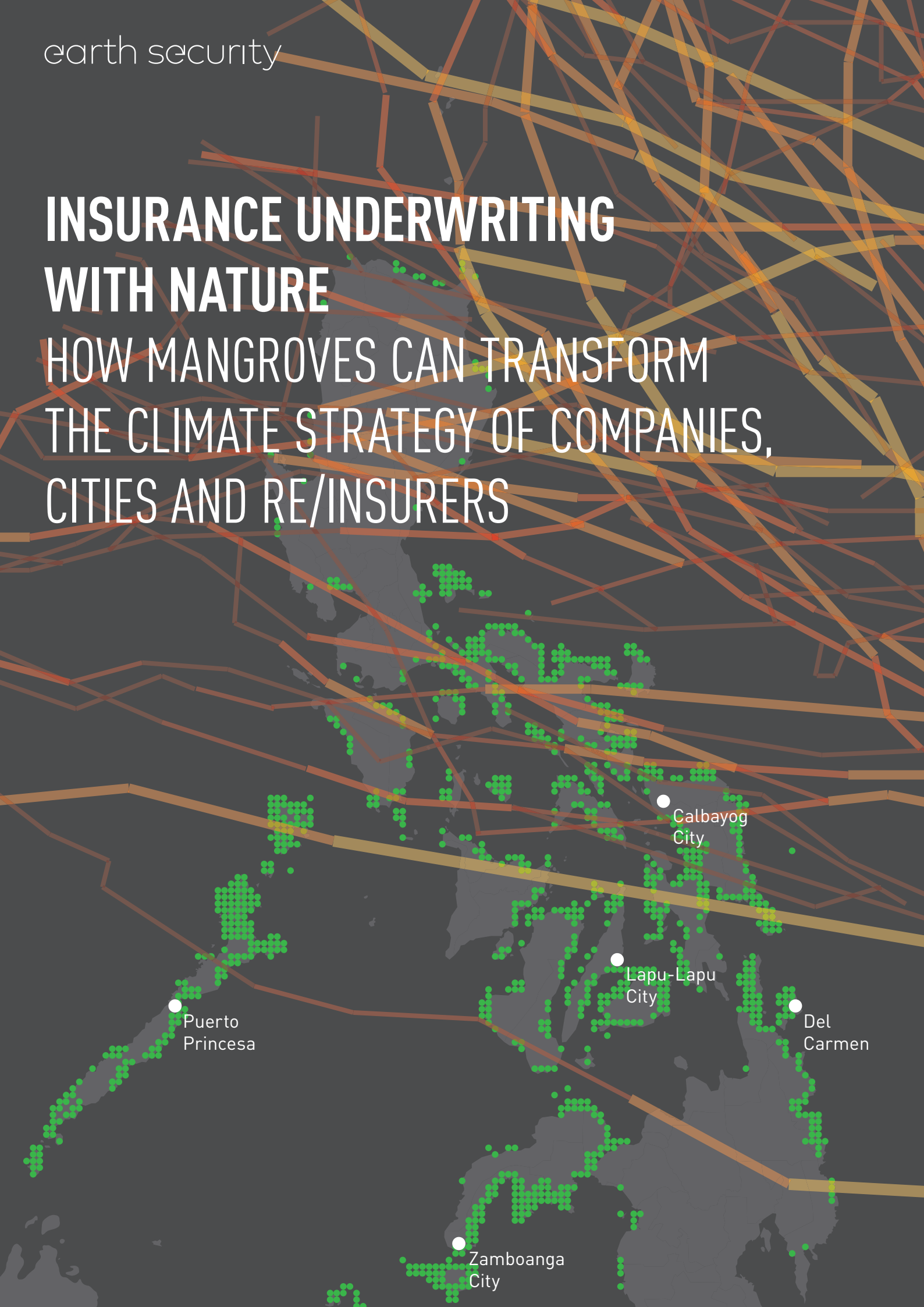
earth security

INSURANCE UNDERWRITING WITH NATURE

HOW MANGROVES CAN TRANSFORM THE CLIMATE STRATEGY OF COMPANIES, CITIES AND RE/INSURERS



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Earth Security is a strategic organisation helping companies, investors and governments to invest in nature's capital for a resilient future.

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Content

Disclaimer

The analysis in this report offers an approach to the estimation of loss avoidance provided by mangrove ecosystems in selected locations in the Philippines. The analysis is based on hypothetical physical assets and simplified ecological data, making a range of transparent assumptions where information is lacking. The data and analysis presented here is not intended to provide any investment, financial or risk advice and therefore should not be used directly as a basis for insurance underwriting or financial decision-making.

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EXECUTIVE SUMMARY

"Growing losses from floods are becoming ever more apparent. Together the public sector and re/insurers can steer investments into protective measures such as green infrastructure. This will help keep assets insurable." [1]

Jérôme Jean Haegeli
Group Chief Economist,
Swiss Re

EXECUTIVE SUMMARY

Mangrove forests can significantly reduce economic losses from storms and floods because they are natural coastline barriers. By factoring them into risk underwriting, insurance products and commercial strategies, re/insurers can meet a growing need from companies and governments to invest in greener infrastructure for a resilient future.

This report offers a simplified quantitative model to illustrate the value of the protection that mangroves provide against tropical cyclones. It focuses on five coastal cities in the Philippines, one of the world's most climate-vulnerable countries.

It uses available science and public datasets to build a business case for supporting innovation in re/insurance products, insurance regulations, and sustainable investments and suggests product innovation routes for re/insurers, companies and governments.

One of the acknowledged difficulties of compiling this report is a lack of data. Our approach is simple, because current underwriting models do not allow for more dynamic and nuanced variables and the available data itself is sparse.

That being the case, however, the evidence points clearly to the potential of natural assets to mitigate the impact of extreme weather events. This opens an opportunity for re/insurance companies, their corporate and government clients, and regulators to prepare for a new era where nature-based solutions will enhance investments, insurance products and business strategies.

LARGE BUSINESSES ARE LIKELY TO CONSIDER PAYING A PREMIUM FOR INNOVATIVE NATURE-BASED INSURANCE SOLUTIONS THAT SUPPORT THEIR WIDER SUSTAINABILITY STRATEGY, OR INCREASINGLY SELECT RE/INSURANCE PROVIDERS ADDING VALUE TO THEIR DIRECTION.

Nature-based solutions to keep assets insurable

Climate change is increasing insured losses and risk premiums for corporations, demanding innovation to keep assets insurable. Over the past 10 years, insurance companies have paid out more than USD 300 billion for coastal storm damages globally.[2] In the next 10 years, this is expected to multiply by a factor of 10.[3]

Global warming will continue to undermine the viability of new investments in coastal areas, in particular in densely developed coastal cities. Cities in the Asia-Pacific region are a case in point, being some of the most exposed in the world to extreme floods and tropical cyclones. Across the region, re/insurance companies must leverage the protection provided by natural ecosystems in their long-term business strategies with corporate and government clients.[4]

Financial decision-makers need greater knowledge of nature-based solutions within re/insurance and investment portfolios. As climate hazards become more frequent and intense, mangroves and coral reefs present a ready, cost-effective solution to manage risk exposures for coastal cities and infrastructure. Protecting mangroves and coral reefs has been found to be 50 times more cost-effective over a 15-year investment period than building a concrete seawall.[5] However, these ecosystems are rapidly deteriorating because of intense development pressures.

The degradation and rapid loss of mangrove ecosystems is leaving coastlines more vulnerable, and half of the world's mangroves have already been lost. Their value to coastal resilience is not being fully registered by city planners, investors and landowners, including by the re/insurance industry, which currently does not consider these as a storm attenuation factor in catastrophe (CAT) modelling or the design of insurance policies. This is due to:

— Limited experience of how to consider and price the resilience value of nature.

— Significant ecological data and modelling gaps preventing seamless integration.

— Lack of flexibility and transparency of proprietary CAT models used by underwriters.

The Philippines provides a business case for nature-based insurance innovation. With extensive mangrove resources as well as an average of 20 tropical cyclones per year and USD 3.5 billion in average annual losses, the Philippines is one of the world's most vulnerable countries to climate change, and one that can tap into its vast natural wealth to increase coastal resilience.[6] Coastal ecosystems here have been found to reduce annual damages to property from extreme weather by up to 30%, saving approximately USD 1 billion yearly in avoided losses.[7] Our analysis of five coastal cities in the Philippines suggests ways in which the protection value of mangroves can be realised as a strategic and commercial opportunity for re/insurers, corporate clients and governments.

Recommendations for greening insurance products and strategies

The report identifies three routes for product and strategy innovation. By enhancing coastal resilience, nature-based solutions such as mangroves can help green infrastructure at a time when corporates and governments must accelerate sustainable and resilient investments:

1 **Re/insurers**
Mobilise chief underwriters, client advisory services, and investment managers to factor mangroves' unique protective value into portfolios, underwriting processes and business development opportunities. Developing pilot projects and prototypes together with leading corporate and government clients will demonstrate the value of green infrastructure as a risk mitigation solution, and support clients to build more resilient businesses.

2 **Corporate clients**
Companies with insured physical assets and operations within mangrove ecosystems need to lead the integration of sustainability criteria into core business strategy and operational processes. They can do this by identifying those assets or locations and engaging with insurance providers to co-develop risk management tools and insurance products that incorporate natural capital. From a corporate strategy perspective, this works to achieve outstanding sustainability outcomes and leadership on climate resilience, while adding the value of natural assets onto corporate balance sheets.

3 **City governments**
Chief executives of Local Government Units (LGUs) can collaborate with government-backed re/insurers to recognise the protection value provided by mangroves to municipal buildings and infrastructure. They can allocate public investment for climate resilience towards the conservation and restoration of mangrove and coastal ecosystems as a risk mitigation strategy. Where mangroves are at high risk from tropical cyclones, local governments can also work with private re/insurers to develop mangrove-linked insurance products that can support ecological restoration after strong tropical cyclones.

In sum, mangroves provide re/insurers with an opportunity to serve a segment of corporate and government clients committing to more sustainable investments. This could include rewarding corporate investments in sectors like power generation, tourism or coastal infrastructure with lower insurance premiums when measures are taken to protect natural ecosystems for resilience purposes.

It is highly likely that large businesses will either consider paying a premium for related pilot solutions that position them as sustainability leaders, or increasingly select insurance providers that demonstrate leadership in this direction.

Moving the dial on industry-level and policy innovation

A disruption in data models used by re/insurers is inevitable. There is an increasing need to integrate climate change and nature-based solutions as risk attenuation factors. As re/insurers, companies and governments face increasing insured losses due to climate change, the demand for CAT models that consider climate change scenarios and natural risk mitigating factors is expected to grow.

Open-source CAT models are starting to challenge incumbent data providers. They are more flexible and transparent platforms and allow wider scope to respond to more complex climate change scenarios. Better awareness of how mangroves reduce risk, and opportunities to integrate them in the underwriting process, will help boost competition among data providers operating in markets across tropical and sub-tropical regions.

The disclosure of nature-related financial risks will stimulate the market. The physical costs and fiscal burden of recurrent extreme weather events is increasing regulatory attention on what companies should do to increase climate resilience. A new financial benchmark, to be introduced by the Task Force on Nature-related Financial Disclosures (TNFD), is expected to make greater demands on financial institutions, re/insurers included, to disclose nature-related exposures.[8] Regulatory changes are also likely to justify the higher costs of improving CAT models and developing new data and knowledge to facilitate effective pricing of natural ecosystems as a climate change resilience factor.

Other policy options, such as tax reductions for insurance products that factor in the protection provided by coastal ecosystems such as mangroves would stimulate experimentation in the sector in this direction. As our strategic partner in this work, the Philippine Insurance and Reinsurance Association (PIRA) offers a platform for an industry-government dialogue on policy options.

Industry-research partnerships are needed to move the market forward. Data is needed for companies and insurers to make informed assumptions about the coastal protection value of mangroves in their risk modelling. While this protective value is understood conceptually, it is only just beginning to get sufficient attention to yield systematic, quantitative data sets applicable across geographies. The costs of site-specific research can be justified through the development of high-value market-leading prototypes.

More and more nuances – water depths, hydrological factors, and the impact that variations in size, structure and species of mangroves have on their ability to slow down storm surges – must be progressively incorporated. By increasing the funding for scientific research programmes, such as the one referenced and used in this study, the re/insurance industry can facilitate the development of data analyses needed to incorporate natural assets into underwriting across markets.[9]

1 INTRODUCTION

1.1 ALIGNING RISK UNDERWRITING WITH NATURE

How nature strengthens climate resilience. Reef and mangrove restoration are among the most cost-effective climate adaptations in coastal areas.[10] Mangroves are particularly effective at absorbing the impact of waves and storm flood surges: 100-meter-wide mangrove forests can reduce the height of waves by up to 70%, while 500-meter-wide forests can reduce it by up to 100%.[11] [12]

Mangroves avoid an estimated USD 65 billion per year in losses from floods and storms, 90% of them associated with tropical cyclones.[13] [14] Coral reefs also protect coastlines from storm surge and waves, in some cases reducing wave energy by 97%.[15] The loss of these precious ecosystems increases the vulnerability of coastal communities.[16] Mangroves have the highest rate of deforestation of any type of trees. Half of all mangroves globally have already been lost, and 75% of the world's coral reefs are considered threatened.

A focus on Property Damage and Business Interruption (PDBI) policies. Global re/insurers and NGOs have increased interest in nature-based solutions to mitigate climate risks and - given the vulnerability of these ecosystems to climate change - to develop insurance products aimed at their protection.

Among notable case studies, the pioneering work by Swiss Re and The Nature Conservancy stands out. Starting from 2016 it issued a parametric insurance product to protect and rebuild a coral reef in Quintana Roo, Mexico.[17] A range of new concepts, including Conservation International's Restoration Insurance Service Company (RISCO), are looking for ways to monetise the coastal protection value provided by mangroves in new ways.[18]

Given that mangroves can also be vulnerable to tropical cyclones, new insurance product concepts are being developed that could insure mangroves against extreme weather events.[19] However, while these sophisticated prototypes point to a new way of thinking about insurance and nature, they do not provide a readily available way to scale up the integration of nature into re/insurance and risk underwriting. Recognising the protection value of mangroves for existing infrastructure would enable the mainstreaming of this value across PDBI policies for hotels, airports, power plants, roads and infrastructure, wherever these policies are underwriting in mangrove rich environments or regions with restorable potential.

Nature-based solutions and catastrophe (CAT) models. Proprietary CAT models used in underwriting rely on historical records to reference hazards (events), exposure (assets hit) and vulnerability (the extent of damage), and ultimately define the levels of risk premiums. They do not generally reflect climate change, something that a range of open-source CAT models are starting to do. Nor do they consider the resilience value of nature.

Reflecting this value would provide an opportunity for a smarter development of insurance policies in the face of growing climate threats:

— Insured clients would get lower insurance prices, or manage risk premium increases, by becoming stewards of coastal natural assets. Insurance premiums could provide an incentive for protecting nature.

— Re/insurers would be able to more accurately price and market their products, providing clients with an opportunity to manage the acknowledged risk of premium increases due to climate change, or potentially widening the range of assets that are insurable.

— This would allow natural ecosystems to be seen as valuable assets for the coastal protection provided to buildings, infrastructure, cities and communities, and factored by urban planners, land owners and investors in the design of investment projects.

1.2
CAT MODELS

Catastrophe (CAT) models require a user to input key data/assumptions about the insured asset and the hazard that the asset is to be insured against. This information is then overlaid with simulations of the probability and severity of the selected hazards to map out expected damages and financial losses over a timeframe. These findings are combined with other considerations such as target profitability, current book of business, risk appetite and other proprietary information, to determine a premium level.

A curve represents the likelihood that a loss equal or greater than a certain level will occur in any year. For example, a 1-in-10,000-year event has only a 0.01 percent (1/10,000) chance of taking place annually, while a 1-in-50-year event has a 2 percent (1/50) chance of happening. Average annual loss (AAL) is the mean annual value of the curve.

Finally, results are incorporated into the price and type of policy an insurer is willing to offer. Proprietary CAT models do not specify climate change scenarios and are based on past data. This makes the issue of climate change and weather system disruption a critical challenge for modelers and the re/insurance companies they serve.

Predicting the damage to an asset by using a CAT model is only as sound as the baseline data inputs drawn from historical observations, and the selected parameters considered useful in making damage predictions. For example, for a tropical cyclone's specific peril such as a storm surge, key data parameters include topography and the presence of artificial flood barriers.

The presence of natural barriers such as mangroves or coral reefs are not generally regarded as parameters, and they are therefore excluded as attenuating factors for damage predictions. As a result, the damage distribution and the resulting losses for assets sheltered by an intact coastal ecosystem will be overestimated and the insurance policy will be ultimately overpriced – or worse, the model may deem the asset to be uninsurable. Crucial to the evolution of CAT models and their ability to consider climate change is the distinction between proprietary and open-source models:

Proprietary models

There are several CAT models currently in use by underwriters, most of which have been developed by specialist multinationals and are licensed to local insurers. The three major model providers include Risk Management Solutions (RMS), AIR Worldwide, and EQECAT. Proprietary CAT models are seen as 'black boxes' where users enter asset and policy data and are provided intermediate loss figures which are then used as inputs for policy premium calculations.

Underwriters have few options to manually adjust any parameters in the hazard or vulnerability modules. As the models developed by these companies are proprietary, this research has not assessed their form or structure directly but instead relied on interviews with insurance experts, CAT modelers and insurers.

Open-source models

The Oasis Loss Modelling Framework (Oasis LMF) is an open-source CAT modelling platform that is free to use. It seeks to change the understanding of risk in insurance and beyond.[20] The platform, currently undergoing Beta testing, seeks to provide access to CAT modelling that increases transparency and flexibility, aimed at a world of increasing climate change and weather volatility.

Oasis LMF allows for adjustments, the inclusion of new datasets, as well as climate change and ecosystem-related information. Its developers have created a toolkit to allow users to rewrite the underlying files and create a bespoke version to fit their needs although the update does not allow for the large-scale underlying structure of events such as hazard data to be modified.

1.3
THE PHILIPPINES
A BUSINESS CASE FOR INSURANCE INNOVATION

Figure 1
Locations of the world's mangrove ecosystems

One of the world's most vulnerable countries to climate change

The Philippines faces an average of 20 tropical cyclones, or typhoons, every year, and USD 3.5 billion in average annual losses due to natural disasters.[21] [22] 'According to the Lloyds City Risk Index, Manila is the city with the third-highest amount of GDP at risk from various hazards after Tokyo and New York. USD 13.27 billion of the city's GDP is at risk, with tropical storms the leading threat'.[23] In 2021, the country was hit by 15 tropical cyclones.

The last of them, Typhoon Rai, also known locally as Typhoon Odette, made landfall in December 2021. It was the strongest typhoon recorded in the islands since the 2013 Yolanda (Haiyan) storm.[24] The country also incurred damage of at least USD 8 billion from disasters between 2011 and 2018 and the cost of recovery and rebuilding reached USD 11.53 billion.[25]

Approximately 50% of the total land area and 85% of the country's output is reported to be vulnerable to disasters.[26] In 2013, Haiyan destroyed 600,000 hectares of farmland and affected over 145,000 fishermen, leading to the loss of 95% of fishing boats and equipment in the affected areas.[27]

Mangroves are missing from the pricing of insurance products and commercial strategies

Coastal ecosystems have been found to reduce annual damages to property from extreme weather in the Philippines by 30%, saving up to USD 1 billion each year.[28] Time and time again after strong typhoons have hit the Philippines, communities and infrastructure surrounded by mangroves have sustained fewer losses than neighbouring areas where mangroves had been cleared.[29]

Protecting mangroves and coral reefs was found to be up to 50-times more cost-effective over a 15-year investment period than building a concrete seawall.[30] A gradual recognition of the resilience value of mangroves by local governments has sparked a range of commitments to restore mangroves as part of a coastal city risk reduction strategy.[31] However, CAT models used in the Philippines and the underwriting of physical coastal assets currently ignore the protection provided by such natural assets.

The Philippines has lost hundreds of thousands of hectares of mangroves over recent decades, to a combination of shrimp farming conversion, local economic pressures and coastal development. The result has been an increase in coastal climate vulnerability.[32] A dwindling but still effective mangrove ecosystem is therefore an important testing ground for new approaches to nature-based insurance innovation.

A gradual recognition of the resilience value of mangroves is leading local governments to commit to restoring mangroves as part of their disaster risk reduction strategy, as is discussed in the case study section, although questions remain about the speed, pace and long-term effectiveness of these efforts.

Nature-based insurance, an untapped opportunity for market innovation

The Philippines has one of the lowest insurance uptake rates in the world. Its exposure to tropical cyclones and to intensifying climate change is a challenge to the growth of the sector.

Recognising and pricing the value that mangroves provide in damage limitation would give re/insurers a competitive advantage by offering better-priced policies. It could also help provide cover for physical assets that would otherwise be considered uninsurable. The largest corporate insurance customers in the Philippines are quickly evolving their commitments to sustainable investment, yet this client segment is not being adequately serviced by re/insurance companies.

The local insurance sector must support corporate clients through sustainability-themed insurance products. This could involve rewarding corporate investments in sectors like power generation, construction, real estate or tourism, which recognise the value of intact mangrove ecosystems with appropriately priced insurance products.

It is highly likely that large local businesses will either consider paying a premium for piloting innovative nature-based insurance solutions that support their sustainability strategies, or increasingly select re/insurance providers that demonstrate leadership in this direction.

Government policy-makers and regulators can support innovation and market development

Property Damage and Business Interruption (PDBI) policies are subject to tax and this can also be a limiting factor on demand particularly amongst small and medium sized businesses for whom the benefits of insurance are often poorly articulated or understood.

Government regulators can provide tax incentives for products that incorporate nature-based solutions, and therefore help steward the natural capital of the Philippines. A lower tax for such products would increase the incentives for re/insurers and their customers to adopt nature-based approaches.

The Philippines is developing government-backed catastrophe re/insurance initiatives to increase the protection of the country's infrastructure and population. The Government Service Insurance System (GSIS) has created USD 20 billion reinsurance cover for catastrophe exposures.[33] The National Reinsurance Corporation of the Philippines (NatRe), the Philippine Insurers and Reinsurers Association (PIRA), and the Insurance Commission of the Philippines are developing the Philippine Catastrophe Insurance Facility (PCIF): a natural catastrophe risk pooling mechanism, with a mandate that will support business disruption of small and medium enterprises.[34]

Recognising the economic value that mangroves provide in the form of reduced economic losses across government-backed re/insurance initiatives is a direct way to support 'green recovery' and incentivise risk preparedness and mitigation through green infrastructure, supporting local communities located among mangrove ecosystems to become stewards of these resources.

All stakeholders in the re/insurance ecosystem of the Philippines have a role to play in increasing the awareness of the role natural assets play in re/insurers' books of business, premiums for corporate clients and infrastructure projects, as well as overall levels of insurability for cities and regions. Making progress in this direction will create an important financial constituency and country-wide incentives for the protection of these vital ecosystems.

2

METHODOLOGY

ASSESSING THE ECONOMIC VALUE OF MANGROVES FOR COASTAL PROTECTION AGAINST TROPICAL CYCLONES

2.1 METHODOLOGY

Drawing on available science and publicly available datasets, we offer a highly simplified quantitative model of the value that mangroves provide in coastal protection against tropical cyclones.

Our objective is to support innovation in re/insurance products, insurance regulations, and sustainable investments in the corporate and government sectors, positioning mangroves in the Philippines as a valuable asset for a 'green recovery'.

Given the limitations of available data, the approach is offered as a first step to create strategic discussion among re/insurers, corporate clients and government decision-makers about the opportunities to mainstream the coastal protection value offered by mangroves across the Philippines and, by extension, across other countries with similar characteristics.

We do this by addressing the shortcomings of the current system, namely:

— The rigidity and opacity of commercial CAT models available to the Philippine re/insurance industry, which allow little flexibility to factor in natural assets.

— The lack of quantitative data on the protective capacity of coastal ecosystems in a format that is usable by re/insurers as a risk attenuation parameter.

— The limited awareness among re/insurance professionals of the value of nature as a risk mitigation factor. This approach in itself is new and therefore intends to challenge the mainstream mindset and methodologies used by risk underwriters.

Ecological and hydrological modelling

Given the lack of ecological data fit for use by CAT modelers and limitations in hazard modelling, our method uses a loss curve and hazard estimations developed by teams from The Nature Conservancy and the Institute of Hydraulics at the University of Cantabria, commissioned in 2017 by the World Bank Wealth Accounting and the Valuation of Ecosystem Services (WAVES) program in the Philippines.[35]

The WAVES report applied an expected damage function recommended by the World Bank to quantify the risk reduction benefits from mangroves in the Philippines. Using high-resolution models, it examined the flooding that would occur with and without mangroves under different storm conditions throughout the Philippines and estimated the annual expected benefits of mangroves for coastal protection.

City locations and physical assets

Our analysis focuses on five coastal cities in the Philippines and explores the reduction in economic losses that mangroves can provide for built assets against tropical cyclones. The cities have been selected based on the existence of a relevant tourism industry (pre-COVID pandemic) and of intact mangrove ecosystems. The cities are Puerto Princesa (Palawan); Del Carmen (Siargao Island/Mindanao); Lapu-Lapu City (Cebu); Zamboanga City (Mindanao); and Calbayog City (Samar).

Our analysis applied the hazard and loss curves of the WAVES report to five coastal cities of the Philippines, and to a series of hypothetical hotel assets (3-star, 4-star, and 5-star hotels) to assess differentials in physical damage and business interruption costs provided by the existence of mangroves, and how these would vary between cities.

To estimate the costs of physical damage and business disruption, we used industry data of construction/replacement costs and annual revenues based on seasonally adjusted room rate and occupancy figures in these locations. The specific focus on tourism assets was selected as hotels are often built very close to the coastline in the natural environment and the sector represents a material source of revenue to companies and city governments in these locations.

During site selection, the mangrove ecosystems were further investigated combining data from existing physical surveys and satellite monitoring via publicly available databases. Google Earth was used to investigate areas where mangroves grew next to built assets. These areas were then individually cross-referenced with known tourism destinations using the map features on popular hotel booking applications.[36] The analysis focused specifically on mangroves, the ecosystem whose coastal protective capacity is best understood.

Loss curve and hazard modelling

The study relied on a simplified loss curve developed by the abovementioned WAVES study. This assumes that regions with mangrove cover will have zero losses for flooding below 50 centimetres in depth, increasing linearly up to 100 percent damage for flooding above 2 metres, for assets located at sea level. The hypothetical hotel assets developed for this study are single-storey buildings very near to the coast and it is assumed that storm surge height approximates actual inundation. All hotels were assumed to be in flat, low-lying coastal areas one meter above sea level, set back from the coast and/or elevated on stilts, as is typical in the area.

Figure 2 illustrates how in this curve there is a linear increase in damage as flood levels rise between these two depths. In our model, we are interpolating the corresponding percentage of damage for the different values of flood surge depth between 50 centimetres and 2 metres.

The loss curve is intended to provide an oversimplified approach for illustration purposes only. Further research is needed on several features of mangroves related to their impact on storm surge reductions, such as the varying effects of vegetation densities, species composition and vegetative morphology. For example, thick mangrove forests, including mangrove species with dense aerial roots, will increase the storm surge reduction effect; however, widely available data on this is still missing.

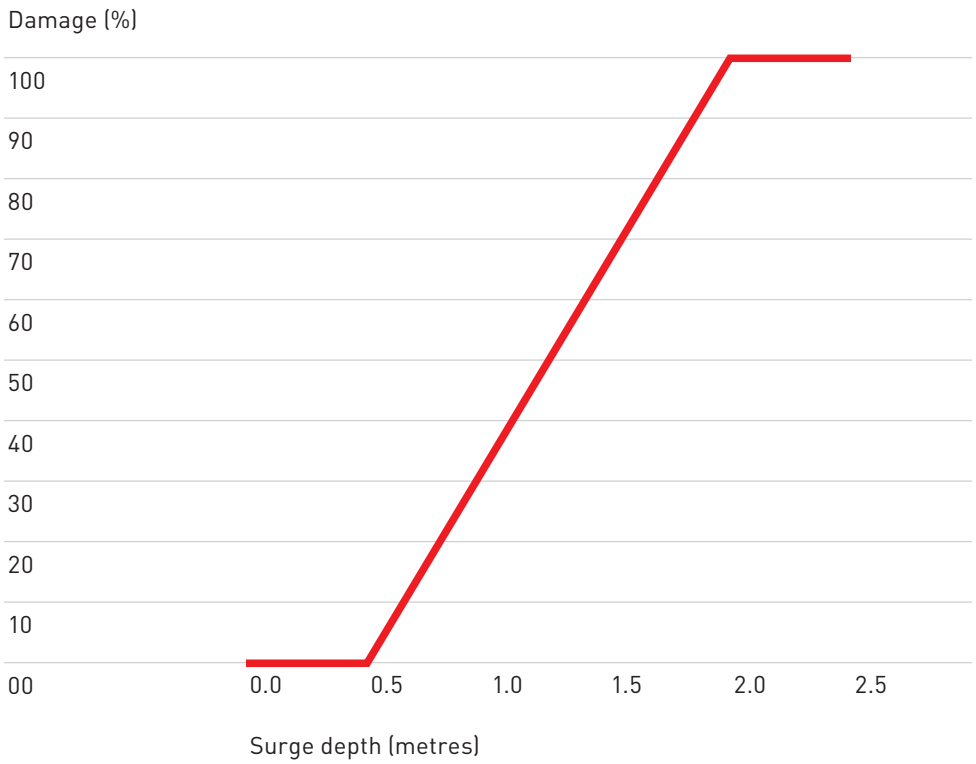
The hazard modelling was also based on the WAVES study in the Philippines, which provides a detailed analysis of historical tropical cyclone paths (1951-2014), wave action, sea levels, coastal bathymetry, and other factors to estimate the maximum storm surge for a tropical cyclone event taking place once every 5, 10, 25, 50 and 100 years in one-kilometre intervals for the entire Philippines' 32,800-kilometre coastline.[37] The more infrequent the storm, the stronger its force.

The ability of mangroves to respond dynamically to rising sea levels may mean they can continue to act as a coastal defence in the future. But the thresholds at which rising sea levels would compromise the integrity of mangrove ecosystems is still to be widely understood and estimated for different regions.[38]

Extreme weather events, such as tropical cyclones, can also severely damage or destroy mangroves and reduce their effectiveness.[39] This is leading re/insurance companies and NGOs to consider new insurance cover products aimed at protecting mangroves themselves, and triggering payments for post-storm restoration.[40]

Figure 2
Loss curve

Source: Losada, I.J., M. Beck, P. Menéndez, A. Espejo, S. Torres, P. Díaz-Simal, F. Fernández, S. Abad, N. Ripoll, J. García, S. Narayan, D. Trespalacios. 2017. Valuation of the Coastal Protection Services of Mangroves in the Philippines. World Bank, Washington, DC.



2.2
INPUTS, OUTPUTS AND ASSUMPTIONS[41]

Inputs

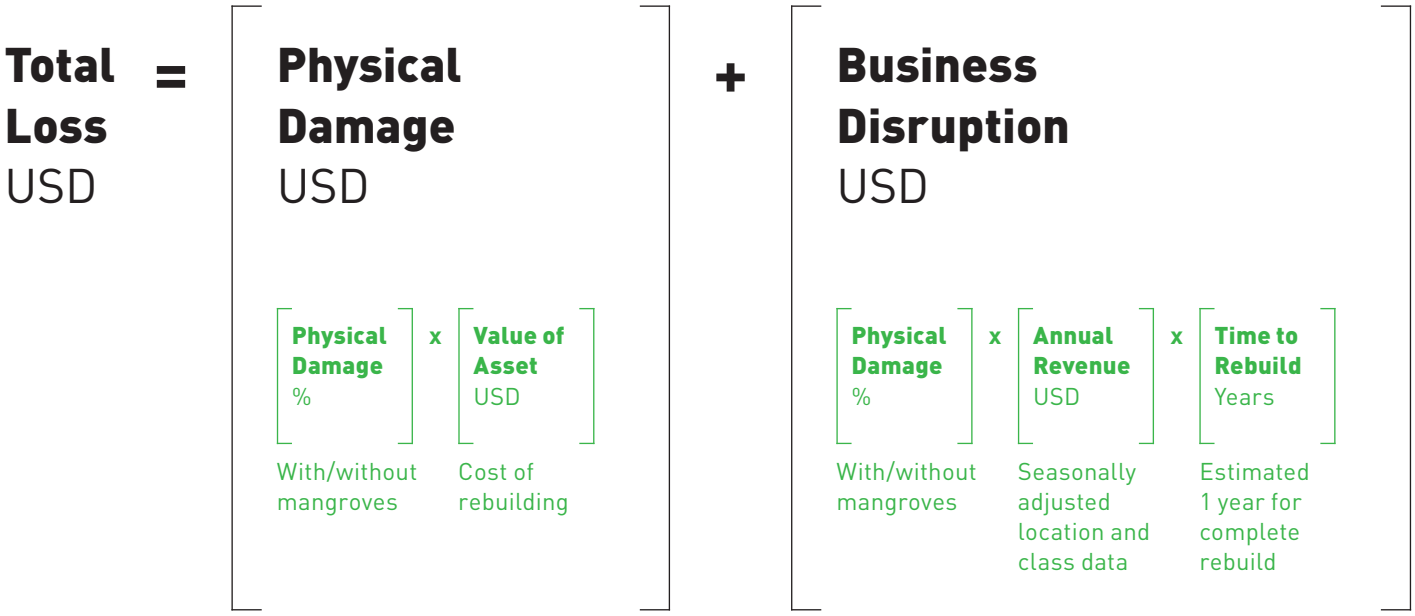
Location of asset	Five locations selected based on existing mangrove ecosystems and tourism industry.
Class of asset	Theoretical hotel assets developed for 3-star (budget), 4-star (deluxe), and 5-star (luxury).
Value of asset (USD)	Asset value based on the construction and fit-out costs of a 50-key hotel and restaurant of the selected class in the Philippines.
Annual revenue of asset (USD)	Hotel revenue based on seasonally adjusted location- and class-specific data.
Position of asset above sea level (cm)	Hotels assumed to be ground level, and elevated 1 metre from the sea level. The topography of each selected area is low-lying and close to sea level.
Intensity of storm	Storm surge modelling for tropical cyclones occurring once every 10, 25, 50, and 100 years. The more infrequent the storm, the stronger its force.
Peak depth of surge with/without mangroves (cm)	Based on hydrological modelling, indicative peak surge size for each location for scenarios with and without adjacent mangroves.

Outputs

Extent of physical damage with/without mangroves %	Based on the indicative loss curve, the ratio (as % of total asset value) assumes flood depths with/without mangroves relative to geo-referenced location.
Cost of physical damage without mangroves (USD)	Hotel value multiplied by damage ratio (without mangroves). Indicative value of physical damage due to flooding in absence of mangroves.
Cost of physical damage with mangroves (USD)	Hotel value multiplied by damage ratio (with mangroves). Indicated value of physical damage due to flooding with the presence of mangroves.
Cost of business disruption without mangroves (USD)	Annual revenue multiplied by damage ratio and the estimated time to rebuild (without mangroves).
Cost of business disruption with mangroves (USD)	Annual revenue multiplied by damage ratio and the estimated time to rebuild (with mangroves).
Total loss without mangroves (USD)	Flood damage (without mangroves) plus business disruption (without mangroves).
Total loss with mangroves (USD)	Flood damage (with mangroves) plus business disruption (with mangroves).
Cost of total loss avoidance due to mangroves (USD)	Flood damage (without mangroves) minus flood damage (with mangroves). Indicated value of avoided flood damage due to the mangroves.
Extent of total loss avoidance due to mangroves %	Total loss avoidance divided by flood damage (without mangroves). Indicated % of avoided flood damage and business disruption due to the mangroves.
Extent of flood reduction due to mangroves %	The difference in flood depth with and without mangroves divided by flood depth with mangroves. Indicative % of avoided flooding due to the mangroves. Relatively minor reductions in flood depth can result in significant loss avoidance.

Calculation

Figure 3
Estimating total losses with & without mangroves
(USD)



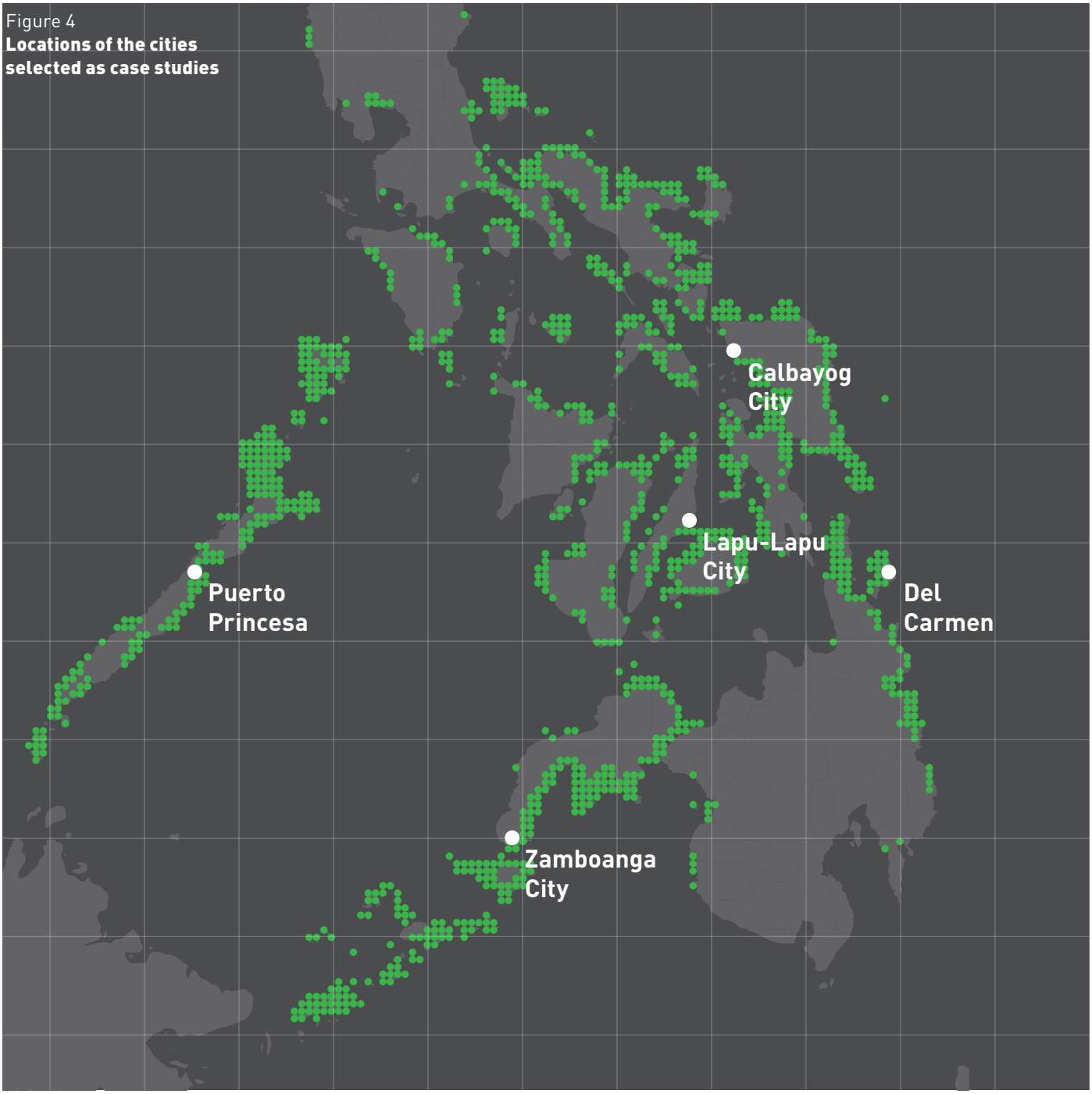
THE COASTAL PROTECTION PROVIDED BY MANGROVES MAKES THEM A TANGIBLE ASSET FOR SUSTAINABLE INVESTMENTS

3

CASE STUDIES

LOCATIONS

Figure 4
Locations of the cities selected as case studies



The selected cities are located across the Philippines. Those on the eastern seaboard of the Philippines are directly in the path of tropical cyclones emerging from the Pacific Ocean and usually where these first make landfall. Those on the west and south of the Philippines tend to be more sheltered from the worst impact of these storms.

We applied the analysis set out in section 2 to calculate the risk reduction benefits from mangroves in each of these locations. The figures examine the impact of flooding that would occur with and without mangroves under different storm conditions, and the reduction of physical damage and business disruption on hypothetical hotel assets in each of the locations:

1 Puerto Princesa, Palawan
2 Del Carmen, Siargao Island, Mindanao
3 Lapu-Lapu City, Cebu
4 Zamboanga City, Mindanao
5 Calbayog City, Samar

3.1
PUERTO PRINCESA
PALAWAN

Puerto Princesa is the capital city of the island province of Palawan and the most westerly city in the Philippines. With a population of 300,000, it is one of the least densely populated cities in the country.

Given its location in the far west, it is less vulnerable to severe tropical cyclones although still subjected to strong winds, rain, and waves. The bay on which the city is built is also susceptible to storm surges [42] although accurate historical data on storm surge levels is not readily available.[43]

Puerto Princesa has significant mangrove ecosystems and a fringing coral reef that surrounds much of it with large seagrass areas. Its 6,000 hectares of mangroves make up nearly 12 percent of the total in Palawan. There are 28 species with 11 floral associates, which identifies the entire bay as one of the most diverse mangrove forests in the country.[44]

However, mangroves in the city have a deforestation rate of 10 hectares per year, which may be partly related to increasing numbers of aquaculture fishponds. A 2016 survey noted that the area's mangroves are relatively simple structurally and that forest density has been reduced due to human disturbance; they need to be protected if their climate adaptation function is to keep providing benefits.[45] Puerto Princesa is home to many hotels and nature-based tourism destinations, including an underground river that has been listed as a UNESCO World Heritage site.

Pre-COVID pandemic, the city received approximately 1.2 million visitors annually, a mix of domestic and foreign tourists. Foreign arrivals were mainly from East Asia (Korea, China, Taiwan) with significant numbers of Europeans, North Americans, and Australians.[46]

Based on the available data, in the absence of mangroves, tropical cyclone-related floods would cause 100% damage in each of the storm scenarios. With mangroves intact, however, flood damage ranges from just 25% in the 10-year storm scenario up to 66% in a 100-year tropical storm.

Figure 5
Indicative protection value of mangroves in Puerto Princesa

	10-year storm	25-year storm	50-year storm	100-year storm
Flood damage without mangroves	100%	100%	100%	100%
Flood damage with mangroves	25%	49%	59%	66%
Damage reduction due to mangroves	75%	51%	41%	34%
Flood reduction due to mangroves	43%	43%	43%	43%

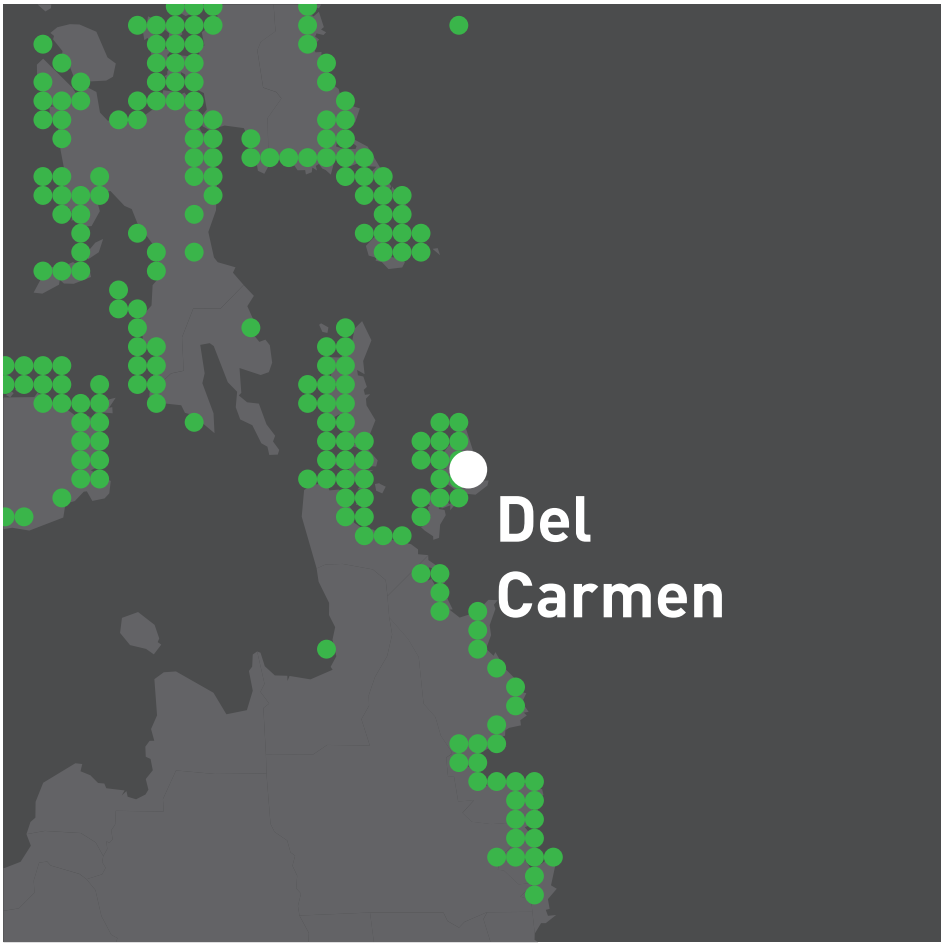
3.2
DEL CARMEN
SIARGAO ISLAND, MINDANAO

Siargao Island is on the eastern seaboard of the Philippines. It is therefore highly exposed to tropical cyclones from the Pacific Ocean and the resulting storm surges, wave action, and wind damage.

The island is on the edge of the Philippine Trench and the deep offshore waters produce strong ocean swells when they encounter Siargao's eastern-facing coral and rock reefs.[47]

Siargao is composed of 48 islands and islets, its governance divided into nine municipalities. The provincial and municipal governments have pledged to protect more than 8,600 hectares of mangroves in the area. The municipality of Del Carmen in Siargao has the largest continuous mangrove forests in Mindanao, and perhaps the whole of the Philippines.[48] Covering an area of nearly 5,000 hectares, the Del Carmen mangroves are home to 44 of the 54 mangrove species identified.[49]

Apart from its reefs, the island offers white sand beaches and mangrove lagoons. It is a popular tourist destination especially for surfers, as it is home to one of the most famous surf breaks in the Philippines, Cloud 9.[50] Western tourists made up most of the island's 200,000 annual arrivals pre-COVID, with significant numbers of Japanese and Chinese tourists as well.[51]



Siargao was severely hit by Typhoon Rai in December 2021.[52] As a result, the local government is calling for the rehabilitation of its natural shore protection. Efforts to identify appropriate recovery methods are underway while immediate actions of replanting, clean up and sustained management are also necessary.[53]

The damage sustained by mangrove ecosystems in Siargao is consistent with the analysis and makes this a potential location in which to explore a parametric insurance product for post-disaster mangrove reconstruction.

Figure 6 **Indicative protection value of mangroves in Del Carmen**	10-year storm	25-year storm	50-year storm	100-year storm
Flood damage without mangroves	100%	100%	100%	100%
Flood damage with mangroves	100%	100%	100%	100%
Damage reduction due to mangroves	0%	0%	0%	0%
Flood reduction due to mangroves	40%	37%	36%	35%

3.3
LAPU-LAPU CITY
CEBU

Lapu-Lapu City's history dates back to the 16th century in the Philippines' colonial past. It is located on the island of Mactan, just off the coast of Cebu City, the second largest in the country with its second busiest airport.

Part of the Visayan Islands in the central Philippines, this area is somewhat sheltered from the paths of tropical cyclones by islands farther to the east but still subject to heavy winds, waves, and storm surges.[54] The island is surrounded by coral reefs, although some have been destroyed by land reclamation and other urban development. Mangrove loss has also taken place in the area though the original extent of these habitats is difficult to estimate due to hundreds of years of development on the island. Some smaller adjacent islands have been flooded recently by seawater during storm surges [55] and some mangrove rehabilitation has taken place in recent years to help protect the city.[56] [57]

In 2020 after episodes of severe flooding, the city of Lapu-Lapu partnered with the Department of Environment and Natural Resources (DENR) to map and increase the protection for mangrove areas to prevent severe flooding in the future. The intention of DENR's land use plan is to certify such forests as natural assets.[58] Given its colonial past and natural beauty, Lapu-Lapu is a popular tourist destination, attracting over 1.3 million foreign visitors (mostly Koreans and Chinese) pre-COVID pandemic and a similar number of domestic tourists.[59]

For less severe tropical cyclones (1-in-10-year storms), Lapu-Lapu's limited intact mangroves still help to avoid just over a third (35%) of losses. However, this protective function decreases rapidly as storm intensity increases, with zero benefit for low-lying coastal assets in a 1-in-100-year storm.

In December 2021, Typhoon Rai also hit Lapu-Lapu as it made its 7th landfall over the neighboring town of Carcar, Cebu. A total of 101,217 houses were damaged and 370,057 people were displaced.[60] The typhoon also sunk ships that since then have been leaking oil – multiplying the threat to local coastal communities as the pollution affects marine ecosystems and local tourism.[61]

Figure 7
Indicative protection value of mangroves in Lapu-Lapu City

	10-year storm	25-year storm	50-year storm	100-year storm
Flood damage without mangroves	84%	100%	100%	100%
Flood damage with mangroves	55%	86%	99%	100%
Damage reduction due to mangroves	35%	14%	1%	0%
Flood reduction due to mangroves	16%	9%	6%	4%

3.4
ZAMBOANGA CITY
MINDANAO

Zamboanga City, in the more sheltered southwest Mindanao, is outside the historical path of tropical cyclones. It is the fifth-most populous and third-largest city in the Philippines in the commercial and industrial centre of the Zamboanga Peninsula with a population of nearly 1 million.[62]

Mangrove forests surround the southern and eastern sides of the city. The mangroves surveyed south of Zamboanga are of mixed density and just five species dominate much of the mangrove forest in the two sites. *Sonneratia alba*, *avicennia marina* and *rhizophora mucronata* are the dominant species and thus the forest floor has significant above-ground aerial roots which provide the greatest type of coastal protection.[63]

The city recognises the protective value of the mangrove forests in its Forest Land Use Plan and has engaged and promoted mangrove rehabilitation and planting programs[64] as well as other community and monitoring programs, including carbon stock assessments.[65] The vast majority of Zamboanga City's 700,000 annual tourists pre-COVID pandemic were domestic. The area's most popular tourist sites include a pink sand beach and 11 nearby offshore islands.[66]

Due to the relatively low surge levels predicted by the available data, the flood attenuation benefits of mangroves were found to be significant. Even for a 1-in-100-year tropical cyclone, the protection afforded by mangroves would reduce damage from 32% to 1%.

Figure 8 **Indicative protection value of mangroves in Zamboanga City**	10-year storm	25-year storm	50-year storm	100-year storm
Flood damage without mangroves	32%	32%	32%	32%
Flood damage with mangroves	0%	0%	0%	1%
Damage reduction due to mangroves	100%	100%	100%	96%
Flood reduction due to mangroves	29%	25%	24%	23%

3.5 CALBAYOG CITY SAMAR

Calbayog City is on the eastern coast of Samar Island. Because the city faces west, it is slightly more protected from the path of tropical cyclones approaching from the Pacific Ocean, although it receives strong winds, rains, and storm surges.[67] The city is home to nearly 200,000 people.[68]

Calbayog has significant mangrove areas and unlike some of the other cities, its mangroves have not received much attention to date. However, as part of a coastal zone planning process, a mangrove rehabilitation program started in the early 2000s because of their value for local fisheries.[69]

Calbayog City is not a particularly popular tourism destination, but it has an airport and some hotel accommodation and is famous for its mangrove mud crab restaurants. The city is an entry point to Samar, the third largest island in the Philippines and home to some lesser-known ecotourism destinations which have little supporting tourism infrastructure. Most visitors are domestic tourists.[70]

Expected loss attenuation from mangroves in Calbayog City was found to be most significant for a 1-in-10-year storm but from a 1-in-50-year storm and above, storm surge is expected to overwhelm any flood attenuation factor provided by mangroves.

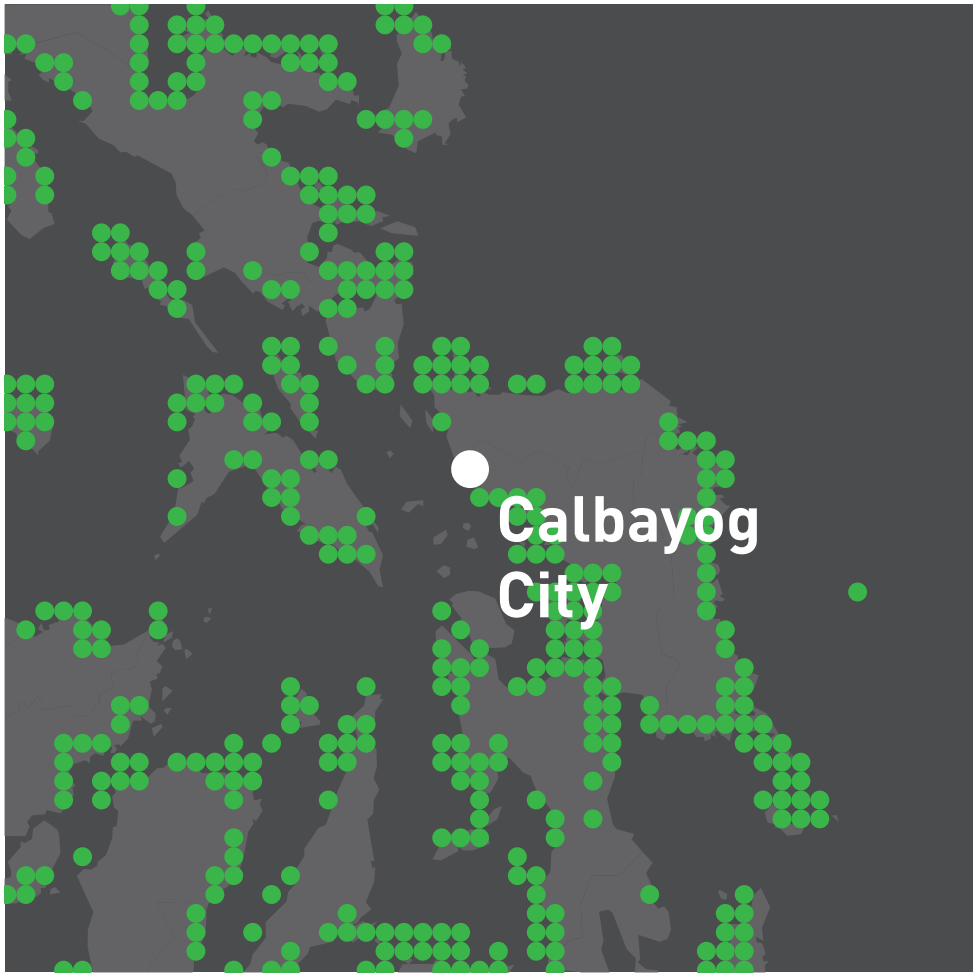


Figure 9
Indicative protection value of mangroves in Calbayog City

	10-year storm	25-year storm	50-year storm	100-year storm
Flood damage without mangroves	100%	100%	100%	100%
Flood damage with mangroves	39%	85%	100%	100%
Damage reduction due to mangroves	61%	15%	0%	0%
Flood reduction due to mangroves	33%	20%	15%	12%

Figure 10
Flood attenuation factor
Difference in flood surge with and without mangroves in selected sites across tropical cyclone scenarios

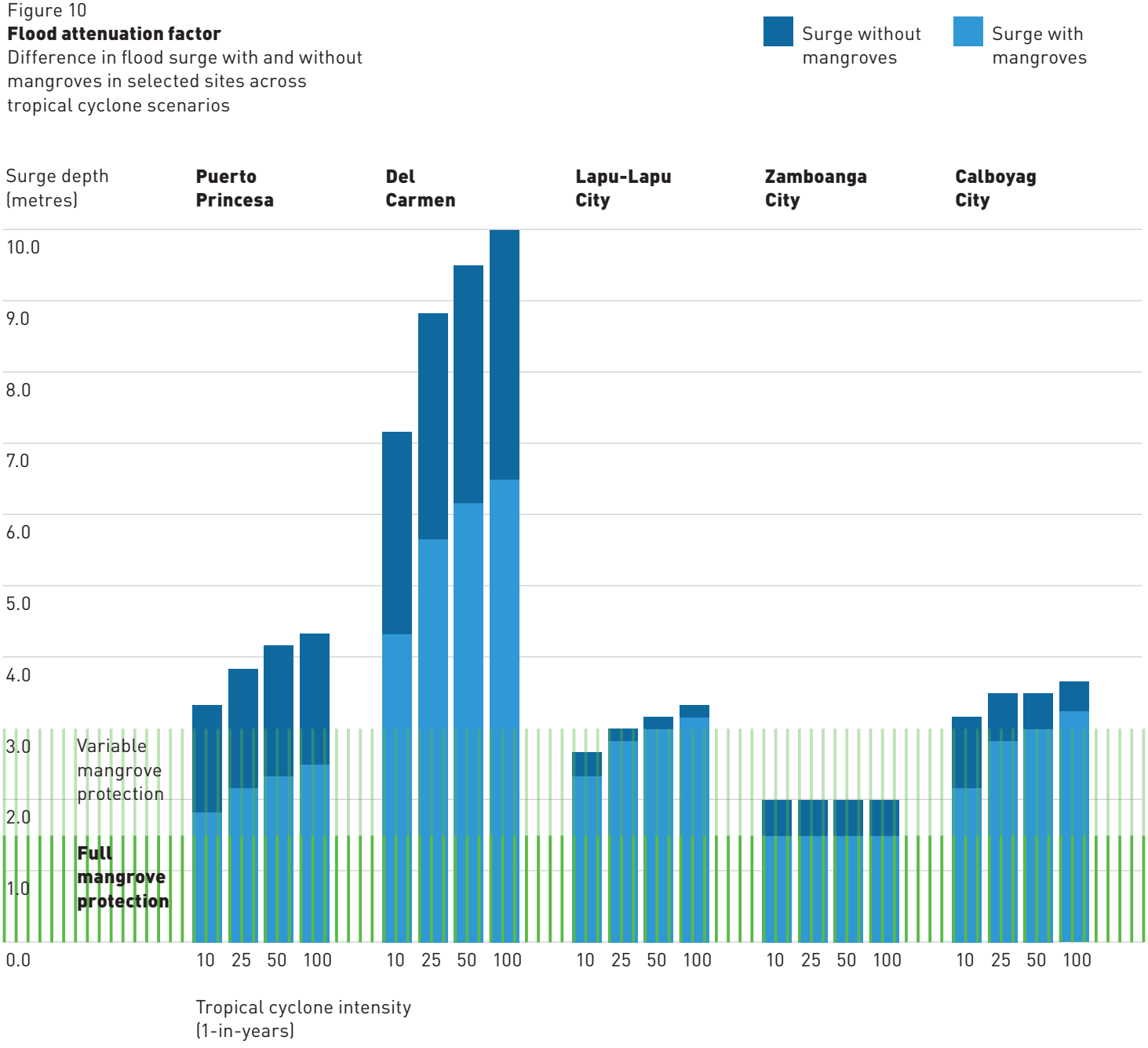
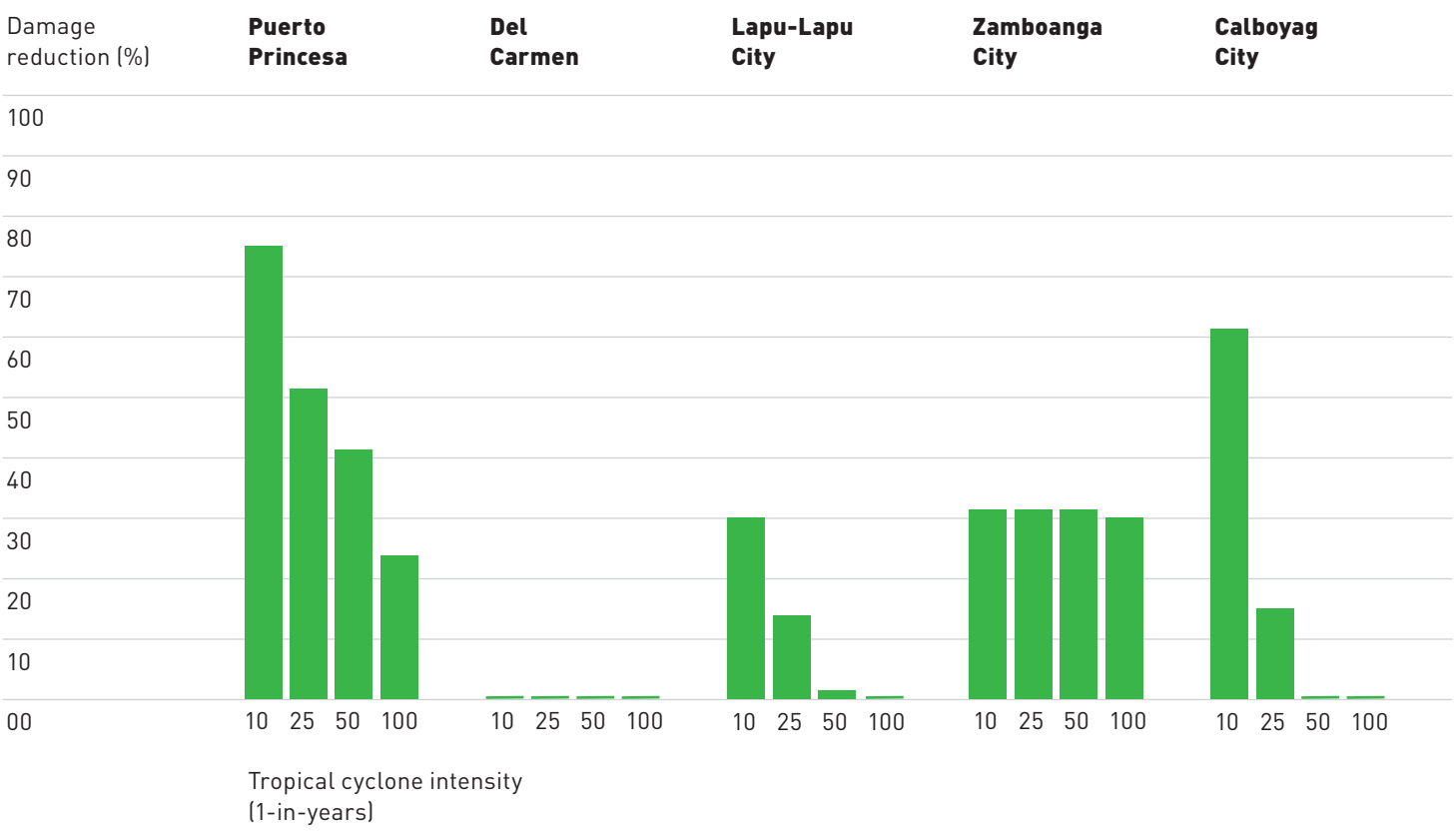


Figure 11
Reduction in damages due to mangroves



THE PROTECTION VALUE OF MANGROVES OFFERS A STRATEGIC AND COMMERCIAL OPPORTUNITY FOR RE/INSURERS, CORPORATE CLIENTS AND GOVERNMENTS

4 RECOMMENDATIONS

RECOMMENDATIONS

There is limited awareness in the re/insurance sector in the Philippines of the value of natural assets such as mangroves as a material damage attenuation factor. This approach presented in this paper is in itself new, and challenges the assumptions and methodologies used by the majority of risk underwriters and re/insurers in the country.

Re/insurers may not be properly equipped to assess the protective effect of mangroves to insured assets in their portfolios. The rigidity of CAT models available to the Philippine re/insurance sector and a lack of accurate data on the protective capacity of coastal ecosystems for underwriting and reinsurance purposes prevents the rapid adoption of such approaches.

However, the Philippines offers a business case for how a country that is highly vulnerable to climate change and abundant in mangrove ecosystems, can make nature-based solutions a key vector of growth of green investments. There is a role for financial services, including re/insurance, to apply this thinking in business development strategies.

A market that increasingly prizes green investments and climate resilience is one that opens opportunities for action, despite having imperfect information. There is an urgent financial and moral imperative to stop the degradation and deforestation of these vital ecosystems, and to attenuate the vulnerability of coastlines, communities and assets to climate change.

Re/insurers

Mobilise chief underwriters, client advisory services, and investment managers to factor mangroves' unique protective value into portfolios, underwriting processes and business development opportunities. Developing pilot projects and prototypes together with leading corporate and government clients will demonstrate the value of green infrastructure as a risk mitigation solution, and support clients to build more resilient businesses.

Corporate clients

Companies with insured physical assets and operations within mangrove ecosystems need to lead the integration of sustainability criteria into core business strategy and operational processes. They can do this by identifying those assets or locations and engaging with insurance providers to co-develop risk management tools and insurance products that incorporate natural capital. From a corporate strategy perspective, this works to achieve outstanding sustainability outcomes and leadership on climate resilience, while adding the value of natural assets onto corporate balance sheets.

City governments

Chief executives of Local Government Units (LGUs) can collaborate with government-backed re/insurers to recognise the protection value provided by mangroves to municipal buildings and infrastructure. They can allocate public investment for climate resilience towards the conservation and restoration of mangrove and coastal ecosystems as a risk mitigation strategy. Where mangroves are at high risk from tropical cyclones, local governments can also work with private re/insurers to develop mangrove-linked insurance products that can support ecological restoration after strong tropical cyclones.

Government regulators

Insurance regulators must evaluate the policy options to support the re/insurance sector to make use of the country's natural assets in mitigating climate risks, especially given the potential to reduce losses to companies, customers and the government. These can include tax reductions for insurance products that incentivise the protection of coastal ecosystems, or mandatory disclosures of nature-related financial risks, in particular in coastal jurisdictions, in line with the Task Force for Nature-related Financial Disclosures (TNFD). As our strategic partner in this work, the Philippine Insurance and Reinsurance Association (PIRA) offers a common platform for industry dialogue on these policies.

Universities and NGOs

This study uses a landmark scientific study in the Philippines developed as a collaboration between universities and NGOs, showing the potential for such research to help define policy and corporate priorities. Other initiatives, including open-source CAT modelling platforms such as the OASIS Loss Modelling Framework, stand to benefit from continued funding from the re/insurance sector to address key data needs. More funding and collaborations are needed between scientists and NGOs and re/insurance companies, including through the development of global data initiatives to address gaps in ecological and hydrological analysis, in a format that can be integrated into re/insurance decisions.

INFORMATION

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Cover

The cover of the report depicts the Philippines mangroves in green, the five cities studied in the analysis, and historical tropical cyclone paths (1951–2014).

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