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PHÂN TÍCH DỰA TRÊN NGUỒN LỰC VỀ BẢO HIỂM RẠN SAN HỒ THAM SỐ TẠI QUINTANA ROO VÀ HÀM Ý CHÍNH SÁCH CHO VIỆT NAM

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Tóm tắt

Rạn san hô là cơ sở hạ tầng tự nhiên quan trọng đối với các nền kinh tế ven biển phụ thuộc vào du lịch. Chúng giúp giảm năng lượng sóng, bảo vệ bờ biển và tạo ra giá trị kinh tế lớn. Tuy nhiên, bão nhiệt đới ngày càng gia tăng đã làm lộ rõ khoảng trống thanh khoản: trong khi bảo hiểm bồi thường truyền thống chi trả chậm, rạn san hô lại cần được phục hồi nhanh để tránh tổn thất không thể đảo ngược. Nghiên cứu này áp dụng Lý thuyết Nguồn lực (RBV) và lý thuyết khả năng chống chịu xã hội-sinh thái để đánh giá mô hình bảo hiểm rạn san hô tham số tại Quintana Roo, Mexico. Phân tích cho thấy các ngưỡng kích hoạt xác định trước, như tốc độ gió vượt 100 knots trong khu vực bảo hiểm, cho phép chi trả nhanh sau thiên tai. Nguồn vốn này hỗ trợ các đội phục hồi rạn san hô, giúp ổn định các rạn bị hư hại sau bão và bảo vệ rạn san hô như tài sản VRIN duy trì năng lực cạnh tranh du lịch. Về thực tiễn, mô hình này gợi mở một khung tham chiếu cho Việt Nam thông qua quỹ tín thác địa phương, cơ chế tài chính hỗn hợp và năng lực phản ứng nhanh.

Từ khóa: bảo hiểm tham số, bảo vệ rạn san hô, Quintana Roo, tài sản công tự nhiên, rủi ro khí hậu

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A RESOURCE-BASED ANALYSIS OF PARAMETRIC REEF INSURANCE IN QUINTANA ROO AND POLICY IMPLICATIONS FOR VIETNAM

Abstract

Coral reefs function as critical natural infrastructure in tourism-dependent coastal economies. They can reduce wave energy by up to 97%, protect coastlines, and support billions of dollars in tourism revenue. However, intensifying storms expose a major liquidity gap: traditional indemnity insurance often delivers delayed payouts, while reefs require rapid stabilization within short biological windows to prevent irreversible damage. This study applies the Resource-Based View (RBV) and socio-ecological resilience theory to examine the parametric coral reef insurance scheme in Quintana Roo, Mexico. Using qualitative analysis of policy and institutional documents, the study shows how predefined triggers—such as wind speeds exceeding 100 knots—enable rapid insurance payouts. These funds support restoration brigades in stabilizing damaged reefs after hurricanes, helping protect reefs as VRIN (valuable, rare, inimitable, non-substitutable) assets sustaining tourism competitiveness. The findings highlight how public–private trusts and tourism-fee financing can transform natural capital into a resilience asset, offering policy insights for ecosystem-based climate risk financing in Vietnam.

Keywords: parametric insurance, coral reef protection, natural public asset, Quintana Roo, climate risk

1. Introduction

1.1. Research rationale

Coral reefs are vital natural infrastructure that supports coastal protection, tourism, and marine biodiversity. Reef structures can reduce up to 97% of incoming wave energy, with the reef crest dissipating about 86%, significantly lowering risks of coastal flooding and storm damage (Ferrario et al., 2014). As a result, hundreds of millions of coastal residents benefit from the protection provided by coral reefs, highlighting their importance for climate resilience and economic stability.

In Mexico, coral reefs play a key role in the Caribbean tourism economy. The Mesoamerican Reef, the second-largest barrier reef system in the world, extends over 1,000 km across Mexico, Belize, Guatemala, and Honduras, including major tourism destinations such as Cancún and Playa del Carmen. Globally, coral reef tourism generates around USD 36 billion annually, accounting for more than 9% of coastal tourism value in reef countries (Spalding et al., 2017).

In Vietnam, coral reefs also support coastal development. The country has about 1,122 km² of reef ecosystems, mainly along the central and southern coasts (Burke et al., 2011). These reefs support tourism in Nha Trang, Phu Quoc, and Con Dao, highlighting the need for effective protection to sustain tourism and strengthen coastal resilience.

1.2. Research Problem

Vietnam's coral reef ecosystems face increasing climate risks, particularly tropical storms and rising sea temperatures. Extreme weather has already caused major damage in coastal areas. For example, Typhoon Damrey in 2017 destroyed about 70–80% of coral reefs in parts of Nha Trang Bay, including Hon Mun and Hon Tam. In Hon Tam, live coral cover fell from 56.8% in July 2017 to 12.5% by December 2017 (VietnamPlus, 2022).

Coral reefs in the bay also experienced severe bleaching, with a 39.5% bleaching rate recorded in 2019. Despite these growing risks and ecosystem losses, coral reefs rarely receive direct financial protection or structured funding for rapid post-disaster recovery.

1.3. Research Objectives

This study analyzes the parametric coral reef insurance programme in Quintana Roo, Mexico, and evaluates its potential relevance for Vietnam.

First, the study analyses the design and implementation of the Quintana Roo scheme, including its institutional structure, stakeholder collaboration, and financing arrangements supporting insurance premiums and post-disaster reef restoration (Green Finance Institute, n.d.; TNC, 2024).

Second, it evaluates the effectiveness of parametric insurance in providing rapid financial resources for reef restoration and reducing delays associated with conventional disaster financing.

Finally, the study identifies lessons from the Quintana Roo experience and proposes policy recommendations for Vietnam.

1.4. Research Questions

This study is guided by four key research questions examining the operation, effectiveness, and policy relevance of the parametric coral reef insurance model in Quintana Roo, Mexico:

(1) How does the Quintana Roo parametric reef insurance model operate institutionally and financially?

(2) How effective is the parametric reef insurance mechanism in supporting coral reef protection and restoration?

(3) What lessons can be derived from the Quintana Roo case for financing coral reef protection?

(4) To what extent could similar insurance-based mechanisms be adapted for coral reef protection in Vietnam?

1.5. Research Scope and Subjects

This study examines parametric insurance as a financial tool for coral reef protection, focusing on the case of Quintana Roo, Mexico, while also considering Vietnam as a secondary context for potential application.

It covers three main aspects. First, it explores the institutional design of the scheme, including stakeholder roles and coordination. Second, it analyses the financial mechanism, particularly trigger conditions, payout structures, and premium financing. Finally, it evaluates how this model could be adapted to Vietnam's institutional and coastal management context.

The study focuses on three key subjects: the parametric insurance mechanism as a disaster risk financing tool, the institutional actors involved, and coral reefs, which are viewed as both ecological systems and valuable economic assets.

2. Research methodology

This study is conducted in three main stages within a qualitative research design. First, the research framework is developed. Next, data are collected through structured document analysis. Finally, the data are analysed to examine the insurance model and its applicability to Vietnam.

An explanatory single-case study approach is used, focusing on the parametric reef insurance scheme in Quintana Roo, Mexico. This allows the study to explore how insurance triggers, payouts, and reef restoration outcomes are connected in practice.

Data are collected from secondary sources, including academic studies, institutional reports, and policy documents. Key materials come from organizations involved in the scheme, while Vietnamese legal documents are used to assess feasibility.

The analysis applies qualitative content analysis. It reconstructs the insurance mechanism, interprets its effectiveness, and then compares Quintana Roo with Vietnam to evaluate the potential for policy transfer.

3. Literature review

3.1. Parametric Insurance: Concept and Mechanism

Parametric insurance, often referred to as index-based risk transfer, differs from traditional indemnity insurance. While traditional insurance compensates based on verified damage – often involving high administrative costs and long settlement periods – parametric insurance provides payouts when a predefined external indicator, such as wind speed, rainfall, or earthquake magnitude, reaches a specific threshold (Barnett & Mahul, 2007). The trigger is objectively measured and independent of the policyholder's actions.

The main advantage of this model is its speed and efficiency. Cummins and Mahul (2009) note that parametric insurance enables rapid payouts, which are especially valuable in disaster situations where immediate funding is crucial for response and restoration. Because payouts rely on satellite data or weather stations rather than human loss assessments, the system also reduces moral hazard and adverse selection (Carter et al., 2017).

However, the mechanism has a key limitation known as “basis risk,” referring to the mismatch between the trigger index and actual losses experienced (Jensen and Barrett, 2016).

3.2. Empirical Evidence on Parametric Insurance for Natural Ecosystems

Research on financing natural capital has increasingly shifted from public funding to market-based mechanisms. Sumaila et al. (2021) identify a major financing gap in marine conservation and argue that private capital should be mobilized through financial instruments such as blue bonds and insurance-linked securities. However, their study does not explain how these tools can be applied to non-revenue-generating assets like coral reefs.

Beck et al. (2018) estimate the economic value of coral reefs in coastal protection and argue that reefs provide services comparable to engineered infrastructure, suggesting they could be insured similarly. However, the study does not address governance challenges such as property rights and identifying a clear policyholder.

Reguero et al. (2020) analyze the parametric insurance model for the Mesoamerican Reef in Quintana Roo and show that rapid payouts enable immediate reef repairs and protect coastal economies. Nevertheless, the study focuses mainly on economic efficiency and does not examine the institutional capacity required to implement such schemes.

3.3. Research Gap

The literature reveals two key research gaps addressed in this report.

First, there is a theoretical gap regarding the organizational requirements for parametric reef insurance. Existing studies mainly focus on financial and engineering feasibility, while limited research applies the Resource-Based View (RBV) to examine internal capabilities – such as governance, technical expertise, and cross-sector coordination – needed to sustain such mechanisms.

Second, there is a contextual gap related to Vietnam. Most empirical research focuses on the Caribbean and Latin America, with limited studies examining how the parametric reef insurance model could be applied in Southeast Asia.

This study addresses these gaps by assessing the Quintana Roo model and its relevance for Vietnam.

4. Theoretical framework

4.1. Resource-based view (RBV)

The Resource-Based View (RBV) was introduced by Wernerfelt (1984) and later formalized by Barney (1991). The theory argues that sustained competitive advantage arises when an organization controls resources that are valuable, rare, inimitable, and non-substitutable (VRIN). Traditionally, RBV has been applied at the firm level to explain why some companies outperform others over time.

The framework has also been extended to environmental contexts. Hart (1995) developed the Natural-Resource-Based View (NRBV), suggesting that constraints imposed by the natural environment can become sources of competitive advantage. In this perspective, natural capital – such as clean water, pollution-prevention technologies, or unique geographic locations – can function as strategic resources.

These studies highlight that environmental assets are not merely externalities but are essential resources influencing economic resilience and regional competitiveness (Aragón-Correa and Sharma, 2003).

4.2. Resilience Theory

Organizational Resilience Theory, originally developed in ecology and engineering, is now widely used in disaster management. Holling (1973) defined resilience as a system's ability to absorb disturbances while maintaining core functions. Later studies emphasize adaptive capacity, or the ability to manage crises and maintain essential functions during disruptions.

Bruneau et al. (2003) identify four key resilience properties: robustness, redundancy, resourcefulness, and rapidity. This study focuses particularly on resourcefulness and rapidity when evaluating financial response mechanisms.

5. Case analysis: the Quintana Roo parametric reef insurance model

5.1. Case Description

The Quintana Roo parametric reef insurance provides rapid funding for coral reef protection, first triggered during Hurricane Delta in 2020 with a USD 850,000 payout for reef stabilization (AP-PLAT, 2023; TNC, 2021).

5.1.1. Case Background

Located on the eastern coast of the Yucatán Peninsula, Quintana Roo lies within the Atlantic “Hurricane Alley,” making it highly exposed to cyclonic storms that threaten coral reefs and coastal infrastructure. Its main natural defense is the Mesoamerican Reef (MAR), the world's second-largest barrier reef system. Coral reefs can absorb up to 97% of wave energy, significantly reducing coastal damage (Ferrario et al., 2014). Without them, global flood damages would double and storm losses would triple (Beck et al., 2018), highlighting their role as critical risk-reduction assets requiring protection and rapid post-storm restoration (Swiss Re, 2024; TNC, 2018).

Quintana Roo's economy is heavily dependent on tourism, with destinations such as Cancún, Cozumel, and Puerto Morelos relying on reef health (TNC, 2018, 2019). The sector is valued at about USD 9 billion, with more than 300 hotels and 100,000 rooms (TNC, n.d.). Reef degradation therefore threatens both coastal stability and economic activity. In addition, the reef attracts over one million visitors annually, generating about USD 60 million for local operators and preventing roughly USD 42 million in structural damage, including USD 20.8 million in avoided hotel losses (Reguero et al., 2019).

5.1.2. Structure of the Insurance Scheme

- *Subject matter of insurance:* Quintana Roo's coral reef system and the coastal protection services it provides across approximately 167 kilometers of shoreline.
- *Policyholder:* Domestic insurers Seguros Afirme and Seguros Banorte issue the policy to the CZMT, while most risk is transferred to global reinsurance markets through one-year renewable contracts (IDB, 2021; TNC, 2019, 2021). The 2019 policy

was backed by Swiss Re, and the 2020 renewal involved Hannover Re as core reinsurer with Global Parametrics providing meteorological modelling.

- *Trigger Mechanism:* The policy applies a “cat-in-the-box” parametric trigger: payouts occur when a hurricane enters the 167-km reef zone with wind speeds above 100 knots (IDB, 2021). Data are independently verified by sources such as the U.S. National Hurricane Center, avoiding slow damage assessments (TNC, 2019; IDB, 2021).

- *Payout:* To align financial compensation with ecological damage, the policy applies a proportional tiered payout structure.

INSURANCE POLICY AND PAYOUT STRUCTURE						
POLICY TERM	COVERAGE AREA	TRIGGER	MAXIMUM PAYOUT	CHARACTERISTICS OF INSURANCE POLICY	USD	MEXICAN PESOS
1 year	167 km of coastline	≥ 100 knots	USD 3.8 million (2019)	Cost of the policy	250,000	4,995,000
				Payout at 100 knots (40%)	850,000	17,000,000
			USD 3.8 million (2019)	Payout at 130 knots (80%)	1,700,000	34,000,000
				Maximum payout at 160 knots or more (100%)	2,125,000	42,500,000

Figure 1. The Quintana Roo reef insurance structure

CAPITAL ALLOCATION

Figure 5 | CASH FLOWS FOR THE COASTAL MANAGEMENT TRUST

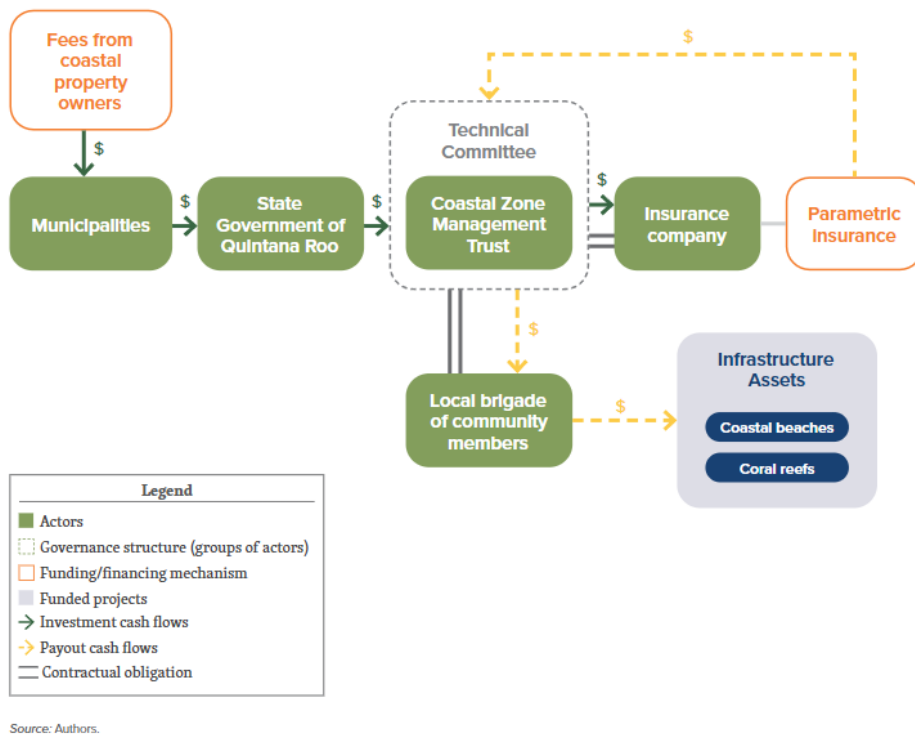


Figure 2. Cash Flow for the Coastal Management Trust

The Quintana Roo Coastal Management Trust operates through a circular cash flow system linking public governance with private-sector risk transfer. Coastal property owners, mainly large resorts, contribute fees through the federal maritime land zone tax (Zofemat), which are collected by municipalities and routed through the State Government of Quintana Roo into the CZMT (TNC, 2019). A Technical Committee comprising state officials, scientists, and NGOs such as TNC oversees the allocation of these funds for maintenance and disaster resilience (Reguero et al., 2020).

Using part of this revenue, the Trust pays annual premiums for parametric insurance to the global insurance market (Swiss Re, 2020). Unlike traditional indemnity insurance, this mechanism releases emergency funds when a hurricane exceeds predefined thresholds, such as wind speeds above 100 knots within the insured reef polygon (Secchiari et al., 2021). This was activated during Hurricane Delta in 2020, when approximately USD 850,000 was paid into the Trust and immediately transferred to local reef brigades (Swiss Re, 2020). These trained fishermen and divers carried out time-sensitive restoration, including reattaching broken coral fragments and uprighting overturned coral heads, to support the rapid recovery of reefs and beaches (TNC, 2019; World Bank, 2021).

5.1.3. Results

The Quintana Roo Coastal Management Trust collects Zofemat maritime land tax revenues from coastal property owners, mainly resorts, which are transferred through municipalities and the state government into the Trust (TNC, 2019). A Technical Committee of government

officials, scientists, and NGOs such as TNC oversees the use of these funds for reef management and disaster resilience (Reguero et al., 2020).

Part of the revenue is used to purchase parametric insurance in the global market (Swiss Re, 2020). When hurricane wind speeds exceed 100 knots within the insured reef zone, the policy releases emergency funds (Secchiari et al., 2021). During Hurricane Delta in 2020, this triggered a payout of about USD 850,000, which was transferred to local reef brigades for rapid coral restoration (TNC, 2019; World Bank, 2021).

5.2. Analytical Evaluation

5.2.1. Strategic Asset Protection

From a Resource-Based View perspective, competitive advantage depends on protecting valuable, rare, inimitable, and non-substitutable (VRIN) resources (Barney, 1991). The Mesoamerican Reef along the coast of Quintana Roo functions as a strategic natural asset, generating economic value through coastal protection, tourism, biodiversity, and fisheries. Its protective function alone significantly reduces flood damage costs (Reguero et al., 2018). Artificial coastal defenses cannot replicate these ecological services at comparable cost, and reef ecosystems develop over centuries, making them effectively inimitable.

The parametric insurance scheme therefore represents a shift from traditional revenue protection toward asset preservation. Rather than compensating businesses for losses, the Quintana Roo model insures the ecological asset itself. By enabling rapid post-storm reef stabilization, the mechanism helps protect the long-term productive capacity of the tourism economy. In RBV terms, it acts as a capability that safeguards a VRIN resource. However, its long-term effectiveness depends on whether post-payout interventions consistently maintain ecological integrity under repeated climate shocks.

5.2.2. Rapid Liquidity Mechanism

Resilience theory highlights the ability of systems to absorb disturbances and maintain core functions (Folke, 2006). For coral reefs, response time is critical, as recovery windows after storms are limited and delays can turn reversible damage into permanent degradation.

The Quintana Roo scheme addresses this challenge through parametric insurance, where payouts are triggered automatically when meteorological thresholds such as hurricane wind speeds are exceeded. Because the mechanism relies on objective parameters rather than post-disaster damage assessments, funds can be released relatively quickly. During Hurricane Delta in 2020, the policy triggered and funds were disbursed within weeks to support reef restoration (Reguero et al., 2020), whereas traditional indemnity insurance typically requires lengthy verification.

In practice, the mechanism provides rapid liquidity that enables trained restoration teams to stabilize damaged reefs soon after storms. However, resilience also depends on institutional coordination and implementation capacity, as effective recovery requires trained personnel, equipment, and appropriate governance arrangements.

5.2.3. Strengths and Limitations

The scheme shows key structural strengths. Liquidity aligns with reef recovery windows, addressing a major management gap. The trust-based structure links government, private actors, and conservation groups, while PPP financing secures tourism-sector premium contributions. Objective meteorological triggers enhance transparency and reduce disputes.

Limitations persist. Basis risk arises because payouts depend on storm parameters rather than actual damage, so losses may occur without disbursement. Premium sustainability is uncertain, as stronger hurricanes can increase actuarial costs and strain reinsurance markets. Effectiveness also relies on governance capacity and trained response teams; without them, rapid payouts may not ensure ecological recovery.

Overall, the scheme combines financial tools with ecosystem management, improving short-term resilience and protecting a strategic natural asset. Long-term viability depends on sustainable premiums, lower basis risk, and consistent institutional performance under rising climate risks.

6. Policy implications for Vietnam

6.1. Comparative Context: Mexico and Vietnam

6.1.1. Natural Differences

In Quintana Roo, Mexico, hurricanes are the main hazard affecting coral reefs, generating strong localized winds that directly damage reef structures (TNC, 2018; Gardner et al., 2005; TNC, 2022). Because wind speed is closely linked to the level of damage, a simple wind-speed trigger can be used to activate insurance payouts.

In Vietnam, coastal areas are exposed to typhoons from the South China Sea, which bring not only strong winds but also heavy rainfall and land runoff (Couasnon et al., 2023; Institute of Actuaries of Australia, 2026). This runoff alters salinity and increases sedimentation, leading to longer-term ecological damage beyond immediate physical impacts (WB, 2016; Narayan et al., 2016).

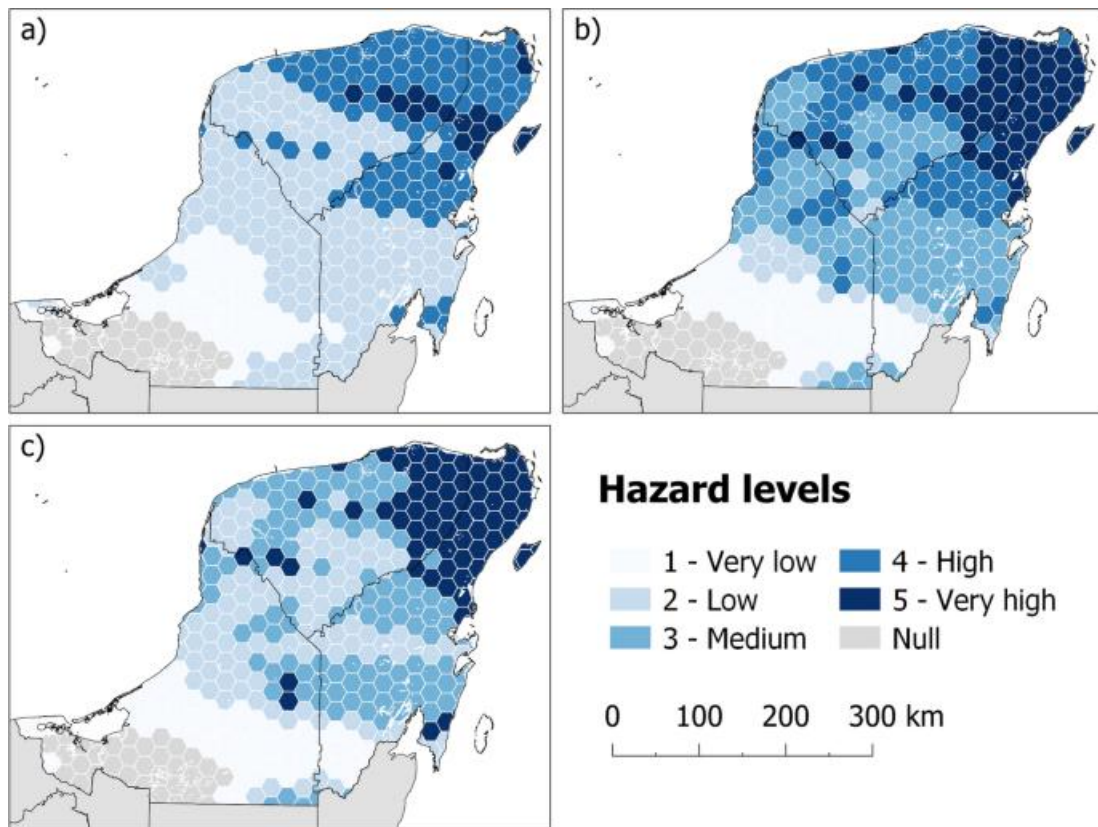


Figure 3. Spatial distribution of hurricane hazard levels in Quintana Roo for years (a) 2000, (b) 2010, and (c) 2020

Source: Romero and José Francisco León-Cruz, 2024

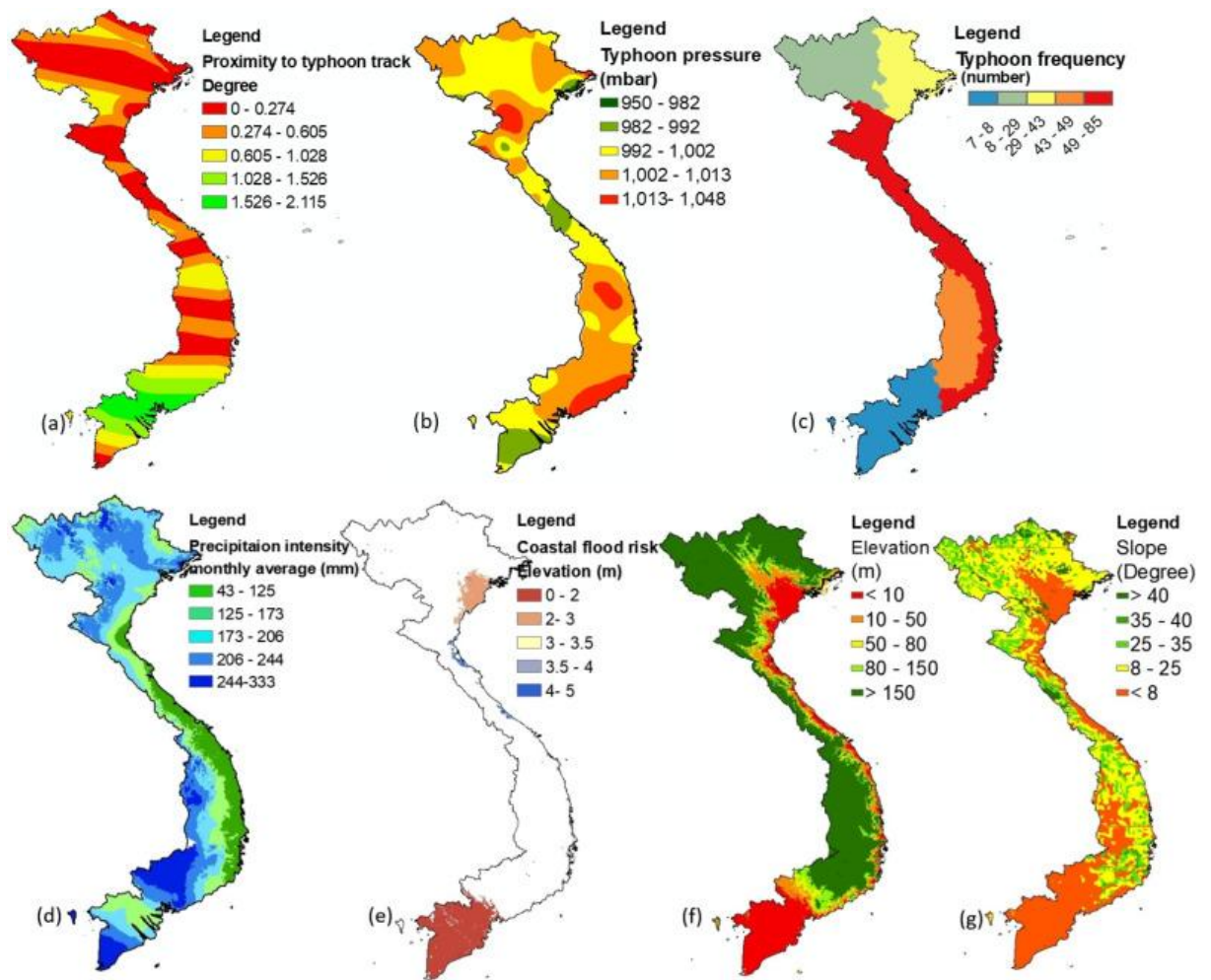


Figure 4. Vulnerability of Vietnam to typhoons

Source: Nguyen, Liou and Terry, 2019

Geography also affects the feasibility of parametric insurance. In Quintana Roo, coral reefs are part of the Mesoamerican Barrier Reef System and are located close to major tourism areas (Ferrario et al., 2019; Green Finance Institute, 2025). This spatial alignment between reefs, hurricane paths, and tourism infrastructure allows wind measurements in a defined area to indicate reef damage, reducing basis risk and enabling a standardized trigger system (Green Finance Institute, 2025; Reguero et al., 2019).

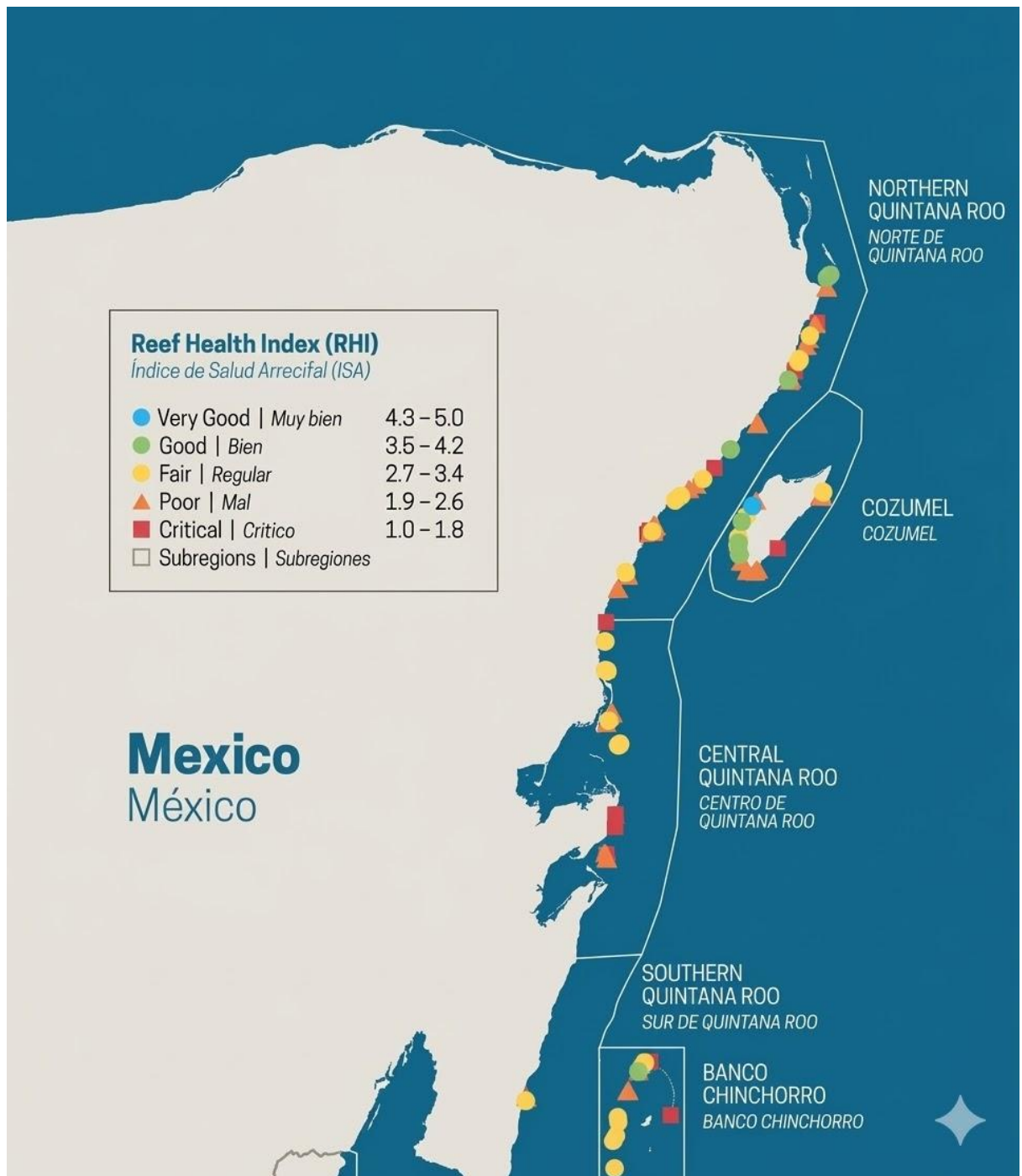


Figure 5. The distribution of coral reef in Quintana Roo

Source: *Punta Sur Divers. (n.d.)*

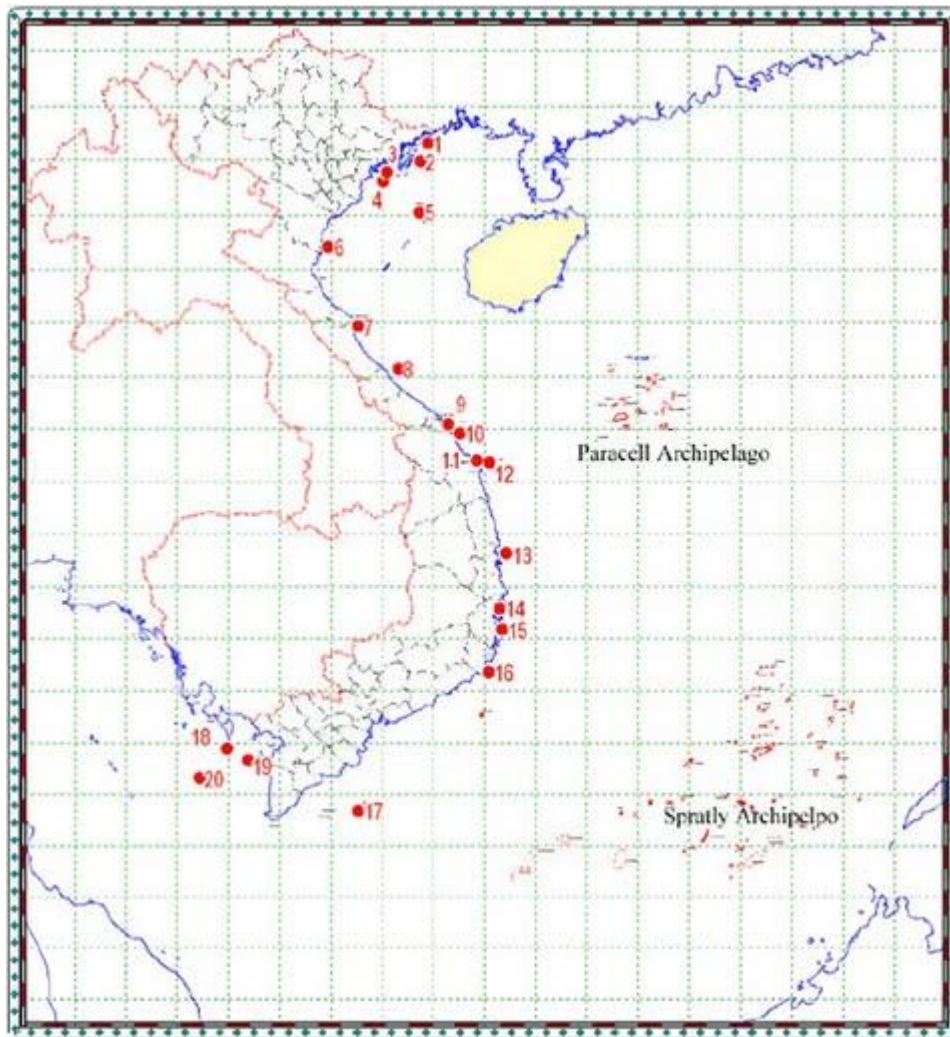


Figure 6. The distribution of coral reef in Vietnam

Source: Son et al, 2007

In contrast, Vietnam's coral reefs are fragmented and spread across regions such as Nha Trang or Phu Quoc (Nguyen et al., 2021). These areas differ in monsoon exposure, river discharge, sediment levels, and coastal conditions. Because of these differences, the link between weather indicators and reef damage is less consistent, requiring localized calibration or multiple triggers.

6.1.2. Economic Structure and Governance Differences

The feasibility of parametric reef insurance depends not only on hazard exposure but also on how coral reefs are valued as economic assets. In Quintana Roo, the economy is highly reef-dependent, with tourism activities closely linked to the Mesoamerican Barrier Reef System. Coral reefs generate hundreds of millions of USD annually, creating strong incentives for both government and businesses to support protection mechanisms such as insurance (TNC, 2018; Narayan et al., 2016).

In Vietnam, coral reefs also provide significant value, estimated at over USD 1 billion annually, with Nha Trang Bay alone generating around USD 60–70 million (Long and Vo, 2013;

Quach, 2018). However, tourism is more diversified, so reef degradation is often seen as an indirect risk, reducing incentives for private investment.

Institutional differences further limit feasibility. Quintana Roo benefits from a dedicated coordination mechanism that enables rapid funding for reef restoration. In contrast, Vietnam's governance remains centralized, and current legal frameworks do not recognize coral reefs as insurable assets. As a result, the main barrier lies in institutional and financial readiness rather than environmental conditions.

6.2. Strategic and Resilience Gap in Vietnam

Four critical gaps constrain the applicability of the Quintana Roo reef insurance model in Vietnam. First, a strategic gap exists in how coral reefs are positioned within the economic system. While the Quintana Roo model treats reefs as strategic assets supporting tourism competitiveness, Vietnam largely manages marine ecosystems as vulnerable public goods rather than revenue-generating natural infrastructure. As a result, despite evidence that reef degradation in areas such as Nha Trang reduces long-term economic returns, the hospitality sector has not fully internalized reefs as core business assets, limiting incentives for private financing.

Second, an institutional gap restricts rapid ecological recovery, as existing disaster funds mainly focus on rebuilding human infrastructure through administrative processes rather than financing ecosystem stabilization.

Third, a market gap exists because Vietnam's insurance sector relies on traditional indemnity products that require post-disaster damage assessments and do not insure public biological assets.

Fourth, a timing gap arises because reefs require stabilization within weeks, while public financing is typically disbursed much later.

6.3. Recommendations

6.3.1. Insurance Design

Subject Matter of Insurance

Physical structure of coral reefs, with coverage focused on measurable mechanical damage to reef frameworks.

Spatial Coverage

Because coral reefs are widely distributed along Vietnam's coastline, a pilot parametric insurance scheme should focus on reef areas with the highest ecological and economic value rather than nationwide coverage.

Nha Trang Bay's coral reef ecosystem services generate about USD 31.5 million annually, including USD 23.7 million from reef tourism (Ngoc, 2019). Con Dao received nearly 590,000 visitors in 2024, generating about VND 2,360 billion (≈USD 95 million) in tourism revenue (Con Dao District People's Committee, 2024). Phu Quoc Island welcomed more than 5.2 million visitors in the first seven months of 2025, producing about VND 24,866 billion (≈USD

1 billion) in tourism revenue (Kien Giang Department of Tourism, 2025). These figures show the strong economic value of reef-dependent tourism.

Based on this data, three reef clusters are suitable for a pilot scheme. Targeting high-value reef polygons improves financial feasibility while protecting ecosystems that generate major tourism and coastal protection benefits.

Policyholder

The policyholder should be a public or semi-public organization responsible for coastal marine resource management. Vietnamese insurance law requires the policyholder to have a legitimate financial interest in the insured asset.

Because coral reefs are state-owned natural resources, individual tourism businesses cannot hold exclusive insurable interest. Instead, an organization representing the collective interests of the coastal region should act as the policyholder. Damage to coral reefs would reduce tourism revenue, affect fisheries productivity, and increase public spending on coastal protection and restoration. These economic consequences create a clear insurable interest.

Peril

Typhoons are selected as the insured peril because they meet the requirements of parametric insurance. Vietnam's long coastline lies along major typhoon corridors, and these storms can quickly damage coral reef structures, especially in central and south-central regions.

Coral bleaching should be excluded. Typhoons are sudden events, while bleaching results from long-term ocean warming and is highly predictable. Insuring predictable losses would require extremely high premiums. In addition, rapid payouts cannot address bleaching because funding cannot reduce ocean temperatures. Bleaching therefore requires long-term environmental management rather than catastrophe insurance.

Insurer

Vietnam's Law on Insurance Business (2022) does not allow foreign reinsurers to directly issue policies to local public entities. Therefore, a domestic insurer must issue the policy and transfer the main risk to international reinsurers.

Bao Minh Insurance Corporation

Bao Minh is a strong candidate for the fronting role due to its experience with index-based insurance programs. It participated in the National Agricultural Insurance Pilot Program under Decree 58/2018/ND-CP, which used weather indices to trigger payouts (Government of Vietnam, 2018). This experience with parametric mechanisms makes Bao Minh capable of managing a wind-based coral insurance policy. Its partial state ownership also supports cooperation with public authorities.

PVI Insurance

PVI Insurance could also act as a fronting insurer or consortium member. As Vietnam's market leader in industrial, energy, and marine insurance, PVI has the technical capacity to

manage large coastal risks. It also holds an “A-” financial strength rating from AM Best (AM Best, 2024), which is important for cooperation with international reinsurers.

Vietnam National Reinsurance Corporation – VINARE

VINARE must serve as the national reinsurance bridge. Domestic insurers cannot absorb large typhoon losses alone, so catastrophic risk must be transferred to VINARE, which then retrocedes the exposure to global reinsurance markets. Swiss Re, a developer of the Quintana Roo model, holds a 25% strategic stake in VINARE (Swiss Re, 2023), providing access to international reinsurance capacity.

Trigger Mechanism

During the pilot phase, the “cat-in-the-box” mechanism should insure only the most valuable coral ecosystems. Instead of covering the entire coastline, geographic polygons are drawn around key Marine Protected Areas (MPAs). This targeted design controls premiums while protecting reefs that generate major tourism and coastal protection value.

A payout is triggered when a typhoon passes through the defined polygon and wind speeds exceed a predetermined threshold. Wind intensity can be measured using the Beaufort Wind Force scale, which classifies wind speeds into standardized levels. Level 12 represents hurricane-force winds capable of causing serious reef damage.

Because the Beaufort scale is used in Vietnam’s national storm warning system, adopting it as the contract index ensures clarity. When the Vietnam Meteorological and Hydrological Administration (VNMHA) records wind speeds reaching the insured level within the polygon, the payout is triggered automatically. This removes subjective damage assessments and allows rapid funding for reef restoration.

Payout Structure: Stepped-Intervention Function

The policy should use a stepped payout structure instead of a binary trigger. Coral reef damage increases with storm intensity (Puotinen, 2007). Moderate storms may dislodge coral fragments, while stronger storms can fracture reef structures.

The payout structure should therefore match restoration costs. Storms at Beaufort Force 10–11 could trigger payouts of 10–20% of the insured amount for stabilization work such as coral fragment collection and reattachment. Stronger storms at Force 12–13 could release 30–60% to support larger restoration operations. Extremely severe storms at Force 14 or higher could trigger 70–100% of the insured amount, allowing large-scale ecological restoration. These examples illustrate how a stepped payout structure aligns financial resources with the level of reef damage.

Premium

Premium pricing depends on hazard frequency, expected loss, and trigger thresholds. In Vietnam, a complex risk profile driven by typhoons leads to higher premiums, creating a barrier to participation. To address this, the project adopts a blended finance model, combining government subsidies, tourism fees, and private sector contributions.

In the early stage, public funding helps de-risk the project and cover upfront costs. As it matures, the model shifts toward financial self-sufficiency through revenue from tourism and private investment.

Financial stability is reinforced through a multi-layered risk-sharing structure, where risks are first covered by domestic insurers, then transferred to VINARE, and ultimately ceded to the global reinsurance market.

6.3.2. Legal and Financial Architecture

The proposed insurance system requires an institution that can collect funding and distribute payouts quickly after disasters. In Vietnam, this role could be performed by the Provincial Fishery Resources Protection and Development Fund under the Law on Fisheries 2017. The fund can serve as a public–private mechanism that receives contributions from government and private actors while allowing payouts outside the normal State Treasury process (National Assembly of Vietnam, 2017).

Because coral reefs protect coastal infrastructure and support tourism, the State should help finance their protection. Provincial People’s Committees could provide initial funding, while counterpart financing could encourage private sector participation during the early stage (National Assembly of Vietnam, 2015).

Private participation remains essential because tourism operators directly benefit from healthy reefs. Funding could be mobilized through coastal resilience fees and annual contributions from tourism businesses, with all revenues directed toward insurance premiums (Government of Vietnam, 2019).

To improve response speed after storms, the Fund charter should include a parametric trigger clause. Once the agreed wind-speed threshold is confirmed, payouts could be released to restoration teams within five working days, avoiding delays in standard public spending procedures (National Assembly of Vietnam, 2017).

6.3.3. Operational Execution

Financial resources alone are not enough if there is no operational capacity to use them. For parametric insurance to work, payouts must quickly translate into reef restoration. This requires clear roles for restoration teams, data verification authorities, and the institution managing payouts so that funding can be converted into practical actions after storms.

Vietnam should establish specialized reef restoration teams, often called “reef brigades,” within the marine protected area (MPA) system. These teams would conduct rapid reef stabilization after storms. Recruitment can combine divers from local dive centres with members of fishery cooperatives responsible for logistics and vessel operations.

To ensure authority during emergencies, these teams should be integrated into the provincial disaster response system. Members should receive standardized training in coral restoration coordinated by national marine research institutions, ensuring restoration follows scientific guidelines (National Assembly of Vietnam, 2017).

Insurance triggers should rely on objective meteorological indicators instead of underwater damage assessments. Official wind-speed data from the Vietnam Meteorological and Hydrological Administration (VNMHA) would serve as the main trigger source, while satellite data from international agencies could provide cross-verification. This dual-source system improves transparency and trust for international insurers (VNMHA, 2021).

6.4. Limitations and feasibility

The proposed coral reef insurance model has several limitations. First, it is subject to basis risk, a common challenge in parametric insurance. Because payouts are triggered by meteorological indicators such as wind speed rather than direct reef damage, mismatches may occur. Strong winds may activate a payout even when reefs remain largely intact, while damaging wave action may occur without reaching the wind-speed threshold.

Second, the scheme faces financial and legal challenges. Catastrophe insurance premiums are expensive, making sole reliance on government budgets unrealistic. A mixed-financing model involving contributions from tourists and local businesses is therefore necessary. However, legal barriers remain under Vietnam's 2022 Law on Insurance Business, which requires policyholders to demonstrate a direct insurable interest. Since coral reefs are state-owned natural resources, a provincial fund does not legally own them, creating regulatory uncertainty.

Third, the mechanism addresses sudden events such as typhoons but cannot respond to slow environmental processes like coral bleaching caused by rising ocean temperatures.

Fourth, multi-stakeholder coordination among provincial authorities, MPA managers, tourism operators, and insurers may create administrative delays that weaken rapid disaster response.

Finally, limited long-term ecological monitoring data in Vietnam makes it difficult to evaluate the long-term effectiveness of reef restoration after storms.

7. Conclusion

This study shows that coral reefs in Quintana Roo can be viewed as strategic natural infrastructure rather than passive environmental assets. From a Resource-Based View perspective, natural systems that generate sustained economic value and are difficult to substitute can function as strategic resources. In Quintana Roo, coral reefs support tourism competitiveness and provide coastal protection, meaning their degradation represents both ecological loss and erosion of territorial assets.

Within this framework, parametric insurance functions as a liquidity-alignment mechanism. Unlike indemnity insurance, which requires damage assessment, parametric structures use predefined triggers such as wind speed, allowing rapid payouts after extreme weather events. This reduces the time gap between disaster impacts and ecological restoration.

The Quintana Roo scheme integrates environmental finance, tourism revenue, and public-private coordination through a dedicated coastal trust. However, transferring this model to Vietnam depends on institutional readiness, including insurance market capacity, governance

structures, and legal frameworks. Financial instruments alone are insufficient without supportive governance systems.

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