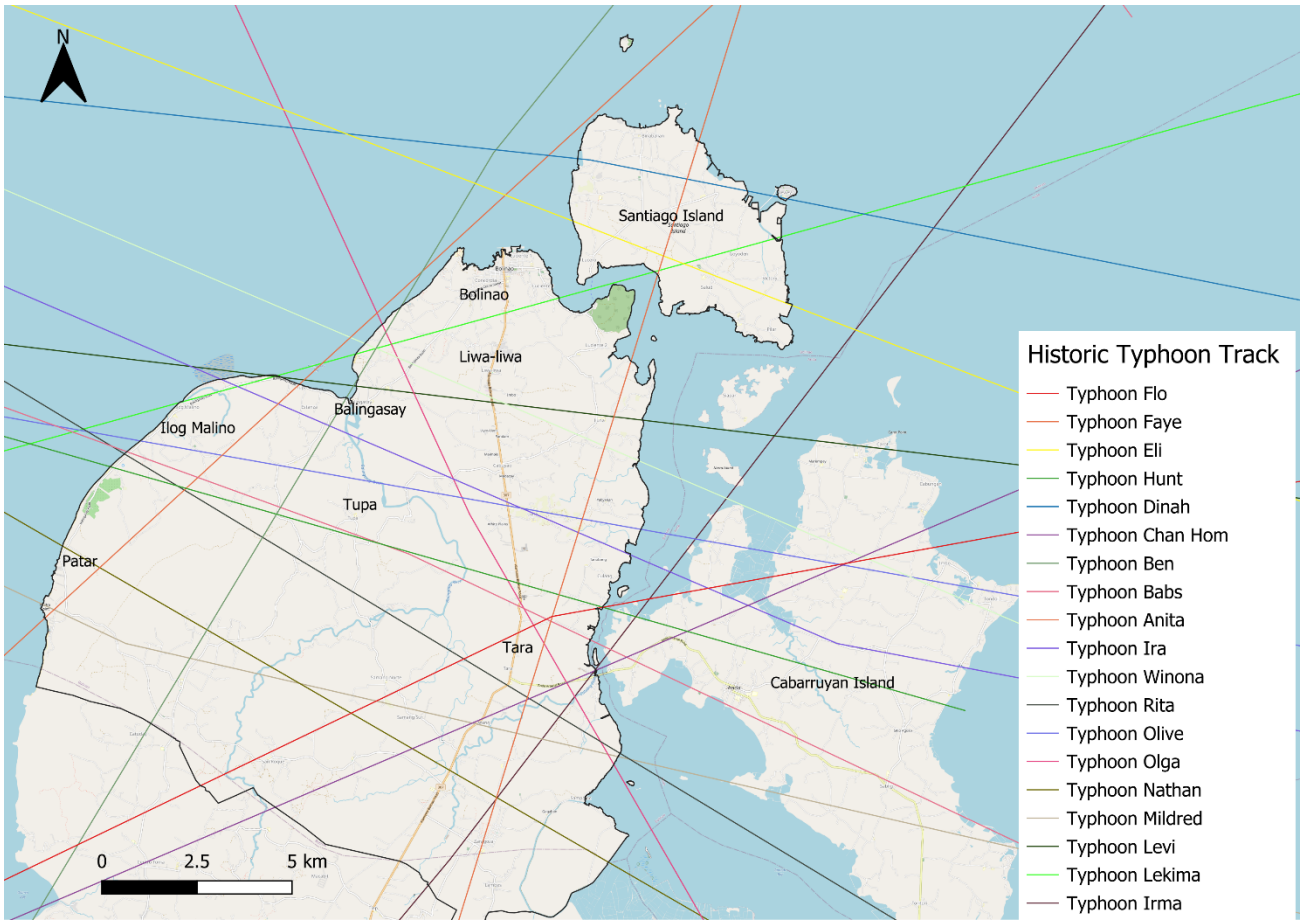
Adverse weather poses significant financial risks for municipal fishers, whose incomes often fall below the poverty threshold, by preventing fishing activities or reducing catch volumes.[127] Despite diversification into tourism and public services, bad weather can impact supplementary income sources. In recent years, several deadly storms (Figure 9), including Tropical Storm "Inday" in 2018[128] and Typhoon "Labuyo" in 2013, highlighted the direct and indirect consequences on the lives and livelihoods of Bolinao fishers.[129] Even aquaculture operators, who tend to earn a higher income than municipal fishers and work in more sheltered channels between Bolinao, Santiago Island and the Island of Anda, face risks in fishing in treacherous conditions, leading to potentially life-threatening situations. [130] Damage can also occur to fish cages and nets, which have a higher upfront cost to build and repair than other fishing equipment. The 2015 Tropical Storm "Lando" inflicted an estimated 3.784 million Philippine Pesos (PHP) damages to fisheries across the affected regions.[131]

Beyond immediate financial repercussions, extreme weather events can bring long-term challenges, causing damage to mangroves, coral reefs, and seagrass beds. Typhoons and heavy rain introduce pollutants, reduce seawater salinity, and disrupt ecosystem structures.[132] The destructive force of typhoons and associated storm surges can destroy marine habitats, damage corals, mangrove forests, and aquatic vegetation by tearing corals and seagrasses from their footings, negatively impacting the comprehensive ecosystem structure and species richness.[133] It can take decades to recover the biodiversity in these Bolinao's ecosystems which have already been negatively impacted.[134]

The economic security of Bolinao's population is intricately linked to the health of its marine ecosystem, necessitating conservation efforts to mitigate the impact of increasingly severe weather events. Addressing the need for support during dangerous weather conditions is crucial to reducing risks to the lives of fishers and sustaining the long-term viability of the fishing industry in the region.

Figure 9: Historic Typhoon tracks from 1980 to May 2019 to directly hit Bolinao

Only names of storms were included (sustained wind speeds of more than 33 knots)[135]



Appendix 7: Climate Change impacts on coastal communities and marine ecosystems

Climate change in the Philippines has induced significant environmental shifts, triggering biophysical anomalies, such as rising water temperatures, decreasing oxygen levels, and increased acidity in the oceans.[136] These changes contribute to sea level rise[137], intensified typhoons[138], and ecosystem degradation[139].

Similar to other parts of the world, the Philippines is experiencing an increase in both mean and maximum daily temperatures, with an average maximum daily temperature increase of 1°C in the 60 years leading up to 2010.[140] This trend is projected to continue with maximum daily temperatures increasing by 3.1°C above pre-2005 levels by 2090 under the RCP8.5 climate change scenario.[141] Extreme daily rainfall has also slightly increased, with wet seasons expected to become wetter and dry seasons drier.[142] These changes may lead to increased freshwater runoff, inhibiting coral growth and elevating the risk of pollution in mangroves.

While there's little evidence that the frequency of cyclones in the Luzon island area has increased due to climate change, the intensity of tropical cyclones during El Niño years has increased.[143] Projections indicate an increase in heavy rainfall associated with tropical cyclones[144], potentially limiting the recovery of marine ecosystems between storms and diminishing the resilience of coastal communities.[145]

The interaction of tropical cyclones with other climate change impacts, such as rising sea levels and an increase in the frequency and intensity of extreme rainfall, is expected to increase risks to life and property from flooding, contributing to a projected 50% increase in response costs to extreme events.[146] Satellite observations from 1993 to 2015 show that the tropical western Pacific region, east of the Philippines, experienced a sea level rise of 5-7 mm/year, about twice the global average.[147] Under the SSP5-8.5 climate change scenario, the global mean sea level is almost certain to continue rising until 2100, with a likely rise of between 0.18 and 0.23m by 2050.[148]

Furthermore, critical ocean conditions such as sea surface temperature, oxygen concentration, and water acidity are at risk of triggering significant upheavals to ocean ecosystems.[149] Ocean acidification occurs when carbon dioxide in the atmosphere dissolves into the ocean, decreasing the pH level and increasing the acidity of the seas. This can lead to the dissolution of the shells and exoskeletons of organisms such as corals, some plankton, and crustaceans.[150] By 2100, there is an anticipated decrease in ocean oxygen concentration of 4.2% and a decrease in ocean pH of 0.25 pH units[151] which could be destructive to Philippine marine ecosystems, causing the destruction of coral reefs and marine habitats, the migration of some species that are not resistant to increased temperatures, and the emergence of new ones.

Appendix 8: Socioeconomic context

The socioeconomic context plays a crucial role in understanding risks and opportunities across various domains. For instance, socioeconomic factors influence how individuals and communities are vulnerable to, perceive and respond to risks and the extent to which they may be willing or able to take out insurance. Lower-income groups may face higher vulnerabilities due to limited resources and access to essential services.

Bolinao is characterised by a young population (age groups 5-9 and 10-14 constitute 11.9% and 11.7% of the population),[152] centred on coastal areas, with high dependency on working age individuals. This makes the population vulnerable to the immediate impact of coastal hazards, and the longer-term economic impacts of these hazards to the fishing industry. Although the population may not be growing as fast as elsewhere, the demographic imbalance could also pose challenges in the short to medium term as young individuals enter the workforce and place more pressure on the fisheries industry.

The socioeconomic context could present difficulties in implementing insurance. The financial insecurity of households in Bolinao could limit the capacity to contribute to insurance premium payments – even if the financial benefits of an insurance policy were defined and understood – it is likely that in times of financial difficulty premium payments would be the first expense to be cut. This could be combatted in the longer term by financing premiums through local or municipal bodies already tasked with disaster risk management and are likely to offer more financial stability (see section 4).

The concentration of populations in coastal zones represents an accumulation of risk, which could drive up premiums paid on an individual level by households for direct protection. As the coastal population increases, there may be increasing cost pressure from policies that are looking to directly protect life or property. When insuring marine ecosystems, however, an increase in the number of coastal beneficiaries

increases the pool of funds available for premium financing without fundamentally changing the accumulation of NAT CAT risks facing the insured ecosystem.

Appendix 9: Capture fishing

The resilience of the municipal fisher sector is increasingly challenged by internal and external pressures, including the rise in coastal population, driven by high population growth averaging 1.7% annually from 2000 to 2020. This demographic pressure has led to the gradual degradation of marine ecosystems and increased vulnerability for small-scale fishers. Despite a licensing system, prevalent overfishing, exacerbated by poverty and dependence on fisheries, has led to fish stock depletion and coastal resource destruction.[153] Diminishing coastal habitat quality and reducing fish catch volumes have caused the output of both commercial and small-scale fishers to dwindle.

Municipal fishing vessels are often fitted with various fishing gear, most commonly being bottom-set gillnets, handlines, multiple hook-and-lines, and spear guns.[154] Although these conventional methods aren't directly damaging, historical illegal practices such as poison and blast fishing have impacted marine ecosystems.[155] These indiscriminate fishing methods have historically been used when conventional fishing fails to produce sufficient yields[156] or because of their cost effectiveness. [157] They not only damage fish stocks but can also lead to the destruction of coral reefs and algae.[158] In response to resource depletion and heightened competition, fishers may increasingly resort to these destructive practices, further exacerbating the degradation of marine ecosystems. It is therefore important to maintain sufficient fish stocks to support the viability of conventional fishing methods, ensure financial security for municipal fishers, and prevent a destructive illegal fishing cycle.

Appendix 10: Aquaculture

Aquaculture in ponds made from converted mangroves proliferated in the 1980s, destroying mangroves in the area before the practice was outlawed.[159] Fish cages, the primary aquaculture form, have proliferated since the 1990s[160], with more than 900 individual cages in the waters around Bolinao and Anda Island in 2014.[161] Aquaculture now contributes 42% of the Philippines' fish catch by value, making it the most important form of fishing nationally.[162]

When correctly managed, aquaculture can offer economic and environmental benefits such as security of yields and avoidance of bycatch. However, overcrowded and poorly managed pens can lead to environmental damage. Waste from fish feed and faeces can decrease sediment quality on the seabed and spread pathogens into the marine ecosystem. An increase in nutrient enrichment in the water can cause algal blooms and reduce the growth and survivorship of seagrasses and corals. Despite municipal licensing and reductions in the number of licensed cages[163], eutrophication of the waters around aquacultures in Bolinao has not only led to mass kills of farmed fish but also to a reduction in biodiversity in the surrounding areas.[164] Nutrient rich plumes of fish farm effluents reaching up to 3km[165] contribute to water quality decline, and have damaged corals and seagrasses in the wider Bolinao area. [166]

Using environmentally damaging fishing practices undermines the ability of insurance solutions focused on protecting marine ecosystems to provide tangible benefits as the protected asset faces significant damages external to the insured risk. In response to this, insurance can play a role in breaking the negative feedback loop perpetuating financial insecurity and destructive fishing. By improving the financial resilience of fishers, insurance can help smooth incomes after natural catastrophes and reduce the reliance on destructive fishing practices. Insuring fishers and aquacultures directly in the absence of

sufficient local governance and assurances could promote harmful practices. As part of a wider capacity building and education programme, insurance could be used as an incentivising mechanism to encourage diversification of income sources into other industries, such as seaweed farming, by targeting coverage in this industry. Environmentally damaging fishing practices undermine marine ecosystem insurance benefits. Insurance may break the cycle of financial insecurity and destructive fishing by improving fishers' financial resilience. However, insuring fishers directly without local governance may promote harmful practices. To counteract this, insurance can incentivise diversification into industries like seaweed farming through targeted coverage.

References

1 Convention on Biological Diversity. (2023). 2030 Targets (with Guidance Notes). Retrieved from: https://www.cbd.int/gbf/targets

2 University of Cambridge Institute for Sustainability Leadership (CISL). (2021). Handbook for nature-related financial risks: key concepts and a framework for identification. Retrieved from: https://www.cisl.cam.ac.uk/system/files/documents/handbook-for-nature-related-financial.pdf

3 United Nations Environment Programme (UNEP). (2022). Decision adopted by the conference of the parties to the convention on Biological diversity. Retrieved from: https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf

4 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Retrieved from: https://zenodo.org/records/6417333

5 United Nations Environment Programme (UNEP). (2023). Nature-Positive Insurance: Evolving Thinking and Practices. Retrieved from: https://www.unepfi.org/wordpress/wp-content/uploads/2023/09/Nature-Positive-Insurance-Briefing-Paper.pdf

6 United Nations Environment Programme (UNEP). (2023). Nature-Positive Insurance: Evolving Thinking and Practices. Retrieved from: https://www.unepfi.org/wordpress/wp-content/uploads/2023/09/Nature-Positive-Insurance-Briefing-Paper.pdf

7 Taskforce on Nature-related Financial Disclosures (TNFD). (2022). The TNFD Nature-related Risk & Opportunity Management and Disclosure Framework. Retrieved from: https://tnfd.global/wp-content/uploads/2023/07/TNFD-Full-Report-Mar-2022-Beta-v0-1-1.pdf?v=1690527771

8 Taskforce on Nature-related Financial Disclosures (TNFD). (2023). Guidance on the identification and assessment of nature-related issues: The LEAP approach. Retrieved from: https://tnfd.global/wp-content/uploads/2023/08/Guidance_on_the_identification_and_assessment_of_nature-related_Issues_The_TNFD_LEAP_approach_V1.1_October2023.pdf?v=1698403116

9 Ana Pachon. (2023). Revolutionizing marine conservation: Blue finance, AXA climate and Howden partner to protect marine ecosystems. Retrieved from: https://climate.axa/marine-protected-areas-blue-finance/

10 Eckstein, D., Künzel, V. and Schäfer, L. (2021). Global Climate Risk Index 2021. 'Who suffers most from extreme weather events? Weather-related loss events in 2019 and 2000-2019' in *Germanwatch Briefing Paper*. Retrieved from: https://www.germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf

11 ADB. (2018). 'Philippine City Disaster Insurance Pool'. Retrieved from: https://www.adb.org/sites/default/files/publication/479966/philippine-city-disaster-insurance-pool-summary.pdf

12 ADB. (2016). The Coral triangle: An Ecosystem under Threat. Retrieved from: https://www.adb.org/multimedia/coral-triangle/#:~:text=The%20World%27s%20Center%20Of%20Marine%20Life&text=Stretching%20across%20six%20countries%20in,world%27s%20total%20coral%20reef%20fish

13 Bunting P., Rosenqvist A., Lucas R., Rebelo L.M., Hilarides, L., et.al. (2018). 'The Global Mangrove Watch - New 2010 Global Baseline of Mangrove Extent' Remote Sensins 10(10). DOI: 10.3390/rs1010669. Retrieved from: https://www.mdpi.com/2072-4292/10/10/1669

14 Menendez, P., Losada, I.J., Beck, M.W., Torres-Ortega, S., Espejo, A., et.al. (2018). 'Valuing the protective services of mangroves at national scale: the Philippines' in *Ecosystem Services.* Retrieved from: *https://conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/CoastalProtectionServicesMangrovesPhilippinesReport-3.pdf*

16 Cruz-Trinidad, A., Geronimo, R.C. and Aliño, P.M. (2008). 'Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines', *Ocean & Coastal Management*, 52(3-4). Retrieved from: https://doi.org/10.1016/j.ocecoaman.2008.12.002

17 Menendez, P., Losada, I.J., Beck, M.W., Torres-Ortega, S., Espejo, A., et.al. (2018). 'Valuing the protective services of mangroves at national scale: the Philippines' in *Ecosystem Services.* Retrieved from: *https://conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/CoastalProtectionServicesMangrovesPhilippinesReport-3.pdf*

18 PAGASA. (2024). Climate Change in the Philippines. Retrieved from: https://www.pagasa.dost.gov.ph/information/climate-change-in-the-philippines#:~:text=Seasonal%20Temperature%20Change,to%202.2%20C%20in%202050

[19] Cruz-Trinidad, A., Geronimo, R.C. and Aliño, P.M. (2008). 'Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines', *Ocean & Coastal Management*, 52(3-4). Retrieved from: https://doi.org/10.1016/j.ocecoaman.2008.12.002

[20] Paz-Alberto, A.M. and Teñoso, A.R.D. (2011). 'Assessment of Mangrove Management Areas in Four Coastal Barangays of Bolinao. Pangasinan, Philippines'. *Silliman Journal* 52(2). Retrieved from: https://sillimanjournal.su.edu.ph/index.php/sj/article/view/164

[21] The Nature Conservancy. (ND). Mapping Ocean Wealth: Fisheries. Retrieved from: https://oceanwealth.org/ecosystem-services/fisheries/

[22] The World Bank Group and The Asian Development Bank. (2021). '*Climate Risk Country Profile: Philippines'* Retrieved from: https://climateknowledgeportal.worldbank.org/sites/default/files/2021-08/15852-WB_Philippines%20Country%20Profile-WEB.pdf

[23] Intergovernmental Panel on Climate Change. (2019). Climate Change and Land. Retrieved from: https://www.ipcc.ch/site/assets/uploads/2019/11/SRCCL-Full-Report-Compiled-191128.pdf

[24] PhilAtlas. (2020). Bolinao, Province of Pangasinan. Retrieved from: https://www.philatlas.com/luzon/r01/pangasinan/bolinao.html#sectionEconomy

[25] PhilAtlas. (2020). Bolinao, Province of Pangasinan. Retrieved from: https://www.philatlas.com/luzon/r01/pangasinan/bolinao.html#sectionEconomy

[26] Municipality of Bolinao/Pangasinan, Garcia, L.C., Yleana, J. and Borja, V.M. (2022). 'Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and the Gulf of Thailand, Bolinao Fisheries Refugia Management Plan', Samut Prakan: Southeast Asian Fisheries Development Center, Training Department. Retrieved from: https://repository.seafdec.or.th/bitstream/handle/20.500.12067/1935/PH-REP2022Q4_82_Bolinao%20Management%20Plan-final.pdf?sequence=5&isAllowed=y

[27] Bureau of Fisheries and Aquatic Resources. (2020). Philippine Fisheries Profile. Quezon City: BFAR. Retrieved from: https://www.bfar.da.gov.ph/wp-content/uploads/2022/02/2020-Fisheries-Profile-Final.pdf

[28] Palomares, M.L.D. and Pauly, D. (2014). 'Philippine Marine Fisheries Catches: A Bottom-up Reconstruction, 1950 to 2010', Volume 22 Number 1. Retrieved from: https://www.seaaroundus.org/doc/publications/books-and-reports/2014/Palomares-and-Pauly-Philippines.pdf

[29] Bureau of Fisheries and Aquatic Resources. (2020). Philippine Fisheries Profile. Quezon City: BFAR. Retrieved from: https://www.bfar.da.gov.ph/wp-content/uploads/2022/02/2020-Fisheries-Profile-Final.pdf

[30] Rare. (ND). Fish Forever in the Philippines. Retrieved from: https://rare.org/program/philippines/

[31] Rare. (ND). Fish Forever in the Philippines. Retrieved from: https://rare.org/program/philippines/

[33] Bureau of Fisheries and Aquatic Resources. (2020). Philippine Fisheries Profile. Quezon City: BFAR. Retrieved from: https://www.bfar.da.gov.ph/wp-content/uploads/2022/02/2020-Fisheries-Profile-Final.pdf

[34] Quimpo, T.J.R., Ligson, C.A., Manogan, D.P., Requilme, J.N.C., Albelda, R.L., et.al. (2020). 'Fish farm effluents alter reef bethnic assemblages and reduce coral settlement.' *Marine Pollution Bulletin.* 153. Retrieved from: https://doi.org/10.1016/j.marpolbul.2020.111025

[35] World Economic Forum. (2023). Global Gender Gap Report 2023. Retrieved from: https://www.weforum.org/publications/global-gender-gap-report-2023/in-full/benchmarking-gender-gaps-2023/

[36] Torell, E., Castro, J., Lazarte, A. and Bilecki, D. (2020). Analysis of Gender Roles in Philippine Fishing Communities. *Journal of International Development*. 33(1), pp.233–255. Retrieved from: https://doi.org/10.1002/jid.3520

[37] Kleiber, D., Harris, L.M. and Vincent, A.C.J. (2014). Gender and small-scale fisheries: a case for counting women and beyond. Project Seahorse. Retrieved from: https://projectseahorse.org/resource/gender-and-small-scale-fisheries-a-case-for-counting-women-and-beyond/

[38] Gopal, N., Hapke, H.M., Kusakabe, K., Rajaratnam, S. and Williams, M.J. (2020). Expanding the horizons for women in fisheries and aquaculture. *Gender, Technology and Development*. 24(1), pp.1–9. Retrieved from: https://doi.org/10.1080/09718524.2020.1736353

[39] Dasig, S. (2020). Difficult but fulfilling: women's lived experiences as leaders in fisherfolk organizations in Bolinao, Philippines. Retrieved from: https://www.tandfonline.com/doi/full/10.1080/09718524.2020.1728158

[40] Gopal, N., Hapke, H.M., Kusakabe, K., Rajaratnam, S. and Williams, M.J. (2020). Expanding the horizons for women in fisheries and aquaculture. *Gender, Technology and Development*. 24(1), pp.1–9. Retrieved from: https://doi.org/10.1080/09718524.2020.1736353

[41] PrepareCenter. (2022). Local Disaster Risk Reduction and Management Fund (LDRRMF). Retrieved from: https://preparecenter.org/resource/local-disaster-risk-reduction-and-management-fund-ldrrmf/

[42] Heyplaces. (ND). Bolinao DRRMC. Retrieved from: https://heyplaces.ph/01913151/Bolinao_DRRMC

[43] UN Office for Disaster Risk Reduction (UNDRR). (2019). Disaster Risk Reduction in the Philippines, Status Report 2019. Retrieved from: https://www.unisdr.org/files/68265_682308philippinesdrmstatusreport.pdf

[44] PreventionWeb. (2019). Philippines: DOST-PAGASA launches new storm surge forecast, warning system. Retrieved from: https://www.preventionweb.net/news/view/57637

[45] ReliefWeb (2013). Typhoon Haiyan Strategic Response Plan Factsheet. Retrieved from: https://reliefweb.int/report/philippines/typhoon-haiyan-strategic-response-plan-factsheet

[46] United Nations (UN). (2013). One month on, UN renews pledge to help Philippines recover from deadly typhoon. Retrieved from: https://news.un.org/en/story/2013/12/457912

[47] Global Disaster Preparedness Center. (2013). Local Disaster Risk Reduction and Management Fund (LDRRMF). Retrieved from: https://preparecenter.org/resource/local-disaster-risk-reduction-and-management-fund-ldrrmf/#:~:text=LDRRMF%20%E2%80%93%20The%20Local%20Disaster%20Risk,investment%20in%20disaster%20risk%20reduction

[48] Bolinao Pangasinan. (2022). LDRRMF Utilization 1st Quarter CY 2022. Retrieved from: https://www.bolinaopangasinan.gov.ph/wp-content/uploads/2022/06/LDRRMF-Utilization-1st-QUARTER-CY-2022.pdf

[49] Araullo, K. (2023). 'Philippines Insurance Penetration Remains Below 2%'. *Insurance Business*. Retrieved from: https://www.insurancebusinessmag.com/asia/news/breaking-news/philippines-insurance-penetration-remains-below-2-456378.aspx

[50] Araullo, K. (2023). 'Philippines planning cover for typhoon losses'. *Insurance Business*. Retrieved from: https://www.insurancebusinessmag.com/asia/news/catastrophe/philippines-planning-cover-for-typhoon-losses-441323.aspx

[51] Araullo, K. (2023). 'PH bill encouraging agricultural insurance growth passes final reading'. *Insurance Business*. Retrieved from: https://www.insurancebusinessmag.com/asia/news/breaking-news/ph-bill-encouraging-agricultural-insurance-growth-passes-final-reading-440380.aspx

[52] Chambers and Partners. (2022). Insurance and Reinsurance 2023: Philippines Trends and Developments. Retrieved from: https://practiceguides.chambers.com/practice-guides/insurance-reinsurance-2023/philippines/trends-and-developments

[53] Forum for Agricultural Risk Management in Development. (ND). 'Philippine Crop Insurance Corporation'. Retrieved from: https://www.farm-d.org/organization/philippine-crop-insurance-corporation/

[54] Card Bank. (ND). Card Pioneer Microinsurance. Retrieved from: https://www.cardmri.com/cpmi/

[55] Asian Development Bank. (2023). Asian Development Bank Member Fact Sheet. Retrieved from: https://www.adb.org/sites/default/files/publication/27790/phi-2023.pdf

[56] Asian Development Bank. (2021). ADB Issues first Blue Bond for Ocean Investments. Retrieved from: https://www.adb.org/news/adb-issues-first-blue-bond-ocean-investments

[57] Ocean Risk and Resilience Action Alliance. (ND). Strengthening the Financial Resilience of Small Scale Fishers. Retrieved from: https://oceanriskalliance.org/project/strengthening-the-financial-resilience-of-small-scale-fishers/

[58] Bureau of Fisheries and Aquatic Resources. (ND). About Us. Retrieved from: https://region5.bfar.da.gov.ph/

[59] Bureau of Fisheries and Aquatic Resources. (ND). BFAR ¦ Mission ¦ Vision ¦ Core Values. Retrieved from: https://region5.bfar.da.gov.ph/about-bfar/

[60] Province of Pangasinan. (2021). Mangrove Tree Planting. Retrieved from: https://www.youtube.com/watch?v=VxVd4CkXrUg

[61] The Philippine Star. (2013). Bolinao Mangrove Planting Promotes Ecotourism. Retrieved from: https://www.philstar.com/business/agriculture/2013/05/05/938337/bolinao-mangrove-center-promotes-ecotourism

[62] Rare. (ND). Fish forever in the Philippines. Retrieved from: https://rare.org/program/philippines/

[63] USAID. (ND). USAID Oceans and Fisheries Partnership. Retrieved from: https://2012-2017.usaid.gov/asia-regional/fact-sheets/usaid-oceans-and-fisheries-partnership#:~:text=USAID%20Oceans%20supports%20the%20development,legally%20caught%20and%20properly%20labeled

[64] NGOs for Fisheries Reform. (ND). Retrieved from: http://site.nfr.ph/

[65] South East Asian Fisheries Development Center. Aquaculture Department. (ND). Retrieved from: https://www.seafdec.org.ph/our-organization/

[66] Philippine Council For Agriculture, Aquatic and Natural Resources Research and Development. (2016). Restoring the Country's Coral Reefs through Filipinovation. Retrieved from: https://www.pcaarrd.dost.gov.ph/index.php/quick-information-dispatch-qid-articles/restoring-the-country-s-coral-reefs-through-filipinnovation

[67] Hands on Manila. Mangrove Planting in Bolinao Pangasinan. (ND). Retrieved from: https://handsonmanila.org/2022-04-mangrove-planting-in-bolinao-pangasinan-2-6394/

[68] ACT4SDGs. (ND). People Planet and Property Local Group Undertake Important Tree Planting Initiative. Retrieved from: https://act4sdgs.org/people-planet-and-property-local-group-undertake-important-tree-planning-initiative/

[69] Haribon Foundation. (ND). 'Meet'. Retrieved from: https://haribon.org.ph/meet/#work

[70] Reuchlin-Hugenholtz, E. and McKenzie, E. (2015). Marine protected areas: Smart investments in ocean health. Gland, Switzerland. WWF. Retrieved from: https://ocean.panda.org/media/WWF_Marine_Protected_Areas_LR_SP.pdf

[71] Vicente, J.A. and Cerezo, R.B., (2010). The Socio-Economic Contributions of Marine Protected Areas to the Fisherfolk of Lingayen Gulf, Northwestern Philippines. Retrieved from: https://ijer.ut.ac.ir/article_233.html

[72] Paz-Alberto, A.M. and Teñoso, A.R.D., (2013). Assessment of Marine Protected Areas in Four Coastal Barangays of Bolinao, Pangasinan. *Silliman Journal*, *54*(1). Retrieved from: https://sillimanjournal.su.edu.ph/index.php/sj/article/view/135

[73] Marine Protected Areas – Philippines. (ND). A Showcase of Marine Protected Area Best Management Practices. Retrieved from: https://mpa-philippines.blogspot.com/p/site.html

[74] Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development. (2016). Restoring the country's reefs through Filipinnovation. Retrieved from: https://www.pcaarrd.dost.gov.ph/index.php/quick-information-dispatch-qid-articles/restoring-the-country-s-coral-reefs-through-filipinnovation

[75] Bryce. E. (2023). 'Can innovative Insurance Help Protect Coral Reefs from Climate Change? *China Dialogue Ocean: Blue Frontiers*. Retrieved from: https://chinadialogueocean.net/content/uploads/2023/10/Blue-frontiers-2023_English.pdf

[76] Wharton, J. (2021). The Mesoamerican Reef: A Cornerstone of Sustainable Development. Retrieved from: https://marfund.org/en/wp-content/uploads/2021/10/Brief_-MAR-Insurance-Programme-_QA.pdf

[77] Wong, C. and Conway,S. (2023). WTW and MAR Fund reef insurance programme pays out to finance restoration after Hurricane Lisa. Retrieved from: https://www.wtwco.com/en-gb/insights/2023/01/wtw-and-mar-fund-reef-insurance-programme-pays-out-to-finance-restoration-after-hurricane-lisa

[78] Evans, S. (2022). 'Parametric Mesoamerican Reef cover expands again with refine parametric cover, Artemis. Retrieved from: https://www.artemis.bm/news/parametric-mesoamerican-reef-cover-expands-again-with-refined-parametric-trigger/

[79] Herrera-Silveira, J. A., Teutli-Hernandez, C., Secaira-Fajardo, F., Braun, R., Bowman, J., Geselbracht, L., Musgrove, M., Rogers, M., Schmidt, J., Robles-Toral, P. J., Canul-Cabrera, J. A. and Guerra-Cano, L. (2022). "Hurricane Damages to Mangrove Forests and Post-Storm Restoration Techniques and Costs." The Nature Conservancy, Arlington, VA. Retrieved from: https://www.tncmx.org/content/dam/tnc/nature/en/documents/mexico/Danos_a_manglares_causados_por_huracanes2.pdf

[80] Environmental Leadership and Training Initiative. (ND). 'Rehabilitating mangroves after Typhoon Haiyan'. Retrieved from: https://elti.yale.edu/our-stories/rehabilitating-mangroves-after-typhoon-haiyan

[81] Hands on Manila. (2022). 'Mangrove planting in Bolinao, Pangasinan', Retrieved from: https://handsonmanila.org/2022-04-mangrove-planting-in-bolinao-pangasinan-2-6394/

[82] Sotelo, Y. (2014). 'Bolinao villagers are fierce protectors of mangrove forests'. Inquirer.net. Retrieved from: https://newsinfo.inquirer.net/594258/bolinao-villagers-are-fierce-protectors-of-mangrove-forests

[83] Cornwall, W. (2022). 'How much is a mangrove worth? In some places USD850,000 per hectare'. Anthropocene. Retrieved from: https://www.anthropocenemagazine.org/2022/07/how-much-is-a-mangrove-forest-worth-in-some-places-850000-per-hectare/

[84] Trogers, M., Secaira-Fajardo, F., Geselbracht, L., Musgrove, M., Roberts, E., et.al. (2022). 'Relevance and Feasibility of Mangrove Insurance in Mexico, Florida, and The Bahamas', Arlington, VA: The Nature Conservancy. Retrieved from: https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_RelevanceandFeasibilityMangroveInsurance270123.pdf

[85] Beck, M. W., N. Heck, S. Narayan, P. Menéndez, S. Torres-Ortega, I. J., et. al. (2020). 'Reducing Caribbean Risk: Opportunities for Cost-Effective Mangrove Restoration and Insurance' Arlington, VA: The Nature Conservancy. Retrieved from: www-axa-com/f83724d2-fcd0-4a41-bde9-e0330a501d07_tnc_mangrove+insurance_final+hi.pdf (axa-contento-118412.eu)

[86] Beck, M. W., N. Heck, S. Narayan, P. Menéndez, S. Torres-Ortega, I. J., et. al. (2020). 'Reducing Caribbean Risk: Opportunities for Cost-Effective Mangrove Restoration and Insurance' Arlington, VA: The Nature Conservancy. Retrieved from: www-axa-com/f83724d2-fcd0-4a41-bde9-e0330a501d07_tnc_mangrove+insurance_final+hi.pdf (axa-contento-118412.eu)

[87] Zurich. (2022). Zurich launches partnership with Marine Conservation Society to help save Britain's seabeds. Retrieved from: https://www.zurich.co.uk/media-centre/zurich-launches-partnership-with-marine-conservation-society

88 Zurich. (2022). Zurich launches partnership with Marine Conservation Society to help save Britain's seabeds. Retrieved from: https://www.zurich.co.uk/media-centre/zurich-launches-partnership-with-marine-conservation-society

89 Reguero, B. G., Beck, M. W., Schmid, D., Stadtmüller, D., Raepple, J., et.al. (2020). 'Financing coastal resilience by combining nature-based risk reduction with insurance', *Ecological Economics*, 169, 106487. Elsevier Science, Retrieved from: https://doi.org/10.1016/j.ecolecon.2019.106487

90 Reguero, B. G., Beck, M. W., Schmid, D., Stadtmüller, D., Raepple, J., et.al. (2020). 'Financing coastal resilience by combining nature-based risk reduction with insurance', *Ecological Economics*, 169, 106487. Elsevier Science, Retrieved from: https://doi.org/10.1016/j.ecolecon.2019.106487

91 Bouillon, S., Rivera-Monroy, V., Twilley, R. and Kairo, J. (2009). 'Mangroves'. In: Laffoley, D. and Grimsditch, G. (eds). The management of natural coastal carbon sinks. Gland: IUCN Retrieved from: https://www.iucn.org/resources/publication/management-natural-coastal-carbon-sinks

92 The Blue Carbon Initiative. (ND). About Blue Carbon. Retrieved from: https://www.thebluecarboninitiative.org/about-blue-carbon#:~:text=Recent%20studies%20estimate%20carbon%20storage,Mg%20CO2eq%20ha%E2%88%921%20for

93 Municipality of Bolinao Pangasinan, Garcia, L.C., Yleana, J. and Borja, V.M. (2022). 'Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand, Bolinao Fisheries Refugia Management Plan'. Samut Prakan: Southeast Asian Fisheries Development Center, Training Department. Retrieved from: https://repository.seafdec.or.th/bitstream/handle/20.500.12067/1935/PH-REP2022Q4_82_Bolinao%20Management%20Plan-final.pdf?sequence=5&isAllowed=y

94 Friess, D. A., Howard, J. Huxham, M. Macreadie, P.I. and Ross, F. (2022). 'Capitalizing on the global financial interest in blue carbo' in *PLOS Climate* 1(8). Retrieved from: https://doi.org/10.1371/journal

95 Song, A.M., Dressler, W.H., Satizabal, P. and Fabinyi, M. (2021). 'From conversion to conservation to caron: The changing policy discourse on mangrove governance and use in the Philippines'. *Journal of Rural Studies. No.58*. Retrieved from: https://doi.org/10.1016/j.jrurstud.2021.01.008

96 Friess, D. A., Howard, J. Huxham, M. Macreadie, P.I. and Ross, F. (2022). 'Capitalizing on the global financial interest in blue carbo' in *PLOS Climate* 1(8). Retrieved from: https://doi.org/10.1371/journal

97 World Economic Forum. (2023). 'The Philippines joined blue carbon action partnership to strengthen coastal ecosystems', Retrieved from: https://www.weforum.org/press/2023/12/the-philippines-joins-blue-carbon-action-partnership-to-strengthen-coastal-ecosystems/

98 Caribbean Development Bank. (ND). *Comprehensive Diagnostic of Gender Sensitive Innovative Disaster Risk Financing Instruments for Resilience Building | Caribbean Development Bank*. DRF Instrument Selection and Recommendations Report. Retrieved from: https://www.caribank.org/publication_types/technical-reports/comprehensive-diagnostic-gender-sensitive-innovative-disaster-risk-financing-instruments-resilience

99 Caribbean Development Bank. (ND). *Comprehensive Diagnostic of Gender Sensitive Innovative Disaster Risk Financing Instruments for Resilience Building | Caribbean Development Bank*. DRF Instrument Selection and Recommendations Report. Retrieved from: https://www.caribank.org/publication_types/technical-reports/comprehensive-diagnostic-gender-sensitive-innovative-disaster-risk-financing-instruments-resilience

100 Start Network. (2021). 'Gender Inclusive Disaster Risk Financing', Practical Action Consulting for the START Network. Retrieved from: https://startnetwork.org/learn-change/resources/library/gender-inclusive-disaster-risk-financing-executivesummary#:~:text=In%202021%2C%20Start%20Network%20commissioned%20a%20piece%20of,differences%20at%20differen%20t%20points%20of%20the%20project%20cycle

101 The World Bank. (2021). Disaster risk Finance for Adaptive Social Protection. Retrieved from: https://openknowledge.worldbank.org/handle/10986/34133

102 FSD Kenya. (2021). 'Can market-led approaches promote economic inclusion?' Retrieved from: https://www.fsdkenya.org/video/can-market-led-approaches-promote-economic-inclusion-video/

103 Light, S. and Kousy, C. (2019). Insuring Ecosystems to Ensure Climate Resilience. Retrieved from: https://esg.wharton.upenn.edu/climate-center/insuring-ecosystems-to-ensure-climate-resilience/

104 Municipality of Bolinao/Pangasinan, Garcia, L.C., Yleana, J. and Borja, V.M. (2022). 'Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand, Bolinao Fisheries Refugia Management Plan' , Samut Prakan: Southeast Asian Fisheries Development Center, Training Department. Retrieved from: https://repository.seafdec.or.th/bitstream/handle/20.500.12067/1935/PH-REP2022Q4_82_Bolinao%20Management%20Plan-final.pdf?sequence=5&isAllowed=y

105 Paz-Alberto, A.M. and Teñoso, A.R.D. (2011). 'Assessment of Mangrove Management Areas in Four Coastal Barangays of Bolinao. Pangasinan, Philippines'. *Silliman Journal* 52(2). Retrieved from: https://sillimanjournal.su.edu.ph/index.php/sj/article/view/164

[106] Bunting P., Rosenqvist A., Lucas R., Rebelo L.M., Hilarides, L., et.al. (2018). 'The Global Mangrove Watch - n New 2010 Global Baseline of Mangrove Extent' Remote Sensins 10(10). DOI: 10.3390/rs1010669 Retrieved from: https://www.researchgate.net/publication/328429071_The_Global_Mangrove_Watch_-_A_New_2010_Baseline_of_Mangrove_Extent

[107] Municipality of Bolinao/Pangasinan, Garcia, L.C., Yleana, J. and Borja, V.M. (2022). 'Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand, Bolinao Fisheries Refugia Management Plan', Samut Prakan: Southeast Asian Fisheries Development Center, Training Department. Retrieved from: https://repository.seafdec.or.th/bitstream/handle/20.500.12067/1935/PH-REP2022Q4_82_Bolinao%20Management%20Plan-final.pdf?sequence=5&isAllowed=y

[108] UNEP-WCMC. (2021). Global distribution of seagrasses (version 7.1). Seventh update to the data layer used in Green and Short (2003). Cambridge (UK): UN Environment World Conservation Monitoring Centre. Data. Retrieved from: https://data.unep-wcmc.org/datasets/7

[109] Municipality of Bolinao/Pangasinan, Garcia, L.C., Yleana, J. and Borja, V.M. (2022). 'Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand, Bolinao Fisheries Refugia Management Plan', Samut Prakan: Southeast Asian Fisheries Development Center, Training Department. Retrieved from: https://repository.seafdec.or.th/bitstream/handle/20.500.12067/1935/PH-REP2022Q4_82_Bolinao%20Management%20Plan-final.pdf?sequence=5&isAllowed=y

[110] Shaish, L., Levy, G., Katzir, G. and Rinkevich, B. (2010). 'Coral Reef Restoration (Bolinao, Philippines) in the Face of Frequent Natural Catastrophes' Restoration Ecology 18(3). Retrieved from: https://doi.org/10.1111/j.1526-100X.2009.00647.x

[111] Allen Coral Atlas. (2020). Imagery, maps and monitoring of the world's tropical coral reefs. Zenodo. Retrieved from: https://zenodo.org/records/6622015

[113] Fuentes Juan, M. (2014). 'How Does Coral Reefs Degradation Impact on Marine Capture Fisheries, and How Can the Tragedy of the Commons Be Solved? A Case Study of the Philippines 1997-2015. ' Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwimkI6D2sODAxXrXUEAHb6iDsQFnoECBMQAQ&url=https%3A%2F%2Fbusiness.leeds.ac.uk%2Fdownload%2Fdownloads%2Fid%2F233%2Fmarina_fuentes_juan__dissertation.pdf&usg=AOvVaw0h7XTdrmBgWs3OU7ehCTmT&opi=89978449

[114] Cruz-Trinidad, A., Geronimo, R.C. and Aliño, P.M. (2008). 'Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines', *Ocean & Coastal Management*. 52(3-4). Retrieved from: https://doi.org/10.1016/j.ocecoaman.2008.12.002

[115] Reyes, S.R.C. and Blanco, A.C. (2012). 'Assessment of Coastal Vulnerability to Sea Level Rise of Bolinao, Pangasinan Using Remote Sensing and Geographic Information Systems', International Archives of the Photogrammetry, *Remote Sensing and Spatial Information Sciences*. Vol XXXIX-B6. Retrieved from: d-nb.info/1148355138/34 https://www.researchgate.net/publication/271535291_Assessment_of_coastal_vulnerability_to_sea_level_rise_of_bolinao_pangasinan_using_remote_sensing_and_geographic_information_systems

[116] Cruz-Trinidad, A., Geronimo, R.C. and Aliño, P.M. (2008). 'Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines', *Ocean & Coastal Management*. 52(3-4). Retrieved from: https://doi.org/10.1016/j.ocecoaman.2008.12.002

[117] III, B.S.M. et al. (2023). Fisheries management areas in the west Philippine sea and their heritage values, AJAD. Retrieved from: https://ajad.searca.org/article?p=2032

[118] The Nature Conservancy (TNC). (ND). Mapping Ocean Wealth: Fisheries. Retrieved from: https://oceanwealth.org/ecosystem-services/fisheries/

[119] The Nature Conservancy (TNC). (ND). Mapping Ocean Wealth: Fisheries. Retrieved from: https://oceanwealth.org/ecosystem-services/fisheries/

[120] III, B.S.M. et al. (2023). Fisheries management areas in the west philippine sea and their heritage values, AJAD. Retrieved from: https://ajad.searca.org/article?p=2032

[121] Talbot, F. and Wilkinson, O. (2001). Coral reefs, mangroves and seagrasses: a sourcebook for managers. Cape Ferguson: Australian Institute of Marine Science. Retrieved from: https://portals.iucn.org/library/node/7999

[122] Menéndez, P., Losada, I.J., Torres-Ortega, S., Narayan, S. and Beck, M.W. (2020). ' the Global Flood Protection Benefits of Mangroves'. Scientific Reports, 10(4404). Retrieved from: https://doi.org/10.1038/s41598-020-61136-6

[123] Asian Development Bank. (2022). 'Insurance: Protecting Marine Coastal Ecosystems'. ADB. Retrieved from: https://www.adb.org/publications/insurance-protecting-marine-coastal-ecosystems-asia-pacific

[124] Menendez, P., Losada, I.J., Beck, M.W., Torres-Ortega, S., Espejo, A., et.al. (2018). 'Valuiing the protective services of mangroves at national scale: the Philippines' in *Ecosystem Services.* Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S2212041618301232

[125] The Nature Conservancy (TNC). (2021). The Global Value of Mangroves for Risk Reduction. Retrieved from: https://coastalresilience.org/global-value-mangroves/

[126] PAGASA. (2024). *Climate Change in the Philippines.* Retrieved from: https://www.pagasa.dost.gov.ph/information/climate-change-in-the-philippines#:~:text=Seasonal%20Temperature%20Change,to%202.2%20C%20in%202050.

[127] Cruz-Trinidad, A., Geronimo, R.C. and Aliño, P.M. (2008). 'Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines', *Ocean & Coastal Management*, 52(3-4). Retrieved from: https://doi.org/10.1016/j.ocecoaman.2008.12.002

[128] Reliefweb. (2018). Southwest monsoon, TS 'Inday' bring flood to Pangasinan, parts of Region 1. Retrieved from: https://reliefweb.int/report/philippines/southwest-monsoon-ts-inday-bring-flood-pangasinan-parts-region-1

[129] Reliefweb. (2013). NDRRMC Update: SitRep No.11 re Preparations for and Effects of Typhoon "Labuyo" (Utor). Retrieved from: https://reliefweb.int/report/philippines/ndrrmc-update-sitrep-no11-re-preparations-and-effects-typhoon-labuyo-utor

[130] Cruz-Trinidad, A., Geronimo, R.C. and Aliño, P.M. (2008). 'Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines'. *Ocean & Coastal Management*, 52(3-4). Retrieved from: https://doi.org/10.1016/j.ocecoaman.2008.12.002

[131] Reliefweb. (2015). *Gov't aid to typhoon victims continues as 'Lando' moves away.* Retrieved from: https://reliefweb.int/report/philippines/southwest-monsoon-ts-inday-bring-flood-pangasinan-parts-region-1

[132] Shaish, L., Levy, G., Katzir, G. and Rinkevich, B. (2010). 'Coral Reef Restoration (Bolinao, Philippines) in the Face of Frequent Natural Catastrophes' Restoration Ecology 18(3). Retrieved from: https://doi.org/10.1111/j.1526-100X.2009.00647.x

[133] Wang, X., Wang, W. and Tong, C. (2014). 'A review on impact of typhoons and hurricanes on coastal wetland ecosystems'. Acta Ecologica Sinica. Retrieved from: A review on impact of typhoons and hurricanes on coastal wetland ecosystems - ScienceDirect. Retrieved from: https://www.sciencedirect.com/science/article/pii/S1872203215000657

[134] Paz-Alberto, A.M. and Teñoso, A.R.D. (2011). 'Assessment of Mangrove Management Areas in Four Coastal Barangays of Bolinao. Pangasinan, Philippines' in *Silliman Journal* 52(2). Retrieved from: https://sillimanjournal.su.edu.ph/index.php/sj/article/view/164

[135] The Humanitarian Data Exchange. (ND). 'Archive of Global Tropical Cyclone Tracks (1980 - May 2019). Retrieved from: https://data.humdata.org/dataset/archive-of-global-tropical-cyclone-tracks-1980-may-2019

[136] Intergovernmental Panel on Climate Change. (2019). 'Climate Change and Land'. Retrieved from: https://www.ipcc.ch/site/assets/uploads/2019/11/SRCCL-Full-Report-Compiled-191128.pdf

[137] Kahana, R., Abdon, R., Daron, J. and Scannell, C. (2016). *Projections of mean sea level change for the Philippines.* Met Office' Retrieved from: https://www.researchgate.net/publication/320800587_Projections_of_mean_sea_level_change_for_the_Philippines

[138] Holden, W. N. and Marshall, S. J. (2018). ' Climate Change and Typhoons in the Philippines: Extreme Weather Events in the Philippines'. *Science Direct.* Retrieved from: https://www.researchgate.net/publication/325187304_Climate_Change_and_Typhoons_in_the_Philippines_Extreme_Weather_Events_in_the_Anthropocene#:~:text=The%20Philippines%20is%20one%20of,PAGASA%20n.d.).%20...

[139] Marshall, N. A., Marshall, P. A., Tamelander, J., Obura, D., Malleret-King, D., et.al. (2010). 'A Framework for Social Adaptation to Climate Change'. IUCN. Retrieved from: https://www.iucn.org/resources/publication/framework-social-adaptation-climate-change-sustaining-tropical-coastal

[140] PAGASA. (2024). Climate Change in the Philippines. Retrieved from: https://www.pagasa.dost.gov.ph/information/climate-change-in-the-philippines#:~:text=Seasonal%20Temperature%20Change,to%202.2%20C%20in%202050

[141] The World Bank Group and The Asian Development Bank. (2021). Climate Risk Country Profile: Philippines. Retrieved from: https://climateknowledgeportal.worldbank.org/sites/default/files/2021-08/15852-WB_Philippines%20Country%20Profile-WEB.pdf

[143] PAGASA. (2024). Climate Change in the Philippines Retrieved from: https://www.pagasa.dost.gov.ph/information/climate-change-in-the-philippines#:~:text=Seasonal%20Temperature%20Change,to%202.2%20C%20in%202050

[144] Intergovernmental Panel on Climate Change. (2019). 'Climate Change and Land'. Retrieved from: https://www.ipcc.ch/site/assets/uploads/2019/11/SRCCL-Full-Report-Compiled-191128.pdf

[145] Mei, W., Xie, S., Primeau, F., McWilliams, J. C. and Pasquero, C. (2015). 'Northwestern Pacific typhoon intensity controlled by changes in ocean temperatures'. *Science Advances.* Retrieved from: https://www.science.org/doi/10.1126/sciadv.1500014

146 The World Bank Group and The Asian Development Bank. (2021). '*Climate Risk Country Profile: Philippines'*. Retrieved from: https://climateknowledgeportal.worldbank.org/sites/default/files/2021-08/15852-WB_Philippines%20Country%20Profile-WEB.pdf

147 Kahana, R., Abdon, R., Daron, J. and Scannell, C. (2016). Projections of mean sea level change for the Philippines. Met Office, Retrieved from: https://www.researchgate.net/publication/320800587_Projections_of_mean_sea_level_change_for_the_Philippines

148 Fox-Kemper, B., H.T. Hewitt, C. Xiao, G. Aðalgeirsdóttir, S.S. Drijfhout, T.L. et.al. (2021). 'Ocean, Cryosphere and Sea Level Chang' In *Climate Change 2021:* The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge. Cambridge University Press. Retrieved from: https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-9/

150 Coast Adapt. (2017). 'Ocean acidification and its effects'. Retrieved from: https://coastadapt.com.au/ocean-acidification-and-its-effects

151 Intergovernmental Panel on Climate Change. (2019). 'Climate Change and Land'. Retrieved from: https://www.ipcc.ch/srccl/

152 PhilAtlas. (2020). Bolinao, Province of Pangasinan. Retrieved from: https://www.philatlas.com/luzon/r01/pangasinan/bolinao.html#sectionEconomy

154 Municipality of Bolinao/Pangasinan, Garcia, L.C., Yleana, J. and Borja, V.M. (2022). 'Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand, Bolinao Fisheries Refugia Management Plan', Samut Prakan: Southeast Asian Fisheries Development Center, Training Department. Retrieved from: https://repository.seafdec.or.th/bitstream/handle/20.500.12067/1935/PH-REP2022Q4_82_Bolinao%20Management%20Plan-final.pdf?sequence=5&isAllowed=y

155 McManus, J.W., Nañola, C.L., Reyes, R.B. and Kesner, K.N. (1992). Resource Ecology of the Bolinao Coral Reef System, Manila: International Center for Living Aquatic resources Management. Retrieved from: https://www.researchgate.net/publication/23947896_Resource_ecology_of_the_Bolinao_reef_system

156 Talbot, F. and Wilkinson, O. (2001). Coral reefs, mangroves and seagrasses: a sourcebook for managers. Cape Ferguson: Australian Institute of Marine Science. Retrieved from: https://policycommons.net/artifacts/1371786/coral-reefs-mangroves-and-seagrasses/1985961/

157 Teñoso, A.M.P. and Paz-Alberto, A.M. (2012). 'Community awareness and Perception of the Implementation of the coastal resource Management programs in Bolinao, Pangsinan, Philippines'. *Sillman Journal,* 53(2). Retrieved from: https://sillimanjournal.su.edu.ph/index.php/sj/article/view/145

158 McManus, J.W., Nañola, C.L.,Reyes, R.B. and Kesner, K.N. (1992). Resource Ecology of the Bolinao Coral Reef System, Manila: International Center for Living Aquatic resources Management. Retrieved from: https://www.researchgate.net/publication/23947896_Resource_ecology_of_the_Bolinao_reef_system

159 Verceles, L.F., Talaue-McManus, L. and Aliño, P.M. (2000). 'Participatory Monitoring and Feedback System: An Important Entry towards Sustainable aquaculture in bolinao, Northern Philippines'. *Science Dilliman*, 12(2). Retrieved from: https://www.researchgate.net/publication/277035418_Participatory_Monitoring_and_Feedback_System_An_Important_Entry_Towards_Sustainable_Aquaculture_in_Bolinao_Northern_Philippines

160 Fortes, M. and Paningit, E. C. (2009). Integrating support system for managing environmental change and human impacts on tropical ecosystems in East Asia and the Pacific *(Final Report for APN Project: ARC 2007-03CMY*) Kobe: Asia-Pacific Network for Global Change Research. Retrieved from: https://www.apn-gcr.org/project/integrating-support-system-for-managing-environmental-change-and-human-impact-on-tropical-ecosystems-in-east-asia-and-the-pacific/

161 Ferrata, C.M., Watanabe, A., Miyajima, T., Diego-McGlone, M.L.S., Morimoto, N., et.al. (2016). 'Phosphorus as a river of nitrogen limitation and sustained eutrophic conditions in Bolinao and Anda, Philippines, a mariculture-impacted tropical coastal area', *Marine Pollution Bulletin*, 105(1). Retrieved from: https://doi.org/10.1016/j.marpolbul.2016.02.025

162 Bureau of Fisheries and Aquatic Resources. (2020). Philippine Fisheries Profile. Quezon City: BFAR. Retrieved from: https://www.bfar.da.gov.ph/wp-content/uploads/2022/02/2020-Fisheries-Profile-Final.pdf

163 Quimpo, T.J.R., Ligson, C.A., Manogan, D.P., Requilme, J.N.C., Albelda, R.L., et.al. (2020). 'Fish farm effluents alter reef bethnic assemblages and reduce coral settlement'. *Marine Pollution Bulletin* 153. Retrieved from: https://doi.org/10.1016/j.marpolbul.2020.111025

164 Paz-Alberto, A.M. and Teñoso, A.R.D. (2011). 'Assessment of Mangrove Management Areas in Four Coastal Barangays of Bolinao. Pangasinan, Philippines'. *Silliman Journal* 52(2). Retrieved from: https://sillimanjournal.su.edu.ph/index.php/sj/article/view/164

[165] Quimpo, T.J.R., Ligson, C.A., Manogan, D.P., Requilme, J.N.C., Albelda, R.L., et.al. (2020). 'Fish farm effluents alter reef bethnic assemblages and reduce coral settlement'. *Marine Pollution Bulletin* 153. Retrieved from: https://doi.org/10.1016/j.marpolbul.2020.111025

[166] Fortes, M. and Paningit, E. C. (2009). *Integrating support system for managing environmental change and human impacts on tropical ecosystems in East Asia and the Pacific. (Final Report for APN Project: ARC 2007-03CMY*) Kobe: Asia-Pacific Network for Global Change Research. Retrieved from: https://www.apn-gcr.org/project/integrating-support-system-for-managing-environmental-change-and-human-impact-on-tropical-ecosystems-in-east-asia-and-the-pacific/